

EXHIBIT L

3.4 REACTOR COOLANT SYSTEM (RCS)

3.4.13 RCS Operational LEAKAGE

LCO 3.4.13 RCS operational LEAKAGE shall be limited to:

- a. No pressure boundary LEAKAGE,
- b. 1 gpm unidentified LEAKAGE,
- c. 10 gpm identified LEAKAGE, and
- d. 150 gallons per day primary to secondary LEAKAGE through any one steam generator (SG).

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. RCS operational LEAKAGE not within limits for reasons other than pressure boundary LEAKAGE or primary to secondary LEAKAGE.	A.1 Reduce LEAKAGE to within limits.	4 hours
B. Required Action and associated Completion Time of Condition A not met. <u>OR</u> Pressure boundary LEAKAGE exists. <u>OR</u> Primary to secondary LEAKAGE not within limit.	B.1 Be in MODE 3. <u>AND</u> B.2 Be in MODE 5.	6 hours 36 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
<p>SR 3.4.13.1</p> <hr/> <p style="text-align: center;">- NOTES -</p> <p>1. Not required to be performed in MODE 3 or 4 until 12 hours of steady state operation.</p> <p>2. Not applicable to primary to secondary LEAKAGE.</p> <hr/> <p>Verify RCS Operational LEAKAGE is within limits by performance of RCS water inventory balance.</p>	<p>72 hours</p>
<p>SR 3.4.13.2</p> <hr/> <p style="text-align: center;">- NOTE -</p> <p>Not required to be performed until 12 hours after establishment of steady state operation.</p> <hr/> <p>Verify primary to secondary LEAKAGE is \leq 150 gallons per day through any one SG.</p>	<p>72 hours</p>

3.4 REACTOR COOLANT SYSTEM (RCS)

3.4.15 RCS Leakage Detection Instrumentation

LCO 3.4.15 The following RCS leakage detection instrumentation shall be OPERABLE:

- a. One containment sump (level or discharge flow) monitor,
- b. One containment atmosphere radioactivity monitor (gaseous or particulate), and
- c. One containment fan cooler unit (FCU) condensate flow rate monitor.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Required containment sump monitor inoperable.	A.1 <div style="text-align: center;"> <hr/> <p>- NOTE - Not required until 12 hours after establishment of steady state operation.</p> <hr/> </div> Perform SR 3.4.13.1.	Once per 24 hours
	AND A.2 Restore required containment sump monitor to OPERABLE status.	30 days

3.4 REACTOR COOLANT SYSTEM (RCS)

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- c. One containment fan cooler unit (FCU) condensate flow rate monitor.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Required containment sump monitor inoperable.	A.1 <u>- NOTE -</u> Not required until 12 hours after establishment of steady state operation. Perform SR 3.4.13.1.	Once per 24 hours
	<u>AND</u> A.2 Restore required containment sump monitor to OPERABLE status.	30 days

EXHIBIT M



OFFICE OF THE SECRETARY

UNITED STATES NUCLEAR REGULATORY COMMISSION WASHINGTON, D.C. 20555

RELEASED TO THE PDR 9/30/92 date initials

September 18, 1992

SMC 10/12-16 76

MEMORANDUM FOR: James M. Taylor, Executive Director for Operations FROM: Samuel J. Chilk, Secretary SUBJECT: SECY-92-223 - RESOLUTION OF DEVIATIONS IDENTIFIED DURING THE SYSTEMATIC EVALUATION PROGRAM

The Commission (with all Commissioners agreeing) has approved the staff proposal in Option 1 of this paper in which the staff will not apply the General Design Criteria (GDC) to plants with construction permits issued prior to May 21, 1971. At the time of promulgation of Appendix A to 10 CFR Part 50, the Commission stressed that the GDC were not new requirements and were promulgated to more clearly articulate the licensing requirements and practice in effect at that time. While compliance with the intent of the GDC is important, each plant licensed before the GDC were formally adopted was evaluated on a plant specific basis, determined to be safe, and licensed by the Commission. Furthermore, current regulatory processes are sufficient to ensure that plants continue to be safe and comply with the intent of the GDC. Backfitting the GDC would provide little or no safety benefit while requiring an extensive commitment of resources. Plants with construction permits issued prior to May 21, 1971 do not need exemptions from the GDC.

The Systematic Evaluation Program (SEP) should be closed. The staff should, however, continue the generic review of the SEP lessons learned and prioritize the issues in the Generic Safety Issue program.

- cc: The Chairman Commissioner Rogers Commissioner Curtiss Commissioner Remick Commissioner de Planque OGC OIG

OC1-5 MO 57

SECY NOTE: THIS SRM, SECY-92-223, AND THE VOTE SHEETS OF ALL COMMISSIONERS WILL BE MADE PUBLICLY AVAILABLE 10 WORKING DAYS FROM THE DATE OF THIS SRM

EXHIBIT N

CRITERION 43 - ACCIDENT AGGRAVATION PREVENTION (Category A)

Protection against any action of the engineered safety features which would accentuate significantly the adverse after-effects of a loss of normal cooling shall be provided.

The intent here was simply to state the criterion in a more positive way.

CRITERION 44 - EMERGENCY CORE COOLING SYSTEM CAPABILITY (Category A)

An emergency core cooling system with the capability for accomplishing adequate emergency core cooling shall be provided. This core cooling system and the core shall be designed to prevent fuel and clad damage that would interfere with the emergency core cooling function and to limit the clad metal-water reaction to acceptable amounts for all sizes of breaks in the reactor coolant piping up to the equivalent of a double-ended rupture of the largest pipe. The performance of such emergency core cooling system shall be evaluated conservatively in each area of uncertainty.

In our opinion, one emergency core cooling system which incorporates a sufficient redundancy of active components and covers the full range of postulated breaks should be adequate. Our modification of this criterion reflects this consensus. For this reason, we have omitted the last sentence of the original criterion.

CRITERION 45 - INSPECTION OF EMERGENCY CORE COOLING SYSTEM (Category A)

Design provisions shall where practical be made to facilitate physical inspection of all critical parts of the emergency core cooling system, including reactor vessel internals and water injection nozzles.

Since inspection of water injection nozzles is not always possible on a reasonably complete and non-destructive basis and since the failure of a safety injection nozzle is assumed in most accident analyses, we have inserted the phrase, "where practical".

CRITERION 46 - TESTING OF EMERGENCY CORE COOLING SYSTEM COMPONENTS (Category A)

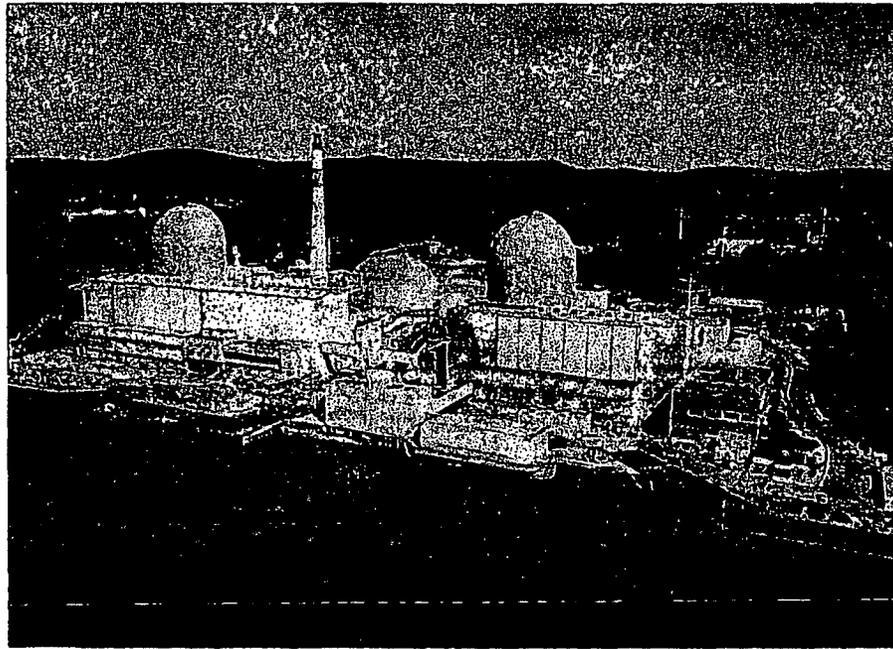
No comment other than the criterion should be presented in the context of a single emergency core cooling system, consistent with the comments offered on Criterion 44.

EXHIBIT O

EXHIBIT P

Indian Point Units License Renewal

Indian Point Unit 1, 2 and 3



Presentation by Karl Jacobs

Background

- **Local Resident of Cortlandt Manor for 18 years**
- **Have never been in the employ of Entergy**
- **20 years of experience with nuclear operations, maintenance, project management, installation of major multi million dollar safety related nuclear and non- nuclear equipment at IP3 that meets the required federal, state and industry accepted codes.**
- **20 years of experience primarily on Indian Point Unit 3 in developing and implementing aging management programs for the Reactor Vessel, Reactor Internals, Pressurizer, Reactor Coolant Piping and Steam Generators etc.**
- **Participated in the License Renewal rulemaking (10CFR50.54a) as IP3 Utility representative and as a Westinghouse Owners Group (PWR NSSS) Subcommittee Chairman, Nuclear Energy Institute (NEI), Electric Power Research Institute and the Nuclear Regulatory Commission**
- **Lead Technical Engineer for the technical and economical studies for Indian Point Unit 3 and James A. Fitzpatrick Nuclear Plant License Renewal evaluations. The IP3 studies were performed for the previous owner are identified.**
 - **License Renewal Comparison of IP3 design, operation and performance characteristics to the Industry Pilot Plant (Surry 1) .**
 - **Life Extension/ License Renewal Program Technical Summary Report**
 - **Cost/Benefit Analysis**

Highlights of the 10CFR 50.54 and revised 10CFR51 Rule

Identification of the License Renewal Components for scoping and screening evaluations and if determined technically that a component does not meet the additional life extension requirements (an aging management programs would be identified for implementation (on –going current licensing basis programs, newly developed and required to be implemented during their license renewal period)

- **This scoping is also to include the identification and evaluation of time limited aging analysis (TLAA)**

Environmental Impact Studies – Opens the door for Cooling Towers to be evaluated and possibly installed in lieu of present Water Cooled Condenser System – The Cooling Towers would help address the zebra mussel issues which are an environmental issue that in the past has plagued the safety related service component and service water cooling systems for IP3 and IP2. (Reduction and possible removal of their chlorination injection program, will also benefit the Hudson River.)

Identify and /or develop aging management programs of the components that are identified through the screening process for managing aging effects and address TLAAs

Emergency Planning and Security is not part of the 10CFR50.54 and revised 10CFR50.51 rule and needs not to be addressed under License Renewal Application

Indian Point Unit 1 License Renewal Scoping Issues

The license renewal application (LRA) is for IP2, IP3 and shared systems with IP1

A review of the scoping of components in the LRA the does not identify Indian Point Unit 1 Containment structure and spent fuel systems and their support systems as being part of the License Renewal Application. See LRA Section 2.4.1 Describes only Unit 2 and Unit 3 Vapor Containment Structure. Unit 1 containment structure is omitted.

Per the License Renewal Application for IP2 and IP3 under containment scoping and screening review in section 2.4.1 page 2.4.-2 state “the containment buildings have the following intended functions for 10CFR54.4(a)(1), (a)(2) and (a)(3).”

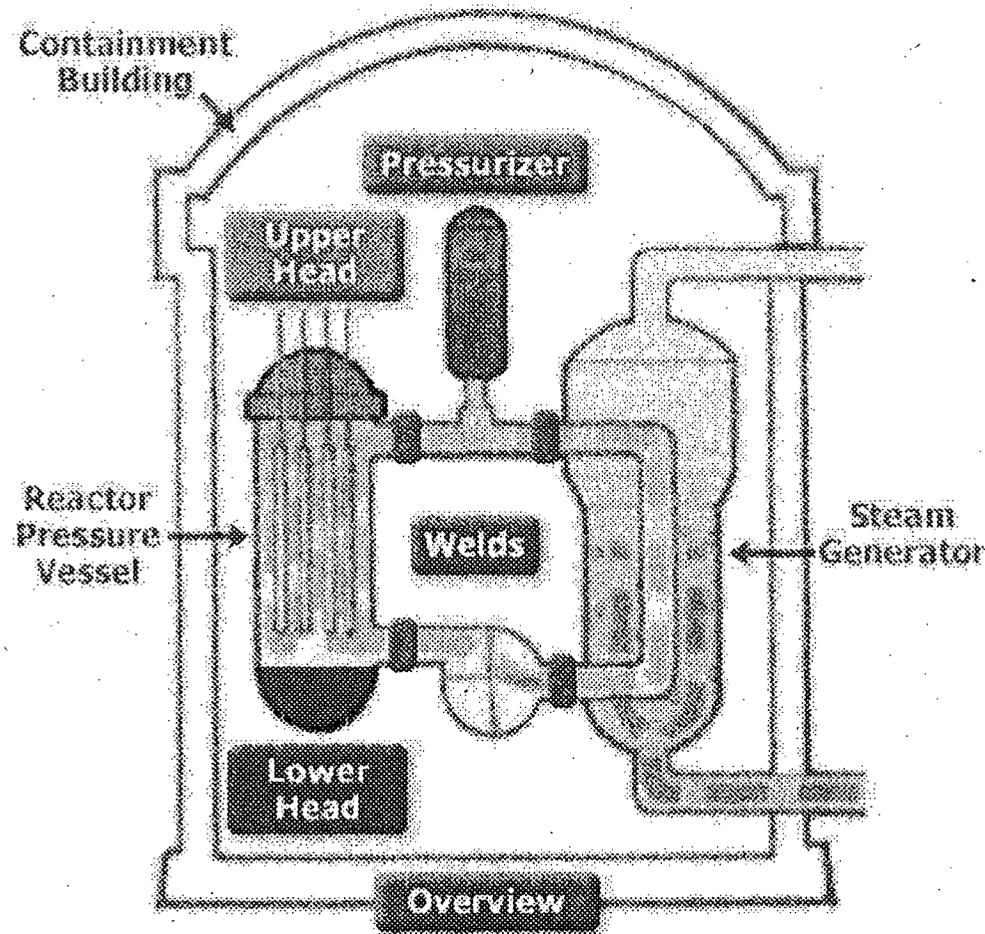
- Provide support, shelter and protection for safety- related equipment**
- Maintain essential leak tight barrier**
- Maintain integrity such that safety –related equipment is not affected.**

Indian Point Unit 1 License Renewal Scoping Issues

Indian Point Unit 1 supports the spent fuel cooling system is located in the containment structure. IP Unit 1's containment performs intended functions as defined by the License Renewal rule function above. In addition other scoping of license renewal scoping and screening systems are inside the containment structure that have been excluded are spent fuel pools structures; HVAC filtration for radioactive airborne particulates, containment penetrations, spent fuel pool system cooling piping and their supports, spent fuel cooling pumps, instrumentation for monitoring the operations of the spent fuel system, electrical wiring, spent fuel bridge, cranes and radiation monitors etc.

With the Entergy IPEC LRA allowing for IP Unit 1 shared components to be included in their application has opened a doorway to allow for a full scoping and screening of IP Unit 1 systems and components to protect the health and safety of the public

IP2 and IP3 Typical RCS Integrity Boundary



Reactor Vessel and Reactor Internals Typical to IP2 and IP3

**Westinghouse
Nuclear Steam
Supply System
Designer and
Fabricator of
Reactor Internals**

**Combustion
Engineering is the
Reactor Vessel
Fabricator**

**IP2 RPV Construction
Code – ASME Section
III 1965 Edition**

**IP3 RPV Construction Code
– ASME Section III Edition
Winter 1965 Addenda**

Reactor Vessel (RPV)

- **Reactor Vessel Major Intended Functions**

- **Maintain the reactor pressure boundary**
- **Support and contain the reactor core and core support structures**
- **Support and guide reactor controls and instrumentation**
- **Contain the reactor coolant around the reactor core and direct the coolant flow into the core and out into the reactor coolant piping and upper head**
- **Interface with the RPV supports to provide a load path to the structural concrete**

- **Subcomponents subject to an aging management review**

- **All of its subcomponents are passive, and only two of the subcomponents do not require an aging management.**
- **There are only two subcomponents that do not require an aging management review. The RPV O-Rings, O-ring leak monitoring tubes and the refueling seal ledge do not support any RPV intended function**

Reactor Vessel (RPV)

- For RPV neutron embrittlement is a critical aging management failure mechanism issue that must be accurately evaluated for License Renewal for both IP2 and IP3 reactor vessels.
- This IP3 reactor vessel has a projected RTndt value that would have exceeded the 10CFR50 Appendix G criteria during life extension if the criteria was not revised by the NRC
- For IP3 the lower shell plate (B2803-3) is the limiting RPV plate material.
- The projected RTpts for this same lower shell plate is very close to the 10CFR50 Appendix G criteria for the end of license renewal. With augmented aging management programs being implemented which are low leakage fuel management for neutron flux reduction, significant expansion of the reactor vessel surveillance capsule monitoring program, implement research and development programs on material crack initiation and crack growth with similar low fracture toughness' properties, along with a higher frequency of volumetric examinations of the RPV beltline than the present frequency requirements of ASME Section XI and Regulatory Guide 1.150 the RTpts may be successfully managed to meet life extension.
- For the same plate, the projected upper shelf fracture toughness energy for 60 calendar years is less than 10CFR50, Appendix G minimum criteria of 50- ft-lbs. This is a critical issue, that Entergy will need the NRC's assistance in a 10CFR50 Appendix G rule change to revise the criteria to a lower threshold value. This plate was originally installed with an initial +74 RTndt value. This was a fabricator miscue to allow the original installation of a shell plate in the Reactor Vessel Beltline with a +74 RTndt material property value to be installed. The plates that are installed in reactor vessels should have minimum initial Rndt value of zero or a minus value to support Reactor Vessel longevity.

RPV

- **The IP3 Reactor Vessel's lower upper shelf energy (a physical/mechanical properties of the RPV vessel wall) is a major concern for its lower shell plate B-2803-3. This plate material will not meet 10CFR50 Appendix G "Fracture Toughness Requirements" for license renewal. This plate is predicted to fall well below the 50 ft-lbs as measured by Reactor Vessel Surveillance Capsules charpy v –notch specimen testing.**
- **IP3 has two alternative approaches which are not even mentioned.**
 1. **An analysis is performed that conservatively demonstrates, making appropriate allowances for all uncertainties, the existence of equivalent margins of safety for continued operation. The margins against fracture must be equivalent to those required by the ASME Code, Section III, Appendix G**
 2. **Additional evidence of the fracture toughness of the beltline materials after exposure to neutron irradiation may be obtained from results of supplemental fracture toughness tests. The problem with this approach is the IP3 Reactor Surveillance Program remaining capsule specimens do not have the limiting plate material B2803-3 in any of this capsules. The statement made by Entergy in the license renewal application Section B.1.32,titled (Reactor Vessel Surveillance) page B-112 under the described enhancements that "The specimen capsule withdrawal schedules will be revised to draw and test a standby capsule to cover the peak reactor vessel fluence expected through the end of the period of extended operation."**

RPV

- **The IP Unit 3 RPV has an on going aging management program called reactor vessel surveillance capsule monitoring program that is in effect for its current licensing basis and does an extra capsules installed in the reactor vessel for life extension. The limiting plate material (B2803-3) as does not have any material in the remaining capsules to monitor the lower shell plate. This also will have a significant effect on their heat and cool down curves which are developed from the most limiting vessel plate material.**
- **The IP3 RPV materials has been volumetric examined (ultrasonic techniques) thoroughly every ten years from initial operation and no reportable indications were found. The volumetric equipment used for these inspections are very good, use a array of ultrasonic transducer probes, with high detection capabilities, sizing and locating any flaws are also very good. Please note that the RPV beltline is 100% inspected but access to allow for 100% of all RPV welds volume is not achievable do to interferences.**
- **Bottom line IP3 reactor vessel beltline plate material absolutely does not support license renewal unless the NRC revises 10CFR50 Appendix G requirement of maintaining a higher USE value of 50 ft –lbs for its belt line material**

RPV

Present Industry Events and experiences has identified that the IP2 and IP3 Reactor Vessels' Heads must be replaced prior to life extension. This is a generic industry concern for the Westinghouse Reactor Vessel Heads' penetration tube welds that started in September 1991 @ the Bugey Unit 3 PWR nuclear plant in France. Then in May 1992 Ringhals Unit 2 , a Westinghouse- designed PWR –in Sweden found a 25 % around through wall crack in the CRDM penetration. Then it came to America. 1995 DC Cook Unit 2 (Westinghouse design) a crack measured as the deepest point of 6.88mm, 25% around the CRDM tube wall. VC Summer Plant was next, then Ringhals 3 and 4 in June 2001, then Oconee and an Entergy Plant ANO-1. NRC Bulletins have been issued.

- **NRC Bulletins 2001 –01 Circumferential Cracking of Reactor Pressure Head Penetration Nozzles**
- **NRC Bulletin 2002-01 Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity**
- **NRC Bulletin 2002-02 Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs**

- **Entergy LRA response – Intend to use ASME Section XI, Sub Section IWB Inservice Inspection and Water Chemistry Control Programs. Detection of Cracking is accomplished through implementation of a combination of bare metal visual examination (external surface of head) and non-visual examination (underside of the head) techniques.**
- **Entergy has not realized as a company that safety and lowering the risk to public health comes first not economics This is real cracking issue that many same design plants are experiencing now! This cracking can lead to a control rod missile ejection followed with a small break loca. This failure would permanently shut IPEC down!**
- **Reactor Coolant Supports are located in a difficult to access area and limits inspection capabilities. Reactor Coolant Supports can corrode since the are serviced with cooling water. A inspection program to fully assess these reactor supports and cooling system requires a definitive aging management program.**

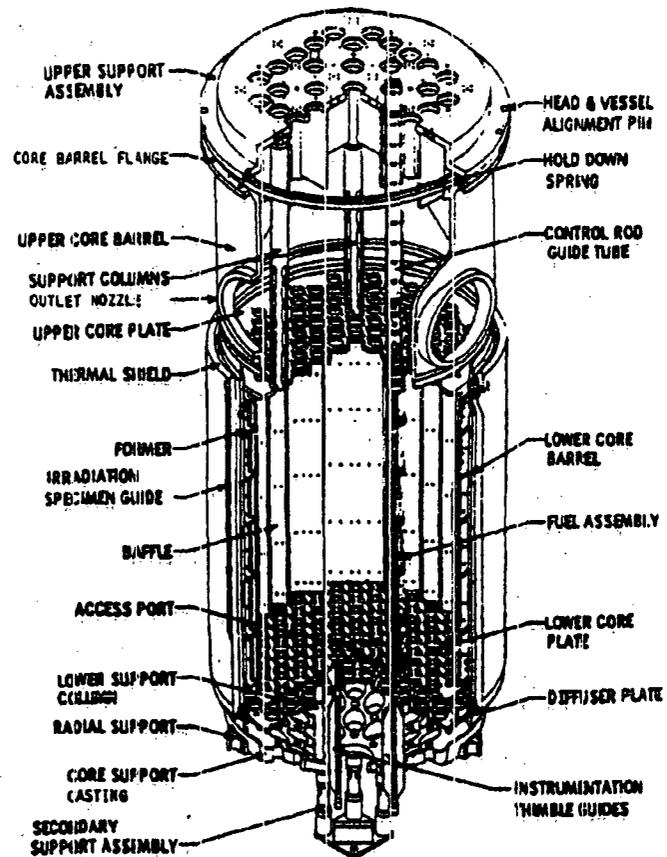
PZR

- **Aging Degradation mechanisms for the IP 2 and IP3 Pressurizers are so significant that replacement is the only option for License Renewal. Some Highlights**
- **The pressure boundary materials of the Pressurizer are susceptible to Primary Water Stress Corrosion Cracking (PWSCC)**
 - ❖ **The pressurizer has Inconel 82/182 weld metal in pressurizer safety, relief, spray and surge nozzles which is susceptible cracking due to PWSCC**
- **The pressure boundary materials of the Pressurizer have significant end of life fatigue issues that will not meet life extension time frame**
 - ❖ **Fatigue of the upper portion of the pressurizer shell (44 years), the spray nozzle(49 years), the manway bolts (46 years), the seismic support lugs(41 years), lower head (due to insurge/outsurge transients), the heater wells (due to insurge and outsurge transients), the surge nozzle, the support skirt and flange (skirt -to-lower-head weld 54 years).**
 - ❖ **Then when you impose the NRC environmental effect to the fatigue calculations the list gets longer. Lower head (42 years), the safety and relief nozzles (53 years) and instrument nozzles (51 years)**
 - ❖ **This is back up by the NRC Final Safety Evaluation Report on the Acceptance for Referencing of a Generic License Renewal Program Topical Report by the Westinghouse NSSS Vendor "License Renewal Evaluation: Aging Management Evaluation For Pressurizers" dated October 26, 2000**
 - ❖ **Aging Management Program 2.3 needs to be imposed. This states that if the TLAA can not show acceptable usage for the license renewal period, the fatigue adequacy will be met by implementing a repair and replacement program in accordance with ASDE Section XI IWA- 004000 or IWA-7000**
- **NRC has issued a Final safety Evaluation Report for "Acceptance for referencing of Generic License Renewal Program Topical report entitle, "License Renewal Evaluation Aging Management Evaluation for Pressurizers" WCAP-14574 Revision 0, July 1996**

Reactor Vessel Internals

- **Aging Management Evaluation for Reactor Internals – WCAP –14573**
- **WCAP –14573 was submitted to the NRC by the Westinghouse Owners Group for IP unit 2 and Unit 3 and received a NRC Safety Evaluation Report accepting this WCAP to support License Renewal**
- **Reactor Vessel Intended Functions**
 - **Ensuring the capability to shut down the reactor and maintain it in a safe shutdown condition**
 - **Providing (Non – Safety Related) intended Functions that support the function listed above**
 - **Ensuring the integrity of the reactor coolant pressure boundary (Bottom Mounted Instrumentation Flux Thimbles Only)**

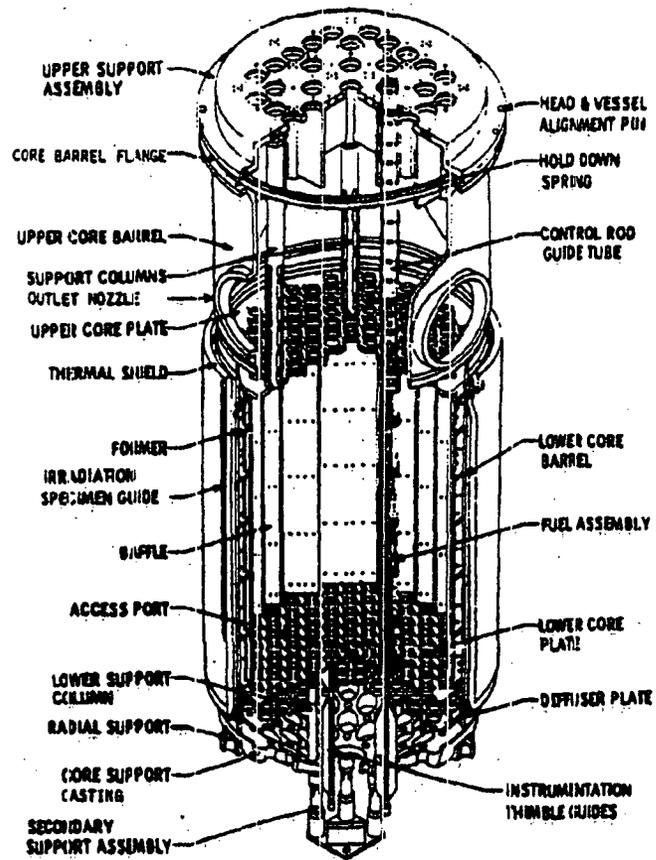
Reactor Vessel Internals



AGING MECHANISMS CONSIDERED

- IRRADIATION EMBRITTLEMENT
- STRESS CORROSION CRACKING
- IRRADIATION-ASSISTED STRESS CORROSION CRACKING
- EROSION and EROSION/CORROSION
- CREEP/IRRADIATION CREEP
- STRESS RELAXATION
- WEAR
- THERMAL AGING
- CORROSION
- FATIGUE
- SWELLING

Reactor Vessel Internals



SUMMARY OF REACTOR INTERNALS SUBCOMPONENTS REQUIRING AGING MANAGEMENT REVIEW

Part or Subcomponent	Aging Management Review Required?
Lower core plate and fuel alignment pins	YES
Lower support forging or casting	YES
Lower support columns	YES
Core barrel and core barrel flange	YES
Radial support keys and keys inserts	YES
Baffle and former plates	YES
Core barrel outlet nozzle	YES
Secondary core support	YES
Diffuser plate	YES
Upper support plate assembly	YES
Upper core plate and fuel alignment pin	YES
Upper support column	YES
Guide tube and flow downcomers	YES
Upper core plate alignment pin	YES
Holddown spring	YES
Head and vessel alignment pins	YES
Control rod	NO
Drive rod	YES
Neutron panels/thermal shield	YES
Irradiation specimen guide	YES
BMI columns and flux thimbles	YES
Head cooling spray nozzles	YES
Upper instrumentation column, conduit, and supports	YES
Mating device	YES
Bolts and locking mechanisms	YES
Specimen plugs	YES

Reactor Vessel Internals

The following actions are needed for reactor vessel internals life extension as a minimum.

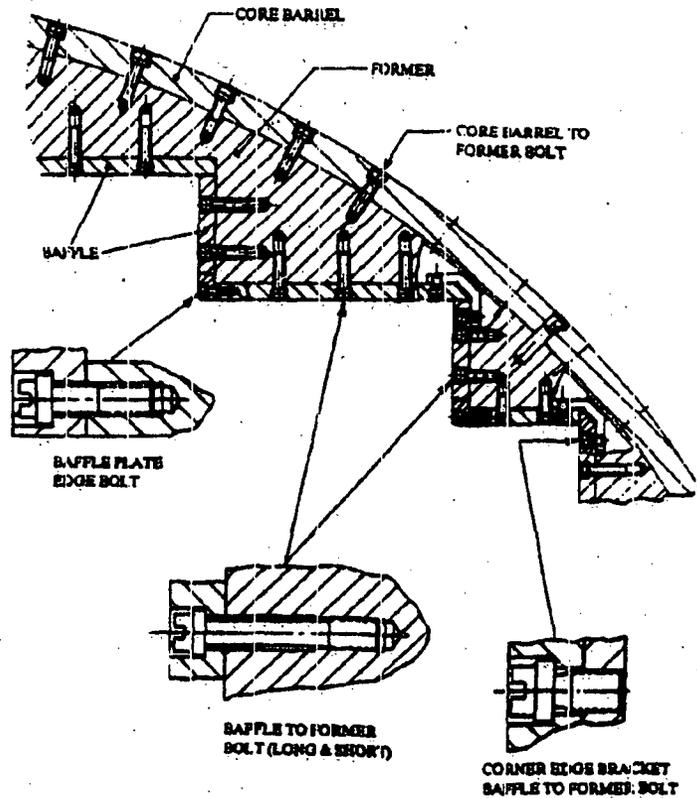
1. Control Rods Replacement for both Units 2 & 3
2. Specific fatigue monitoring programs for numerous Reactor Vessel Internals parts that are fatigue sensitive.
 1. Baffle Former Bolts
 2. Barrel Former Bolt
 3. Lower Core Plate
 4. Lower Support Plate
 5. Radial Key Weld
 6. Core Barrel Nozzle Weld
 7. Guide Tube/flow downcomers
 8. Upper support plate assembly

Note these fatigue sensitive parts as calculated do not include the NRC request to include environmental effects.

3. Replacement Program for Baffle Former Bolts as a Lead Indicator for the other plant and for managing Barrel Former Bolts aging degradation. Cracked Baffle Bolts have already been replaced at Point Beach Unit 2 and RC Ginna Nuclear Power Plant in upstate New York.
4. Wear Management program for BMI flux Thimbles; Upper core plate alignment pins; radial keys and clevis inserts Per Commitments to NRC I&E Bulletin 88-09
5. Split Pin Replacement for Unit 2 with flexure modification to flexure less insert . with split pin replacement results from Unit 2, the results could be a lead indicator for Unit 3 aging management for split pins. This is only to be considered for mitigating the consequences of loose parts in the Reactor Vessel, Reactor Internals, and protection of the Steam Generators' tube sheet.

Reactor Vessel Internals

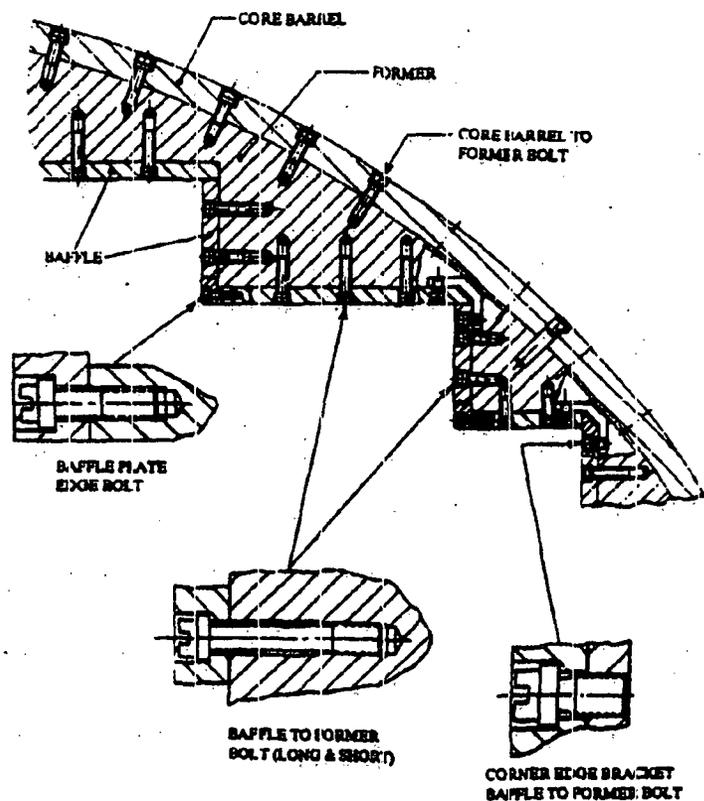
ADDITIONAL ACTIVITIES AND PROGRAM ATTRIBUTES FOR AGING MANAGEMENT OF BAFFLE/FORMER BOLTS (AMP-4.6)



Attribute	Description
Scope	Effects of cracking caused by fatigue, irradiation-induced changes in material properties, and irradiation-induced changes in stresses
Surveillance Techniques	<ul style="list-style-type: none"> Visual inspection per Examination Category B-N-3 of ASME Section XI, Subsection IWEI and Draft Subsection IWG Loose parts detection monitoring system Chemistry RC detection system Augmented inspections (e.g., ultrasonic inspections)
Frequency	<ul style="list-style-type: none"> Monitor with loose parts detection system Monitor with RC chemistry detection system ASME Section XI requirements, IWB-2410, -2411, -2412, -2420, -2430 and Draft IWG-2410, -2420, and -2430 Perform sample baseline inspections prior to LR term with enhanced frequency in accordance with corrective actions
Acceptance Criteria	<ul style="list-style-type: none"> Acceptable RC chemistry per technical specifications and No loose parts from baffle/former bolt assembly and Fatigue management program in Figure 4-1 and Number of acceptable bolts and location \geq the minimum number and location required to maintain core coolability and departure from nucleate boiling ratio (DNBR) within CLB limits, or if needed, for justification of continued operation (JCO), number of acceptable bolts and location \geq JCO assumptions
Corrective Actions	<p>The following courses of action depend on the bolt condition determined by the monitoring and inspection programs:</p> <ul style="list-style-type: none"> Supplemental examinations, analytical justifications or repair/replacement when relevant conditions are detected Visual inspections, baffle gap measurements, augmented inspections (e.g., ultrasonic inspections), analytical justifications or repair/replacement when baffle/former bolt assembly loose parts are detected Fuel inspections, visual baffle plate inspections, baffle gap measurements, augmented inspections (e.g., ultrasonic inspections), analytical justifications or repair/replacement when RC chemistry limits are violated Adjustment of frequency of inspections and coverage Analysis (e.g., fracture mechanics techniques, risk-based technology, advanced thermal/hydraulic methodologies) Bolt replacement of a sample set so the existing bolts with indications may be analyzed (materials testing) and the new bolts monitored Follow actions prescribed in fatigue management program
Confirmation	<p>Acceptable performance per:</p> <ul style="list-style-type: none"> Loose parts monitoring and RC chemistry programs Augmented examinations (e.g., baffle gap inspections, ultrasonic examinations) Analytical justification

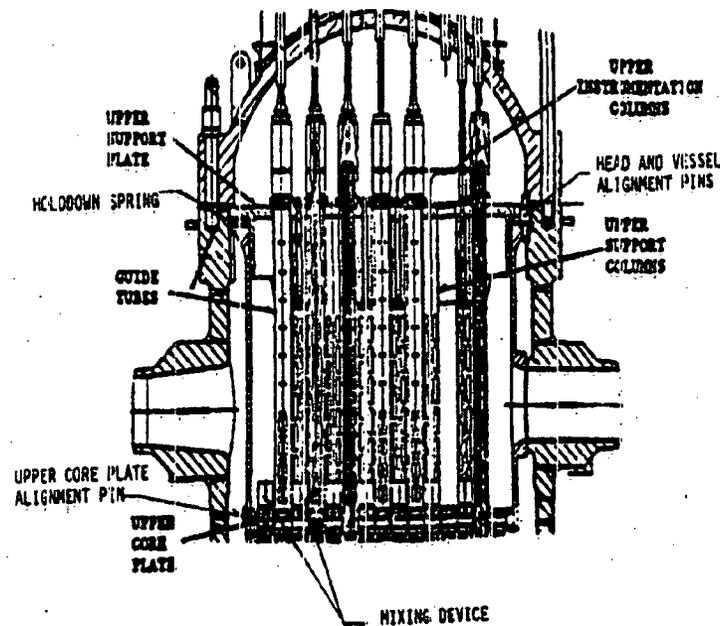
Reactor Vessel Internals

ADDITIONAL ACTIVITIES AND PROGRAM ATTRIBUTES FOR AGING MANAGEMENT OF CORE BARREL/FORMER BOLTS (AMP-4.7)



Attribute	Description
Scope	Effects of cracking caused by fatigue, irradiation-induced changes in material properties, and irradiation-induced changes in stresses
Surveillance Techniques	<ul style="list-style-type: none"> Visual inspection per Examination Category B-N-3 of ASME Section XI, Subsection IW/B and Draft Subsection IWG Loose parts detection monitoring system Augmented inspections
Frequency	<ul style="list-style-type: none"> Monitor with loose parts detection system ASME Section XI requirements, IWB-2410, -2411, -2412, -2420, -2430 and Draft IWG-2410, -2420, and -2430 Perform sample baseline inspections prior to I.R term with enhanced frequency in accordance with corrective actions
Acceptance Criteria	<ul style="list-style-type: none"> No loose parts from barrel/former bolt assembly and Fatigue management program in Figure 4-1 and Number of acceptable bolts and location \geq the minimum number and location required to maintain core coolability and DNBR within CLB limits, or, if needed, for JCO, number of acceptable bolts and location \geq than JCO assumptions.
Corrective Actions	<p>The following courses of action depend on the bolt condition determined by the monitoring and inspection programs:</p> <ul style="list-style-type: none"> Supplemental examinations, analytical justifications or repair/replacement when relevant conditions are detected Visual inspections, augmented inspections (e.g., ultrasonic inspections), analytical justifications or repair/replacement when barrel/former bolt assembly loose parts are detected Adjustment of frequency of inspections and coverage Analysis (e.g., fracture mechanics techniques, risk-based technology, advanced thermal/hydraulic methodologies) Bolt replacement of a sample set so the existing bolts with indications may be analyzed (materials testing) and the new bolts monitored Follow actions prescribed in fatigue management program
Confirmation	<p>Acceptable performance per</p> <ul style="list-style-type: none"> Loose parts monitoring program Augmented examinations (e.g., ultrasonic examinations) Analytical justification

Reactor Vessel Internals



Upper Head Aging Parts that require Aging Management Efforts

- **Guide Tubes (Guide Tubes) – Wear**
- **Control Rods – Wear, Cracking -**
- **GT Flexure Replacement for IP Unit 2- Original Flexures are susceptible to SCC**
- **Split Pins – Stress Corrosion Cracking**

**UNITED STATES
NUCLEAR REGULATORY COMMISSION**

In the Matter of)
ENTERGY NUCLEAR INDIAN POINT 2, L.L.C.) Docket No. 50-247
and ENTERGY NUCLEAR OPERATIONS, INC.) License No. DPR 26
Indian Point Entergy Center Unit 2)
License Renewal Application)

**FIRST DECLARATION OF ULRICH WITTE
Review of Contentions 1 - 5**

1. My name is Ulrich Witte. The "Friends United for Sustainable Energy" (FUSE) has retained me as a consultant with respect to the above-captioned proceeding. I am a mechanical engineer with over twenty-six years of professional experience in engineering, licensing, and regulatory compliance of commercial nuclear facilities. I have considerable experience and expertise in the areas of configuration management, engineering design change controls, and licensing basis reconstitution. I have authored or contributed to two EPRI documents in the areas of finite element analysis, and engineering design control optimization programs. I have led industry guidelines endorsed by the American National Standards Institute regarding configuration management programs for domestic nuclear power plants. My 26 years of experience has generally focused on assisting nuclear plant owners in reestablishing fidelity of the licensing and design bases with the current plant design configuration, and with actual plant operations. In short, my expertise is in assisting problematic plants where the regulator found reason to require the owner to reestablish competence in safely operating the facility in accordance with regulatory requirements. My curriculum vitae is attached hereto as Attachment A.

2. I submit the following comments in support of Contentions 1-5; The Applicant violated the Administrative Procedures Act in bypassing the Code of Federal Regulations (CFR) and instead used *trade* guidance for Indian Point 2 as opposed to the General Design Criteria for current design, and the current operating license with regard to the Applicant's LRA for an additional 20 years of operation

With more than 26 years in licensing, design engineering control, configuration management. Establishing the legal ground for what Indian point 2 received its original operating license against should be straight forward in particular given the 64 design criteria that provide the fundamental framework. Essentially every other element of safety hinges on respect for the licensing and design basis, and compliance with the law, and lawful operation of the facility. One would think one could simply examine the SER, along with the rest of the CLB circa the original operating license granted and find transparent the records for design basis, construction, licensing conditions, maintenance and safe operation of the plant.

After careful examination of the facts, as represented in the table of events, it appears that just the opposite is true. Applicable rules as found in 10 CFR are not followed, and in fact it appears the applicant and the regulator are doing the opposite routinely. Bypassing the core protection provided to the public under the Administrative Procedures Act.

The past and present owners of Indian Point have failed for forty years to ensure that the nuclear reactor(s) are in compliance with regulations established by the US Nuclear Regulatory Commission to ensure public health and safety.

In its application for a 20-year license extension, Entergy has misrepresented the official record of the Federal Register to give a false appearance of compliance with

regulations. In fact, the reactor has been out of compliance since it was granted its original operating license 40 years ago.

The License Renewal rule requires the applicant to identify which set of rules and regulations the reactor complies to (NRC regulations have been changed and updated several times since the 1960's.) However, the Applicant and the NRC are unable or unwilling to state which regulations are applicable to Indian Point.

The Nuclear Regulatory Commission has failed in its responsibilities by allowing Indian Point to operate under a set of "guidelines" proposed forty years ago by an industry lobbying group, but never approved by the NRC's mandatory "rule-making" process.

In its application for license extension, Entergy has failed to describe aging programs for the reactor's systems. Instead, they have "promised" compliance at some future date and time—after license renewal approval. This is a clear violation of the NRC's mandated procedures for license renewal. Indian Point 2 has serious environmental issues with spent fuel pool leaks, and radioactive leaks from underground piping that have not been addressed in their license renewal application.

The results of this are painfully obvious. A plant that experienced a design basis event tube rupture, spent fuel pools leaking, and pipes leaking. The most recent leak is cited under contention x, and was reported only a few weeks ago. The establishing of and maintaining of the design basis is impossible, when the core general design criteria are simply set aside.

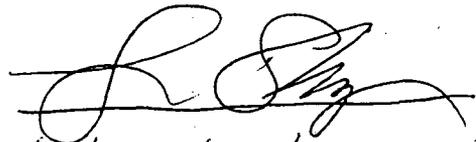
Renewal of the license with the comingling of an administrative court (the NRC), and the rulemaking function of the NRC, should successfully establish the clear mandate

to the licensee that laws protecting the health and safety are supposed to be followed. Not
by passed.

I cannot endorse relicensing the Indian Point Unit 2 facility based upon the record
and the facts of the shameful record of construction, management, and oversight of the
plant.



Ulrich Witte



Witnessed and sworn to
before me on this 21st
day of September, 2007

Ulrich K. Witte

71 Edgewood Way
Westville, Connecticut 06515
Home: 203 389 7374
Office: 860 577 8077
Mobile: 860 391 1183

Summary:

Over twenty-six years' of professional experience in engineering, configuration management, licensing, regulatory compliance of large scale commercial nuclear facilities. This includes management and implementation of design change control programs, engineering standards programs, multi-department/multi-functional licensing initiatives, plant design basis and engineering process improvement programs for six energy companies operating seven nuclear power plants. Responsibilities include:

- Systems solutions to plant operations, engineering modifications, safety analyses, design changes, installation and testing, software, drawing change programs, and training. Optimized function interfaces to insure proper coordination and synchronization for cost effective and compliant operation of the facility.
- Technical support management, and issue resolution programs that identified potential hardware, operational or equipment function issues, as well as document problems, data management problems and organizational enhancements
- Engineering Change Processes from change inception to document close-out
- Multi-department Configuration Management Program including technical approach, consensus, approval, and implementation. Managed a standing Configuration Management Programs Group whose goal was to integrate ten functional areas under a corporate strategic plan encompassing two nuclear facilities.
- Vertical slice system design/operation reviews, design bases / regulatory rule reconciliation, and licensing bases reconstitution and transitioning projects
- Integration of plant equipment information systems with business processes within engineering, materials management, maintenance, and plant operations.
- Structured business process modeling. Application of functional analysis purely from a data prospective—to enhance change management, efficiency.
- Chaired ANSI certified industry guidance on cost effective, compliant, and institutionalized programs for successful configuration management enhancement
- EPRI guidance on optimizing the Engineering Change Process
- Formal training to engineering department personal with specific courses on the engineering change process, plant safety analysis, and modification testing. Trained engineering personal on the requirements of the plant wide Configuration Management Program.

Technical Consultant

Northern Lights Engineering, L.L.C., 71 Edgewood Way, Westville, Connecticut 06515 (May 2002 –Today)

Established a consulting practice where I provided expertise in matters affecting the safe operation and regulatory compliance of commercial nuclear power facilities. This includes licensing and regulatory compliance issues, modification and implementation of industry standards, engineering design reviews, and configuration management analysis associated with an unexpected event, a design failure, or an elevated risk condition, and includes review of proposed changes to the plant operating license in preserving design efficacy.

Technical Advisor and Expert Witness to the law firm of Shems, Dunkiel, Kassel, & Saunders, PLLC

Currently providing technical assistance in prefiled testimony regarding Entergy Nuclear Operations application for renewing the operating license of Vermont Yankee. This includes Aging Review Program, in particular flow-accelerated corrosion issues, and finite element fatigue analysis reviews of susceptible components and a number of other contentions related to the safe operation of the plant beyond its 40 year license at 120% of originally design power.

Technical Advisor, to the law firm of Leroche, Meyers, and Conswel, LLP.

Provided licensing and regulatory compliance expertise in legal claim and derivative action by the board of directors of the First Energy Corporation against its corporate officers in their role associated with the Northeast black out of August 2003, and the mismanagement of the Davis Besse Nuclear Power Plant.

Technical Advisor to the Union of Concerned Scientists

Provided technical review of UCS analysis of the Davis Besse reactor head corrosion event. This included analysis of the loss of integrity of the reactor vessel, and the immediacy of the reactor head failure.

Senior Scientist, Dominion Resources Inc, Millstone Station:

P.O. Box 128, Waterford, Connecticut 06385-0128 (December 1996 – 2002)

Project Manager, Licensing Commitments. Established the Regulatory Commitment Management Program. Developed a program that established senior management and department level control of more than 30,000 licensing commitment that was previously broken. The substantially enhanced program captured, dispositioned, consolidated, and managed implementation of docketed commitments to the NRC. Status, responsibility and clear communication were successfully implemented to allow Millstone to successfully restart Units 2 and 3.

The effort required substantial procedure revisions, customer consensus building, and integration of separate free-standing department specific database applications, as well as the station wide action item tracking system. A near term deliverable necessary for the successful restart of Unit 3 was to provide a workable, compliant and functioning regulatory commitment management program.

Project Manager, 50.54(f) Licensing Bases Transition Project. I led a team of 14 individuals to disposition and validate approximately 5100 regulatory commitments necessary for restart of Unit 3. The effort has led to a quality rate of more than 98 percent with production average of about four hours per commitment.

Manager, Configuration Management Program, New York Power Authority:

123 Main Street, White Plains New York 10621, Nuclear Generation Department, Engineering Division
(November 1991 - November 1996)

Established the Configuration Management Program for the New York Power Authority's nuclear facilities. Included are 10 functional areas and integrated controls as authored in the corporate strategic plan. Management functions and technical skills include the following:

- Established Configuration Programs Group. This group and my position were established as a result of INPO Plant Evaluation calling for configuration management enhancement, and resolution of design control issues identified by the NRC in their DET Inspection of 1991 of the FitzPatrick Plant, as well as independent assessments. Recruited permanent staff, and supplemented the group with contracted staff on as needed basis to support both plants.
- Modified the engineering change process. Areas of immediate attention included the Design Control and Modification Programs, where a series of working groups were established to correct technical content and improve quality, ownership, and business efficiency of the design change process. This effort was achieved via: (1) a formal process to assess, model, and enhance the design change and modification process and interfaces to key functions; and (2) immediate changes to engineering procedures.
- Assessed and enhanced the Plant Equipment Data Base and controls for each plant. Results of the assessment indicated that the IP3 Plant Equipment Database contained significant problems with component classification, equipment type and status, maintenance history etc. Prepared and implemented a recovery plan and project team to reestablish the controls and content of database to be compliant with NRC Generic Letter 83-28 and to support the plant restart. Streamlined and enhanced the component classification process for both plants. Established controlled and non-controlled segregation of plant equipment in accordance with recent EPRI guidance.
- Automated and validated existing fragmented and corrupt sources of engineering information. These data sources were compiled, validated, and controlled and included multi-department areas such as set point controls, Electrical Cable and Raceway Information Systems for JAF and IP3, along with the fuse controls and data management.
- Developed design basis problem resolution process, "Design Document Open Item". Established methods for prioritizing, tracking and closing out design document issues. Established proper interface and control room notifications as per tech spec requirements. Provided guidance on operability determinations and reportability. Provided oversight for classifying and tracking more than 1100 open design issues for IP3 and 300 for JAF. Defended program to the NRC.
- Established working groups between Nuclear Generation Department and the corporate wide Information Management Organization. Gained management endorsement for areas of data quality improvement and automation for the Nuclear Generation Department. This led to enhanced implementation of the equipment information systems for both sites.

Project Manager, Program to Assure Completion and Quality, Tennessee Valley Authority:

(December 1990 - March 1991) Under contract by CYGNA Energy Services to the Vice-President, Engineering and Operations Department, Watts Bar Nuclear Plant.

- Developed a comprehensive plan to measure progress and confirm quality of the in-progress design evolution of the plant. Developed a methodology for linking specific plant equipment to that equipment's respective design basis (and associated design attributes); license commitments; and numerous verification programs currently in place. The five phase program was presented to NRR in January and received approval as an activity to assist TVA in removing the stop work order on construction of the facility.

Technical Manager, Configuration Management Program, Southern Nuclear Operating Company:

(December 1988 - November 1991). Under contract by ABB Impell and CYGNA Energy Services to Corporate Engineering Manager, Edwin I. Hatch Nuclear Plant, Georgia Power Company.

- Established and implemented the Hatch Configuration Management Program. Phase one of the effort included definition, establishment of management objectives, specification of the configuration management program scope and development of a reference manual.
- Developed and executed formal rigorous horizontal evaluations (the second phase of the project) of each relevant functional area including engineering design, implementation, plant operations and maintenance, procurement, information systems, document control and others. The program integrates functional areas across the plant, each architect engineer, and corporate (SONOPCO and Southern Company Services) organizations.
- Implemented enhancements to the program. This phase includes upgrading the design change process to achieve successful integration across organizations; stricter adherence to closure activities; and formal design engineering involvement in such activities as procurement of replacement items (equivalency). Additional controls were established such that misapplication of information obtained through informal design change processes such as the "Request for Engineering Assistance".
- Reconciling the plant's design basis. A second major activity of the program was to compile, consolidate, and ultimately, automate the plant's design basis. A major objective is to provide access and retrievability of current design basis to each of the key users of each participant organization.
- Applied Structured Business Analysis including CASE tools in the evaluation and enhancement phases. The as-found configuration management activities of all relevant processes were modeled and analyzed with this technique. Proposed enhancements are then tested on the model prior to actual implementation.
- Chaired the subcommittee for the Nuclear Information and Records Management Association which is developing a Technical Position Paper entitled, "Implementation of a Configuration Management Enhancement Program for a Nuclear Facility".

Team Leader, NRC Safety System Functional Inspection Response Organizations:

Led the NRC Safety System Functional Inspection Response Teams for Georgia Power Company (1989), and Sacramento Municipal Utility District (1987). Assisted as team coordinator in the GPC - Plant Hatch Electrical Distribution System Functional Inspection Response Team (1991). Under contract by ABB Impell (December 1987 - November 1990) to the site Engineering Manager, Rancho Seco, SMUD. and CYGNA Energy Services (December 1990 - November 1991) to the Corporate Engineering Manager, Edwin I. Hatch Nuclear Plant, Georgia Power Company.

- In the case of GPC, the NRC SSFI resulted in validation of the in progress implementation of the Hatch Configuration Management Program, and only one violation to the licensee.
- The effort included an SSFI self-assessment as well as managing the utility through the NRC inspection.
- For SMUD, developed and executed a plan for closure of both immediate findings and long term corrective action required. Assisted in defending the plan to the NRC.
- For GPC - Plant Hatch EDSFI in June 1991. Developed and implemented an EDSFI Preparation Plan for the Engineering (both A/Es) and site organizations. This effort included management of a 27 man team preparation and inspection response team for the Hatch EDSFI.

Deputy Mechanical Engineering Manager, Engineering Department

Under Contract to the Site Engineering Manager, Rancho Seco, Sacramento Municipal Utilities District, Rancho Seco (April 1986 - September 1987)

Managed the implementation and closure of over 400 modifications to the plant. Provided the NRC with a basis for allowing a successful restart of the facility. (January 1986 to November 1986) Impell Lead Project Engineer, Class 1 Piping and Support Recertification Effort, SMUD.

- Developed an engineering department action plan to improve technical quality, reconstitute design basis for five systems, control costs of plant modifications, and improve adherence to schedule.
- Responsible for the complete recertification of the Pressurizer Relief Line, Decay Heat System, and others. Responsible for expediting and implementing design changes as necessary through to closure. Assisted in Utility responses to NUREG-0737, and I&E 79-14.
- Upgraded the Engineering Department procedures to gain credit for the relaxation of ASME code requirements in structural damping values. Initiated the FSAR changes as well.

Project Engineer, Fire Protection:

Under Contract to Sacramento Municipal Utilities District, Rancho Seco (November 1984 to April 1986), SMUD Fire Protection Coordinator, Fire Protection Program

- Developed the SMUD Appendix R Fire Protection Program. Established or substantially revised 110 plant and engineering procedures including shutdown procedures on total loss of the plant's control room, technical specification surveillance procedures, fire protection system maintenance procedures, and the development of a fire protection program manual.

Successfully defended the program to the NRC during the 1985 Appendix R Inspection, with no resulting findings or open items.

Additional Experience (6/78 through 8/84):

Senior Engineer, performed original pipe stress analysis and support placement for Duke Power's Catawba Plant. Qualified approximately 8 class one and two plant systems. (ABB Impell 6/78 - 12/79).

Non-linear finite element analysis of large diameter piping for EPRI. Analysis of production stress codes versus non-linear evaluation techniques, versus actual in situ testing of the system. Results were published in EPRI Report "Seismic Piping Test and Analysis. (ABB Impell, 1980 -1981)

As Project Engineer, directed the preparation of the annual Emergency Plan exercises for Kansas Gas and Electric Company, Union Electric Company, and Texas Utilities. In two plants, the exercise was installed on the plants simulator, and received recognition from the NRC for realism of the scenario. (ABB Impell 1982-1984).

EMPLOYER SUMMARY:

Northern Lights Engineering, L.L.C.
71 Edgewood Way
Westville, CT 06515

12/2002 – current

Northeast Utilities /Dominion Resources Inc 12/1996 – 12/2002
(Under Contract via Cataract Inc through 9/97.)
2500 McClellan Ave.
Pennsauken, NJ 08109

New York Power Authority 11/1992 - 12/1996
123 Main Street
White Plains, New York 10671

Cygn Energy Services 11/1991 - 11/1992
5600 Glenridge Drive, Suite 380
Atlanta, Georgia 30075

ABB Impell Corporation 6/1978 - 11/1991
333 Research Court
Technology Park-Atlanta
Norcross, Georgia 30095

EDUCATION:

University of California, Berkeley
B.A. Physics, 1983
Senior level and graduate course work in Mechanical Engineering, and Electrical Engineering

Quinnipiac University School of Law
J.D expected June, 2009

PUBLICATIONS:

- EPRI Report Number 108736, "Guidelines for the Optimization of the Engineering Change Process," March 1994.
- NIRMA PP-03, "Position Paper for a Configuration Management Enhancement Program for a Nuclear Facility," April, 1992. Subcommittee Chair.
- EPRI Report Number 8480, " Seismic Piping Test and Analysis," 1980.

PROFESSIONAL AFFILIATIONS AND AWARDS

American Society of Mechanical Engineers, American Nuclear Society, Nuclear Information and Records Management Association, Who's Who For Rising Young Americans.

REFERENCES:

References available upon request.

EXHIBIT R



This is a printer friendly version of an article from the **The Journal News**.
To print this article open the file menu and choose Print:

Leak found in pipe at Indian Point

By **BRIAN J. HOWARD**
THE JOURNAL NEWS

(Original Publication: September 7, 2007)

BUCHANAN - Workers have discovered a pinhole-sized leak in a conduit used to transfer spent fuel from the reactor to the containment pool at Indian Point 2.

The leak was found Wednesday during testing for groundwater contamination from leaks of radioactive tritium and strontium 90 that were first discovered in 2005.

"It appears that there is a potential pinhole leak in the fuel transfer canal, which we believe could be a contributing source to the groundwater contamination that we've been talking about," said Jim Steets, a spokesman for Entergy Nuclear Northeast, the plant's owner.

A vacuum test like the one that turned up the leak, as well as an ultrasonic test, will be performed to confirm the size and scope of the leak, Steets said. That will take a few more days. Repairs would follow, but would not require a reactor shutdown.

Plant officials say the leak has not contributed significantly to the groundwater contamination. The origin of the leak remains unclear.

"We'll know better about what might have caused it when we complete the testing that we're doing," Steets said. "You hate to speculate."

Nuclear Regulatory Commission spokesman Neil Sheehan said the leak was above where external moisture was found by workers during an excavation.

The leak point is under water only when the canal is flooded for refueling, which occurs every 18 to 24 months. More testing is needed before a connection can be drawn to the groundwater contamination, Sheehan said.

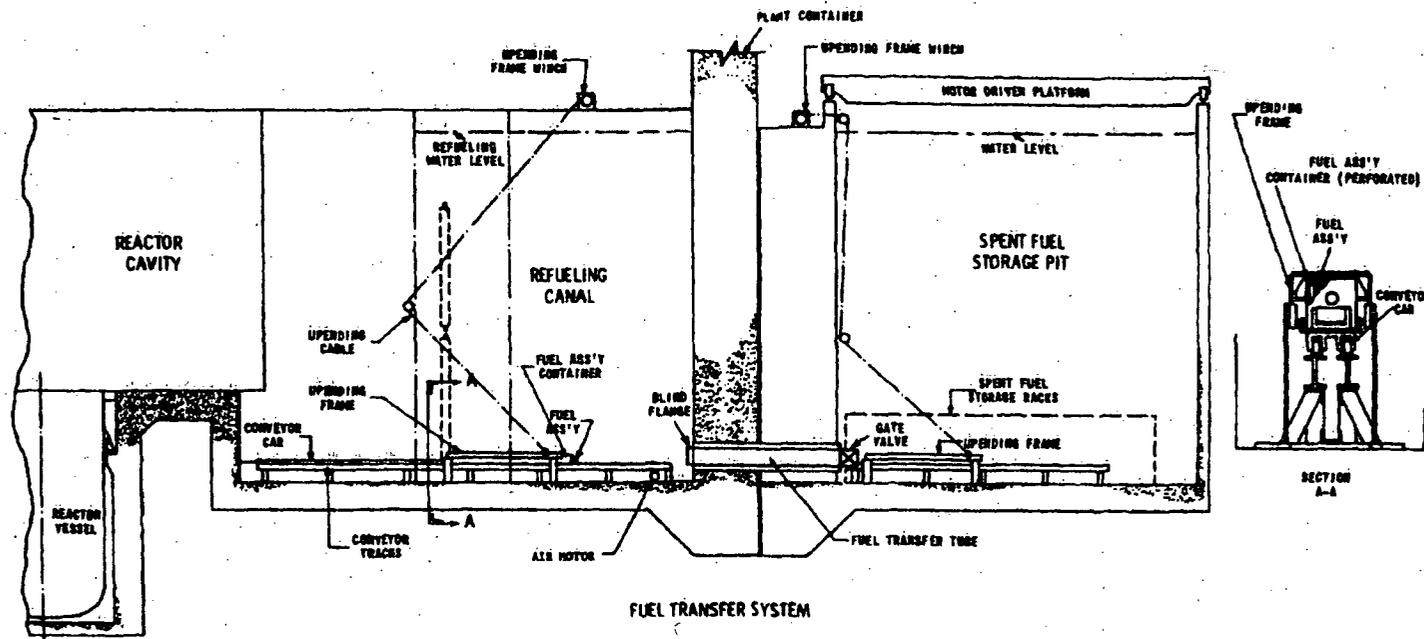
"Whether this is the cause, whether this is part of the cause, we don't know that yet, and there's still more work to be done," he said.

Buchanan Mayor Dan O'Neill learned of the leak yesterday and was assured there was no threat to the health of residents or workers at the plant.

"It does not sound like it's anything major at this time" O'Neill said.

Phillip Musegaas, a staff attorney with the environmental group Riverkeeper, said the leak underscored why the NRC should require more thorough testing of systems holding radioactive water.

"This is a switch from Entergy's earlier position, because in their relicensing application they have stated that they didn't believe there was an ongoing leak at Indian Point 2 at all," Musegaas said. "The fact that they found this on further inspection suggests that they may find more leaks."



CONSOLIDATED EDISON
INDIAN POINT UNIT No. 2

UFSAR FIGURE 9.5-1

FUEL TRANSFER
SYSTEM

MIC. No. 1999MC3886 | REV. No. 16A

EXHIBIT S



Entergy Nuclear
P.O. Box 31995
Jackson, MS 39286-1995
Tel 601 368 5692

Michael R. Kansler
President, Chief Executive Officer
& Chief Nuclear Officer

July 30, 2007
ENOC-07-0026

U.S. Nuclear Regulatory Commission
Attention: James E. Dyer
Director, Office of Nuclear Reactor Regulation
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Subject: Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Station
Docket No. 50-293
Indian Point Nuclear Generating Unit No. 1
Docket No. 50-003
Indian Point Nuclear Generating Unit No. 2
Docket No. 50-247
Indian Point Nuclear Generating Unit No. 3
Docket No. 50-286
James A. FitzPatrick Nuclear Power Plant
Docket Nos. 50-333 & 72-12
Vermont Yankee Nuclear Power Station
Docket Nos. 50-271
Palisades Nuclear Plant
Docket No. 50-255 & 72-7
Big Rock Point
Docket Nos. 50-155 & 72-43

Application for Order Approving Indirect Transfer of Control of Licenses

Pursuant to Section 184 of the Atomic Energy Act of 1954, as amended (the Act), and 10 CFR 50.80, Entergy Nuclear Operations, Inc. (ENO), acting on behalf of itself and Entergy Nuclear Generation Company, Entergy Nuclear FitzPatrick, LLC, Entergy Nuclear Vermont Yankee, LLC, Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, and Entergy Nuclear Palisades, LLC, (together, Applicants), hereby requests that the Nuclear Regulatory Commission (NRC) consent to the indirect transfer of control of the above-captioned licenses. The indirect transfer of control results from certain restructuring transactions that will involve the creation of new intermediary holding companies and/or changes in the intermediary holding companies for the ownership structure for the corporate entities that hold the NRC licenses for Pilgrim, Indian Point 1, 2, and 3, FitzPatrick, Vermont Yankee, Palisades and Big Rock Point (together, Facilities), including both the six corporate entities (named among the

A001

LIMS501

Applicants above) licensed for their ownership of the Facilities and ENO, which is the entity licensed to operate or maintain the Facilities. The licensees remain the same, and the ultimate corporate parent, Entergy Corporation, remains the same. Simplified organization charts reflecting the current and post-reorganization ownership structures are provided as Figures 1 and 2.

Through the attached Application, ENO requests, on behalf of the Applicants, that the NRC consent to this proposed indirect transfer of control. The proposed indirect transfer of control will not result in any change in the role of ENO as the licensed operator of the facilities and will not result in any changes to its technical qualifications.

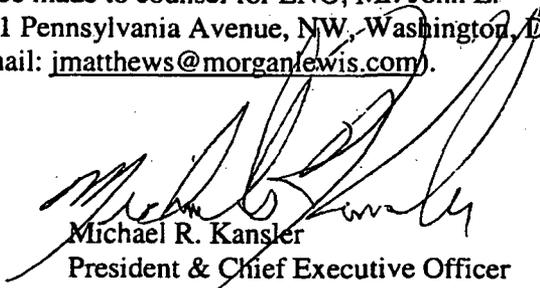
In summary, the proposed indirect transfer of control will be consistent with the requirements set forth in the Act, NRC regulations, and the relevant NRC licenses and orders. The proposed indirect transfer of control will not result in any physical changes to the Facilities or changes in the officers, personnel, or day-to-day operation of the Facilities. The proposed indirect transfer of control will not involve any changes to the current licensing basis of the Facilities. It will neither have any adverse impact on the public health and safety, nor be inimical to the common defense and security. This transfer does not involve any ownership, control or domination by any foreign entity. The Applicants therefore respectfully request that the NRC consent to the indirect transfer of control of the licenses for the Facilities in accordance with 10 CFR 50.80.

ENO requests that NRC review this Application on a schedule that will permit the issuance of NRC consent to the indirect transfer of control by December 31, 2007. Such consent should be made immediately effective upon issuance and should permit the indirect transfer of control at any time for one year following NRC's approval. ENO will inform NRC if there are any significant changes in the status of any other required approvals or any other developments that have an impact on the schedule.

The Application includes a proprietary, separately bound addendum that provides Attachments 2A and 3A, which contain confidential commercial or financial information. ENO requests that Attachments 2A and 3A be withheld from public disclosure pursuant to 10 CFR 2.390, as described in the Affidavit of Michael R. Kansler, which is provided in Attachment 4 to the Application. Non-proprietary versions of Attachments 2A and 3A suitable for public disclosure are provided as Attachments 2 and 3 to the Application.

Regulatory commitments made by Entergy are identified in the table provided in the Enclosure titled "Commitments".

If NRC requires additional information concerning this license transfer request, please contact John McCann, ENO's Director, Fleet Regulatory Affairs, at (914) 272-3370 or jmccan1@entergy.com. Service on ENO of comments, hearing requests or intervention petitions, or other pleadings, if applicable, should be made to counsel for ENO, Mr. John E. Matthews at Morgan, Lewis & Bockius, LLP, 1111 Pennsylvania Avenue, NW, Washington, DC 20004 (tel: 202-739-5524; fax: 202-739-3001; e-mail: jmatthews@morganlewis.com).



Michael R. Kansler
President & Chief Executive Officer

Enclosures: Regulatory Commitments
Oath & Affirmation
Application For Order Approving Indirect Transfer Of Control Of Licenses

cc: w/o proprietary Addendum except *

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406-1415

Regional Administrator, Region III
U.S. Nuclear Regulatory Commission
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Lisle, IL 60532-4352

* U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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* Steven R. Hom
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Mail Stop OWFN/12-D3

Mr. James J. Shea, Project Manager
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Mr. John Boska, Project Manager
Plant Licensing Branch I-I
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U.S. Nuclear Regulatory Commission
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Washington, DC 20555

Mahesh L. Chawla, Project Manager
Project Directorate III
Division of Licensing Project Management
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Mr. David O'Brien, Commissioner
VT Department of Public Service
112 State Street - Drawer 20
Montpelier, Vermont 15620-2601

Mr. Peter R. Smith, President
New York State Energy, Research, and
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17 Columbia Circle
Albany, NY 12203-6399

Mr. Paul Eddy
New York State Department
of Public Service
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Albany, NY 12223

Mr. Charles Donaldson, Esquire
Assistant Attorney General
New York Department of Law
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New York, NY 10271

Mayor, Village of Buchanan
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Buchanan, NY 10511

Michigan Department of Attorney General
Special Litigation Division
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Mr. Raymond L. Albanese
Four County Coordinator
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Hawthorne, NY 10532

USNRC Resident Inspector
Entergy Nuclear Vermont Yankee
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Vernon, Vermont 05354

Mr. Robert Walker, Director
Massachusetts Department of Public Health
Schrafft Center Suite 1 M2A
Radiation Control Program
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Charlestown, MA 02129

Resident Inspector's Office
U.S. Nuclear Regulatory Commission
James A. FitzPatrick Nuclear Power Plant
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Lycoming, NY 13093

Ms. Cristine McCombs, Director
Mass. Emergency Management Agency
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Framingham, MA 01702

U.S. Nuclear Regulatory Commission
Resident Inspector's Office
Palisades Plant
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Covert, MI 49043

Mr. Peter R. Smith, President
New York State Energy, Research,
& Development Authority
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Albany, NY 12203-6399

Senior Resident Inspector's Office
Indian Point 2
U. S. Nuclear Regulatory Commission
P.O. Box 59
Buchanan, NY 10511

Supervisor
Covert Township
P. O. Box 35
Covert, MI 49043

Senior Resident Inspector
Pilgrim Nuclear Power Station

Office of the Governor
P. O. Box 30013
Lansing, MI 48909

Michigan Department of Environmental Quality
Waste and Hazardous Materials Division
Hazardous Waste and Radiological
Protection Section
Nuclear Facilities Unit
Constitution Hall, Lower-Level North
525 West Allegan Street
P.O. Box 30241
Lansing, MI 48909-7741

Commitments

This table identifies actions discussed in this letter for which Entergy commits to perform. Any other actions discussed in this submittal are described for the NRC's information and are not commitments.

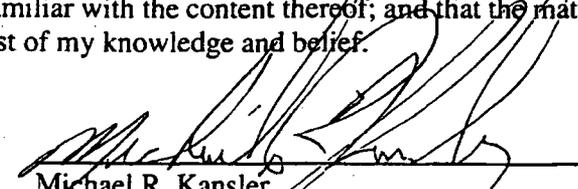
COMMITMENT	TYPE (Check one)		SCHEDULED COMPLETION DATE (If Required)
	ONE-TIME ACTION	CONTINUING COMPLIANCE	
1. For entities listed on Attachment 1 that have not yet been formed, these entities will be formed in the states indicated, with the business address indicated, and with the Directors or Managers and Executive Personnel indicated.	x		No later than the date on which the indirect license transfers are implemented.
2. Entergy Nuclear Finance Holding, LLC, will execute a financial Support Agreement in favor of the Applicants substantially in the form provided in Attachment 5.	x		No later than the date on which the indirect license transfers are implemented.
3. Entergy Nuclear Finance Holding, LLC, will provide a letter of credit or other financial assurance instrument in compliance with 10 CFR 50.75(c)(1) to be held by Entergy Nuclear Palisades, LLC and to replace the \$5 million Guaranty of decommissioning funding assurance for the Big Rock ISFSI.	x		No later than the date on which the indirect license transfers are implemented.

**UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION**

In the Matter of)	
)	
Entergy Nuclear Operations, Inc.)	
)	
Pilgrim Nuclear Power Station	)	Docket Nos. 50-293
Indian Point Nuclear Generating Unit No. 1	)	50-003
Indian Point Nuclear Generating Unit No. 2	)	50-247
Indian Point Nuclear Generating Unit No. 3	)	50-286
James A. FitzPatrick Nuclear Power Plant	)	50-333 &
FitzPatrick ISFSI	)	72-12
Vermont Yankee Nuclear Power Station	)	50-271
Palisades Nuclear Plant	)	50-255 &
Palisades ISFSI	)	72-7
Big Rock Point	)	50-155 &
Big Rock Point ISFSI	)	72-043

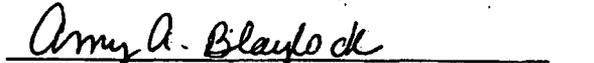
AFFIRMATION

I, Michael R. Kansler, being duly sworn, hereby depose and state: that I am President & Chief Executive Officer, of Entergy Nuclear Operations, Inc.; that I am duly authorized to sign and file with the Nuclear Regulatory Commission the attached application for order approving indirect transfer of control of licenses; that I am familiar with the content thereof; and that the matters set forth therein are true and correct to the best of my knowledge and belief.


 Michael R. Kansler
 President & Chief Executive Officer

STATE OF MISSISSIPPI)
)
 COUNTY OF HINDS)

Subscribed and sworn to me, a Notary Public, in and for the State of Mississippi, this 30th day of July, 2007.


 Notary Public in and for the State of Mississippi



Notary Public State of Mississippi At Large
 My Commission Expires June 17, 2009
 Bonded Thru Helden, Brooks & Garland, Inc.

Application for Order Approving Indirect Transfer of Control of Licenses

Entergy Nuclear Operations, Inc. (All Dockets)
Pilgrim Nuclear Power Station, Docket No. 50-293
Indian Point Nuclear Generating Unit No. 1, Docket No. 50-003
Indian Point Nuclear Generating Unit No. 2, Docket No. 50-247
Indian Point Nuclear Generating Unit No. 3, Docket No. 50-286
James A. FitzPatrick Nuclear Power Plant, Docket Nos. 50-333 & 72-12
Vermont Yankee Nuclear Power Station, Docket Nos. 50-271
Palisades Nuclear Plant, Docket No. 50-255 & 72-7
Big Rock Point, Docket Nos. 50-155 & 72-43

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Attachment 3A	Projected Income Statements: 2007-2012 (Proprietary Version)

I. INTRODUCTION

Pursuant to Section 184 of the Atomic Energy Act of 1954, as amended (the Act), and 10 CFR 50.80, Entergy Nuclear Operations, Inc. (ENO), acting on behalf of itself and ~~Entergy Nuclear Generation Company~~ Entergy Nuclear FitzPatrick, LLC, Entergy Nuclear Vermont Yankee, LLC, Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, and Entergy Nuclear Palisades, LLC, (together, Applicants), hereby requests that the Nuclear Regulatory Commission (NRC) consent to the indirect transfer of control of the above-captioned licenses. The indirect transfer of control results from certain restructuring transactions that will involve the creation of new intermediary holding companies and/or changes in the intermediary holding companies for the ownership structure for the corporate entities that hold the NRC licenses for Pilgrim, Indian Point 1, 2, and 3, FitzPatrick, Vermont Yankee, Palisades and Big Rock Point (together, the Facilities), including both the six corporate entities (named among the Applicants above) licensed for their ownership of the Facilities and ENO, which is the entity licensed to operate and/or maintain the Facilities. The licensees remain the same, and the ultimate corporate parent, Entergy Corporation, remains the same. Simplified organization charts reflecting the current and post-reorganization ownership structures are provided as Figures 1 and 2.

II. STATEMENT OF PURPOSE OF THE TRANSFERS AND NATURE OF THE TRANSACTION MAKING THE TRANSFERS NECESSARY OR DESIRABLE

The restructuring transactions will centralize ownership and control of the owner Applicants under a new intermediate holding company structure in the Entergy Corporation system that will be wholly owned by Entergy Nuclear Finance Holding, LLC (HoldCo.). The transactions also will centralize ownership and control of ENO and Entergy's other nuclear service businesses under Entergy Nuclear, Inc. The restructuring will enhance the financial

strength of the Applicants, simplify the Applicants' and Entergy Corporation's corporate structure to the benefit of customers, regulators, capital markets and shareholders, and facilitate the financing of Holdco and its direct and indirect subsidiaries as a discrete and integrated business. The restructuring is fully consistent with the continued safe operation of the Facilities. By reorganizing a currently diffuse organization, the wholesale nuclear business will be positioned for future growth.

For historic reasons the Applicants are currently part of a dispersed structure within the Entergy Corporation system. Financing is provided internally in a top down fashion, with debt attributable to the wholesale nuclear business residing primarily with Entergy Corporation. This structure has resulted in complex financing and operating relationships. The Applicants believe that by aggregating their ownership and financing activities under Holdco within a discrete business segment structure, and aggregating their nuclear services businesses under Entergy Nuclear, Inc., they will own and operate the company's nuclear plants with more clarity and enhance their ability to attract capital.

The restructuring will create an organizational structure that is consistent with Entergy Corporation's characterization and management of the wholesale, non-utility nuclear business as one of its primary business segments. Operating revenues and net income from its nuclear services business and its wholesale, non-utility nuclear generation business will be segregated for the benefit of this business segment. This will create discrete operating history and focused operating results.

The restructuring will isolate and simplify the structure of the businesses that comprise the wholesale nuclear business segment. This simplification will enhance the ability of analysts, regulators, capital markets and shareholders to understand and evaluate this business segment.

The Applicants believe that the organization of a separate and integrated intermediate holding company system will clarify responsibilities within the Entergy Corporation system, facilitate capital formation, enhance the ability to retain and recruit qualified personnel and highlight growth opportunities for this important segment of Entergy Corporation's business.

III. GENERAL CORPORATE INFORMATION

The following are the names of the corporate entities licensed by the NRC:

- Entergy Nuclear Operations, Inc.
- Entergy Nuclear Generation Company
- Entergy Nuclear FitzPatrick, LLC
- Entergy Nuclear Vermont Yankee, LLC
- Entergy Nuclear Indian Point 2, LLC
- Entergy Nuclear Indian Point 3, LLC
- Entergy Nuclear Palisades, LLC

The following are the names of the parent corporate entities that will directly or indirectly own the NRC licensed corporate entities.

- Entergy Corporation
- Entergy Nuclear, Inc.
 - (by merger, successor to Entergy Nuclear Holding Company #2)
- Entergy Global Trading Holdings, LTD
- Entergy International Holdings, LTD
- Entergy Global Investments, Inc.
 - (formerly, Entergy Global, LLC)
- Entergy Power Gas Holdings Corp.
- Entergy Power Gas Operations Corp.
- Entergy Nuclear Holding Company #1
- Entergy Global Holdings, Inc.
- Entergy Nuclear Finance Holding, LLC
 - (formerly, Entergy Nuclear Finance Holding, Inc.)
- Entergy Nuclear Holding, LLC
 - (formerly, Entergy Nuclear Holding Company)
- Entergy NHC, LLC
- Entergy Nuclear Midwest Investment Company, LLC
- Entergy Nuclear Northeast Investment Company, LLC
 - (formerly, Entergy Nuclear New York Investment Company 1, and by merger, successor to Entergy Nuclear Holding Company #3 LLC)
- Entergy Nuclear Investment Company, LLC
- Entergy Nuclear Vermont Investment Company, LLC

The parent company relationships of the licensed corporate entities both before and after the indirect transfer of control are reflected in Figures 1 and 2. The information regarding each corporate entity required by 10 CFR 50.33(d)(3) is provided in Attachment 1.

All of the current and proposed directors and executive personnel of the corporate entities are citizens of the United States.

IV. FOREIGN OWNERSHIP OR CONTROL

Entergy Corporation is a publicly traded company, and its securities are traded on the New York Stock Exchange and are widely held. Section 13(d) of the Securities Exchange Act of 1934, as amended, 15 U.S.C. 78m(d), requires that a person or entity that owns or controls more than 5% of the securities of a company must file notice with the Securities and Exchange Commission (SEC). Based upon filings with the SEC, ENO is aware of one alien, foreign corporation, or foreign government that holds or may hold beneficial ownership of more than 5% of the securities of Entergy Corporation. AXA Assurance I.A.R.D. Mutuelle, a French entity, and its affiliates (together, AXA) have filed a statement indicating that as of December 31, 2006, AXA had beneficial ownership of 5% of the shares of Entergy Corporation. AXA does not have any representation on Entergy Corporation's Board of Directors, and its SEC filing specifically certifies that AXA did not acquire these shares for the purpose of or with the effect of changing or influencing the control of Entergy Corporation. See 17 CFR 240.13d-1(c)(1) (requirements for Schedule 13G filing).

The current and proposed directors and executive officers of Entergy Corporation and the Entergy subsidiaries that directly or indirectly own the Applicants are United States citizens. There is no reason to believe that the Applicants are owned, controlled, or dominated by any alien, foreign corporation, or foreign government. Thus, the indirect transfer of control of the

licensed entities and their corporate parents will not result in any foreign ownership, domination, or control of these entities within the meaning of the Atomic Energy Act of 1954, as amended.

V. TECHNICAL QUALIFICATIONS

The technical qualifications of ENO are not affected by the proposed indirect transfer of control. There will be no physical changes to the Facilities and no changes in the officers, personnel, or day-to-day operations of the Facilities in connection with the indirect transfer of control. It is anticipated that ENO will at all times remain the licensed operator of the Facilities, or in the case of permanently shutdown reactors the entity licensed to maintain the Facilities.

VI. FINANCIAL QUALIFICATIONS

The Applicants are all indirect, wholly-owned subsidiaries of Entergy Corporation ("Entergy"). Headquartered in New Orleans, Louisiana, Entergy is an integrated energy company engaged primarily in electric power production and retail electric distribution operations. Entergy owns and operates power plants with approximately 30,000 MW of electric generating capacity, and Entergy is the second-largest nuclear power generator in the United States. Entergy delivers electricity to 2.6 million utility customers in Arkansas, Louisiana, Mississippi, and Texas. Entergy generated annual revenues of \$10.9 billion in 2006 and had approximately 13,800 employees as of December 31, 2006. Through its subsidiaries (both regulated and non-regulated), Entergy Corporation owns and operates eleven nuclear power plants at nine sites. These include the Facilities that are the subject of this application, as well as five other nuclear power plants owned by affiliates of the Applicants: Arkansas Nuclear One Units 1 and 2, Grand Gulf Nuclear Station, River Bend Station, and Waterford 3 Steam Electric Station.

A. Projected Operating Revenues and Operating Costs

Financial information regarding Entergy Corporation and its subsidiaries is provided in its 2006 Annual Report (SEC Form 10-K) dated March 1, 2007, which is available along with Entergy's prior annual reports on the internet at:

<http://www.shareholder.com/entergy/edgar.cfm?DocType=Annual,Quarterly&Year=>

In addition, Applicants have prepared balance sheets and projected income statements for the licensed owners of the Facilities, as well as a projected consolidated balance sheet and projected income statement for Entergy Nuclear Finance Holding, LLC (HoldCo), which is an intermediary holding company that will indirectly own all of the corporate entities licensed to own the Facilities, as well as other assets and businesses related to non-utility nuclear generation business of Entergy Corporation.

ENO, the corporate entity licensed to operate the operating Facilities and to maintain the non-operating Facilities, will be a wholly-owned subsidiary of Entergy Nuclear, Inc., which itself will be a direct wholly-owned subsidiary of Entergy Corporation. Entergy Nuclear, Inc. will own the nuclear services businesses of Entergy Corporation. ENO will receive the revenue necessary to operate and maintain the Facilities, including decommissioning funds to pay for such expenses, from the corporate entities licensed to own the Facilities pursuant to operating agreements or other intra-corporate arrangements that have been previously described to NRC. If any changes are made to replace the existing arrangements, any new agreements are expected to be consistent with the current arrangements. Any new agreements will be made available for inspection by NRC. As such, ENO relies upon the financial qualifications of the licensed owners of the Facilities, because these corporate entities will be financially responsible for the operation and decommissioning of the units.

In accordance with 10 CFR 50.33(f) and the Standard Review Plan on Power Reactor Licensee Financial Qualifications and Decommissioning Funding Assurance (NUREG-1577, Rev. 1) ("Standard Review Plan"), projected balance sheets for each of the licensed owners of the Facilities are provided in a separately bound proprietary addendum as Attachment 2A. In addition, a projected opening balance sheet for the consolidated businesses of Entergy Nuclear Finance Holding, LLC is also provided in Attachment 2A. ENO requests that Attachment 2A be withheld from public disclosure, as described in the Affidavit provided in Attachment 4. Redacted versions of these balance sheets, suitable for public disclosure, are provided as Attachment 2.

In addition, *pro forma* Projected Income Statements for the six year period from January 1, 2007 through December 31, 2012 for each of the licensed owners of the Facilities and Entergy Nuclear Finance Holding, LLC are provided in a separately bound proprietary addendum as Attachment 3A. In addition, a sensitivity analysis of these projections (reflecting a 10% reduction in projected revenue) is provided in Attachment 3A. ENO requests that Attachment 3A be withheld from public disclosure, as described in the Affidavits provided in Attachment 4. Redacted versions of these balance sheets, suitable for public disclosure, are provided as Attachment 3.

The Projected Income Statements for the licensed owners show that anticipated revenues from sales of capacity and energy from the Facilities provide reasonable assurance of an adequate source of funds to meet the ongoing operating and maintenance expenses for the Facilities. In addition, Entergy Nuclear Finance Holding, LLC will execute a financial Support Agreement with the Applicants, including each of the corporate entities licensed to own the Facilities, in the total amount of \$700 million, to pay for the operating and maintenance (O&M)

costs for all six operating Facilities, if called upon to do so. This provides assurance that adequate funds will be available to fund ongoing O&M expenses with respect to all of the operating Facilities. A form of this agreement is provided as Attachment 5.

~~The financial projections for Entergy Nuclear Finance Holding, LLC~~ establish that it will have adequate resources from its consolidated businesses to provide funding if necessary under the Support Agreement. In addition, this parent company is expected to have access to a line of credit of at least \$1 billion or more, which provides additional assurance of its ability on an ongoing basis to provide funds for the licensed entities.

Pursuant to the Support Agreement, the licensed owners will have access to funds sufficient to pay the fixed O&M costs in the event of any unanticipated plant shutdown in accordance with the guidance provided in the Standard Review Plan. Pursuant to this agreement, Entergy Nuclear Finance Holding, LLC will make up to an aggregate amount of \$700 million in funding available to any and all of the Applicants to meet their obligations to NRC relating to the Facilities. This arrangement replaces the prior financial support arrangements under which funds were available to each licensed owner individually in limited amounts, and Applicants seek NRC's prior written approval of the revocation of the prior arrangements through NRC's approval of the new Support Agreement, which rescinds the prior arrangements under the terms of Section 7 of the Support Agreement.

Under the new Support Agreement, each of the licensed entities will have access to up to a total of \$700 million, to the extent not previously utilized, for any single plant outage or for a multiple plant outage should the circumstances necessitate access to such funds. As such, the proposed Support Agreement would provide funding for any individual site that significantly exceeds the six-month period suggested by the NRC's Standard Review Plan guidance, which

requests demonstration of a source of funds to pay fixed O&M expenses in the event of an extended plant outage. The availability of the entire aggregate amount of funding under the Support Agreement for each plant is superior to the current disparate support arrangements. Moreover, the total amount available would fund nearly six-months worth of fixed O&M expenses for all six operating Facilities. Finally, Applicants note that they do not expect to need to request funding under this formal agreement, as they expect that during their day-to-day operations and otherwise as the need for funding arises, they will have access to funds from capital contributions, loans, credit lines, or other sources that provide adequate funding to support safe operation of all of the Facilities.

B. Decommissioning Funding

The financial qualifications of the Applicants to continue to own the Facilities are further demonstrated by the decommissioning funding assurance provided in accordance with 10 CFR 50.75(e)(1). Details regarding the status of the decommissioning funding assurance maintained by the Applicants for the Facilities are provided in the March 29, 2007 decommissioning funding status report (ENOC-07-00007) submitted by ENO in accordance with 10 CFR 50.75(f), except for Palisades and Big Rock Point which were not included in this report. This report demonstrates that there is reasonable assurance of adequate decommissioning funding that is provided by pre-paid amounts maintained as assets in external sinking funds segregated from licensee assets and outside licensee administrative control in accordance with the requirements of 10 CFR 50.75(e)(1)(i).

With respect to Palisades, the trust fund balance for Palisades as of April 30, 2007 was approximately \$252.9 million, and with credit for earnings taken into account as permitted by NRC rules, less than \$205 million in pre-paid assets maintained in a trust would be sufficient to fully fund the NRC's current "formula amount" estimate for Palisades decommissioning costs at

\$345.9 million, calculated pursuant to 10 CFR 50.75(c). Thus, the existing trust fund balances maintained by Entergy Palisades LLC as assets in an external sinking fund segregated from licensee assets and outside licensee administrative control provide decommissioning funding assurance in accordance with the requirements of 10 CFR 50.75(e)(1)(i). There is, therefore, reasonable assurance that the amount of decommissioning funds available will be sufficient to pay decommissioning costs for Palisades at the time permanent termination of operations is expected.

With respect to Big Rock Point, the NRC acknowledged in its recent approval of the transfer of this facility to Entergy Palisades LLC that NRC has approved the release of most of the Big Rock Point site, and the remaining decommissioning obligation is approximately \$2.8 million estimated for the decommissioning of the Independent Spent Fuel Storage Facility (ISFSI). Entergy Corporation committed to provide a Parent Guaranty for \$5 million. Prior to the indirect transfer of the Big Rock Point license, this Parent Guaranty will be terminated and replaced by an alternative financial assurance mechanism acceptable under the terms of 10 CFR 50.75(e)(1), such as a letter of credit from a financial institution or a pre-paid decommissioning trust in an amount not less than \$2.8 million. None of the other existing arrangements for Big Rock Point as approved in the prior license transfer will be affected. This provides reasonable assurance of the availability of funds for decommissioning the Big Rock Point ISFSI pursuant to 10 CFR 50.75 and 72.30.

Other than the changes to the Parent Guaranty for Big Rock Point described above, the Applicants do not anticipate any changes in the existing decommissioning funding assurance provided in connection with the proposed indirect transfers of control. Applicants also do not anticipate any changes or amendments to any nuclear decommissioning trust fund agreements,

and if any amendments are to be made in the future, the existing trust agreements require prior written notice be provided to the NRC. Moreover, any existing NRC license conditions governing these trust agreements will remain in effect and unchanged.

VII. ANTITRUST INFORMATION

This Application post-dates the issuance of the operating licenses of the facilities, and therefore no antitrust review is required or authorized. Based upon the Commission's decision in *Kansas Gas and Electric Co., et al.* (Wolf Creek Generating Station, Unit 1), CLI-99-19, 49 NRC 441 (1999), the Atomic Energy Act of 1954, as amended, does not require or authorize antitrust reviews of post-operating license transfer applications.

VIII. RESTRICTED DATA AND CLASSIFIED NATIONAL SECURITY INFORMATION

The proposed transfers do not involve any Restricted Data or other Classified National Security Information or result in any change in access to such Restricted Data or Classified National Security Information. ENO's existing restrictions on access to Restricted Data and Classified National Security Information are unaffected by the proposed transfers. In compliance with Section 145(a) of the Act, the applicants agree that restricted or classified defense information will not be provided to any individual until the Office of Personnel Management investigates and reports to the NRC on the character, associations, and loyalty of such individual, and the NRC determines that permitting such person to have access to Restricted Data will not endanger the common defense and security of the United States.

IX. ENVIRONMENTAL CONSIDERATIONS

The requested consent to indirect transfer of control of the facilities' licenses is exempt from environmental review because it falls within the categorical exclusion contained in 10 CFR 51.22(c)(21), for which neither an Environmental Assessment nor an Environmental Impact

Statement is required. Moreover, the proposed indirect transfer does not involve any amendment to the facility operating licenses or other change, and it will not directly affect the actual operation of the Facilities in any substantive way. The proposed transfer does not involve an increase in the amounts, or a change in the types, of any radiological effluents that may be allowed to be released off-site, and involves no increase in the amounts or change in the types of non-radiological effluents that may be released off-site. Further, there is no increase in the individual or cumulative operational radiation exposure, and the proposed transfer has no environmental impact.

X. PRICE-ANDERSON INDEMNITY AND NUCLEAR INSURANCE

The proposed indirect transfer of control does not affect the existing Price-Anderson indemnity agreements for the Facilities, and does not affect the required nuclear property damage insurance pursuant to 10 CFR 50.54(w) and nuclear energy liability insurance pursuant to Section 170 of the Act and 10 CFR Part 140.

XI. EFFECTIVE DATE AND OTHER REQUIRED REGULATORY APPROVALS

Accordingly, ENO requests that NRC review this Application on a schedule that will permit the issuance of NRC consent to the indirect transfer of control by December 31, 2007. Such consent should be made immediately effective upon issuance and should permit the indirect transfer of control at any time within a year after issuance. ENO will inform the NRC if there are any significant changes in the status of any other required approvals or any other developments that have an impact on the schedule.

XII. CONCLUSION

Based upon the foregoing information, ENO respectfully requests, on behalf of the Applicants, that the NRC issue an Order consenting to the indirect transfer of control.

FIGURE 1

SIMPLIFIED ORGANIZATION CHART - CURRENT

Figure 1: SIMPLIFIED ORGANIZATION CHART – CURRENT

NOTE: NRC Licenses held by EN entities are referenced in parentheses and italics, e.g., (IP1 & IP2).

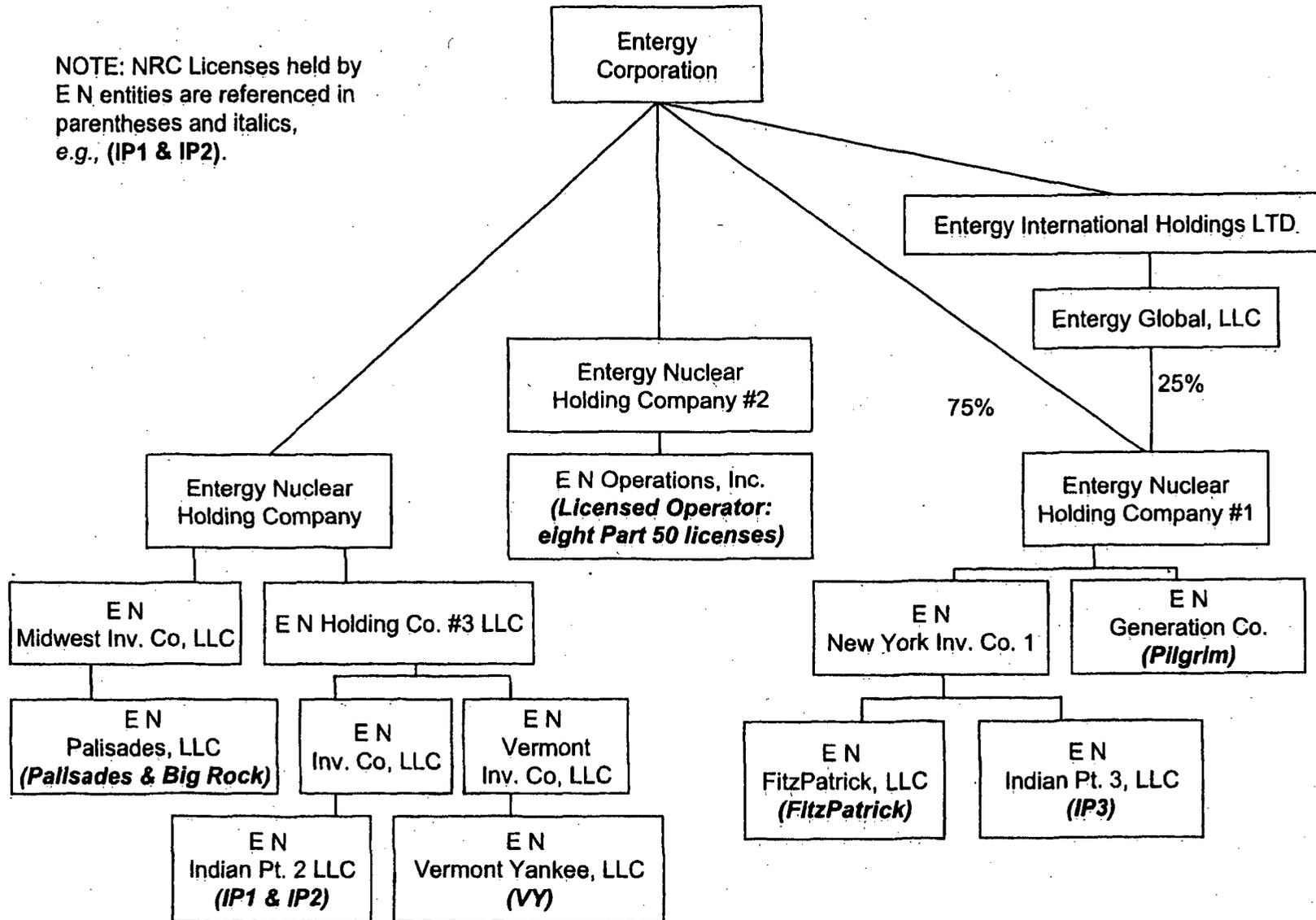
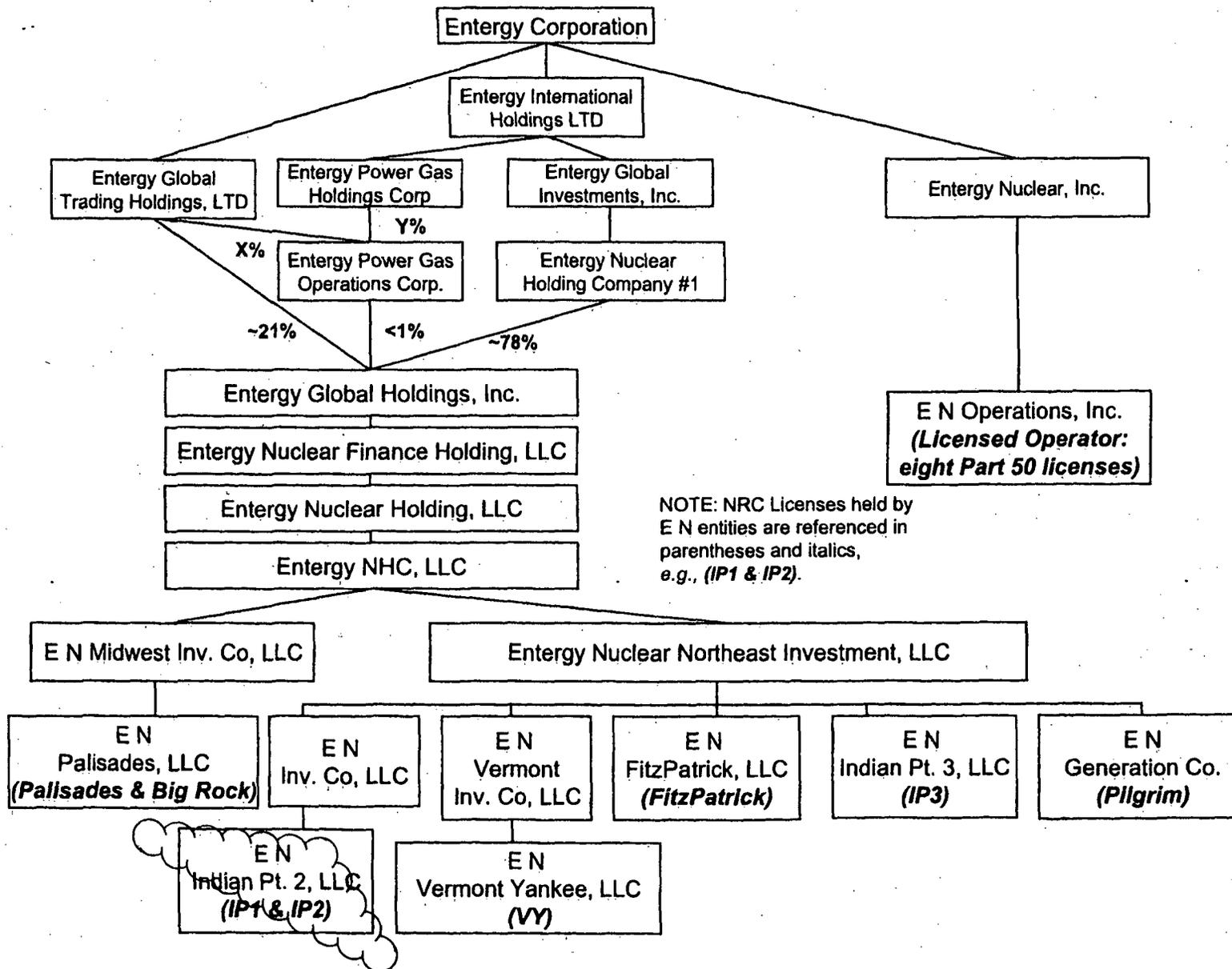


FIGURE 2

SIMPLIFIED ORGANIZATION CHART – POST REORGANIZATION

Figure 2: SIMPLIFIED ORGANIZATION CHART – POST REORGANIZATION



ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Corporation
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	639 Loyola Avenue New Orleans, LA 70113
DIRECTORS:	J. Wayne Leonard (Chairman) Maureen S. Bateman W. Frank Blount Simon D. deBree Gary W. Edwards Alexis M. Herman Donald C. Hintz Stuart L. Levinick James R. Nichols William A. Percy, II W. J. "Billy" Tauzin Steven V. Wilkinson
EXECUTIVE PERSONNEL	J. Wayne Leonard – Chief Executive Officer Richard J. Smith – President & Chief Operating Officer Gary J. Taylor – Group President, Utility Operations Leo P. Denault – Executive VP & CFO Curtis L. Hebert, Jr. – Executive VP, External Affairs Michael R. Kansler – Executive VP & Chief Nuclear Officer Mark T. Savoff – Executive VP, Operations Robert D. Sloan – Executive VP / General Counsel & Secretary Theodore H. Bunting, Jr – Senior VP & Chief Accounting Officer Joseph T. Henderson – Senior VP & General Tax Counsel Terry R. Seamons – Senior VP, Human Resources & Administration Steven C. McNeal – VP & Treasurer Paul A. Castanon – Assistant Secretary

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear, Inc.
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	1340 Echelon Parkway Jackson, Mississippi 39213
DIRECTORS:	Michael R. Kansler – Chairman Leo P. Denault C. Randy Hutchinson
EXECUTIVE PERSONNEL	Michael R. Kansler – President & Chief Executive Officer C. Randy Hutchinson – Senior VP, Development Robert D. Sloan – Executive VP & Secretary Wanda Curry – VP Chief Financial Officer, Nuclear Operations Danny R. Keuter – VP Business Development Steven C. McNeal – VP & Treasurer Dana Atchison – Assistant Secretary Amy A. Blaylock – Assistant Secretary Terence A. Burke – Assistant Secretary Mary Ann Valladares – Assistant Treasurer Patricia A. Galbraith – Tax Officer Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Global Trading Holdings, LTD
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	10055 Grogans Mill Road, Parkwood II Building The Woodlands, TX 77380
DIRECTORS:	Barrett E. Green John Wengler James E. Striedel
EXECUTIVE PERSONNEL	Barrett E. Green – President John Wengler – VP & Treasurer James E. Striedel – Vice President Thomas Wagner – Secretary Joseph T. Henderson – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy International Holdings LTD
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	20 Greenway Plaza, Suite 500 Houston, TX 77046
DIRECTORS:	Steven C. McNeal Eddie Peebles Andrew Rosenlieb
EXECUTIVE PERSONNEL	Eddie Peebles – President Steven C. McNeal – Vice President & Treasurer Andrew Rosenlieb – Vice President & Secretary Thomas G. Wagner – Assistant Secretary Joseph T. Henderson – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Global Investments, Inc. (Proposed Conversion)
STATE OF INCORPORATION:	Arkansas
BUSINESS ADDRESS:	425 West Capitol Avenue Little Rock, AR 72201
DIRECTORS:	Douglas Castleberry Steven C. McNeal O. H. Storey, III
EXECUTIVE PERSONNEL	Douglas Castleberry – President Robert D. Sloan – Executive VP, General Counsel, & Secretary Steven C. McNeal – Vice President & Treasurer O. H. Storey, III – Vice President Sue Chambers – Assistant Secretary Janan E. Honeysuckle – Assistant Secretary Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents --**

NAME:	Entergy Power Gas Holdings Corporation
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	20 Greenway Plaza, Suite 500 Houston, Texas 77046
DIRECTORS:	Steven C. McNeal
EXECUTIVE PERSONNEL	James E. Striedel – President Joseph T. Henderson – Tax Officer Steven C. McNeal – VP & Treasurer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents.**

NAME:	Entergy Power Gas Operations Corporation
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	Entity Services (Nevada), L.L.C. 2215-B Renaissance Dr., Suite 5 Las Vegas Nevada 89119
DIRECTORS:	Richard F. Boland Douglas Castleberry Steven C. McNeal Tom D. Reagan
EXECUTIVE PERSONNEL	Tom D. Reagan – President Richard F. Boland – VP, Secretary, & Assistant Treasurer Steven C. McNeal – VP & Treasurer Thomas G. Wagner – Assistant Secretary Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear Holding Company #1
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	20 Greenway Plaza, Suite 500 Houston, Texas 77046
DIRECTORS:	Michael R. Kansler (Chairman) Wanda Curry
EXECUTIVE PERSONNEL	Michael R. Kansler – President & Chief Executive Officer Joseph T. Henderson – Senior VP & General Tax Counsel Wanda Curry – VP Thomas G. Wagner – Secretary Paul A. Castanon – Assistant Secretary Rory L. Roberts – Tax Officer Steven C. McNeal – VP & Treasurer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Global Holdings, Inc. (Proposed Entity/Not Yet Created)
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	10055 Grogans Mill Road, Parkwood II Building The Woodlands, TX 77380
DIRECTORS:	James E. Striedel* Andrew Rosenlieb*
EXECUTIVE PERSONNEL	James E. Striedel* – President Andrew Rosenlieb* – Vice President John Wengler* – VP & Treasurer Reginald G. Rice* – Secretary Joseph C. Henderson* – Tax Officer

*Subject to additional internal review by Affiliate Rules Compliance

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear Finance Holding, LLC (Proposed Conversion)
STATE OF INCORPORATION:	Arkansas
BUSINESS ADDRESS:	425 West Capitol Little Rock, AR 72201
MANAGERS:	Douglas Castleberry – Management Committee Member Michael R. Kansler – Management Committee Member O. H. Storey – Management Committee Member
EXECUTIVE PERSONNEL	Michael R. Kansler – President & Chief Executive Officer Douglas Castleberry – Vice President Steven C. McNeal – VP & Treasurer O. H. Storey – VP & Secretary Sue Chambers – Assistant Secretary Janan E. Honeysuckle – Assistant Secretary Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear Holding, LLC (Proposed Conversion)
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	20 Greenway Plaza, Suite 500 Houston, Texas 77046
MANAGERS:	Wanda Curry – Management Committee Member Eddie Peebles – Management Committee Member
EXECUTIVE PERSONNEL	Michael R. Kansler – President & Chief Executive Officer Robert D. Sloan – Executive VP & Secretary Joseph T. Henderson – Senior VP & General Tax Counsel Wanda Curry – Vice President Steven C. McNeal – VP & Treasurer Rory L. Roberts – Tax Officer

ATTACHMENT I

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents.**

NAME:	Entergy NHC, LLC (Proposed Entity/Not Yet Created)
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	10055 Grogans Mill Road, Parkwood II Building. The Woodlands, TX 77380
MANAGERS:	James E. Striedel* Andrew Rosenlieb*
EXECUTIVE PERSONNEL	James E. Striedel* – President Andrew Rosenlieb* – Vice President John Wengler* – VP & Treasurer Reginald G. Rice* – Secretary Joseph C. Henderson* – Tax Officer

* Subject to additional internal review by Affiliate Rules Compliance

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear Midwest Investment Company, LLC
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	1340 Echelon Parkway Jackson, Mississippi 39213
MANAGERS:	C. Randy Hutchinson – Management Committee Member
EXECUTIVE PERSONNEL	Joseph T. Henderson – Senior VP & General Tax Counsel Terence A. Burke – VP & Secretary Steven C. McNeal – VP & Treasurer Amy A. Blaylock – Assistant Secretary Paul A. Castanon – Assistant Secretary David Gibbs – Assistant Secretary Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear Northeast Investment Company, LLC (Proposed Conversion)
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	1340 Echelon Parkway Jackson, Mississippi 39213
DIRECTORS OR MANAGERS:	Michael R. Kansler – Management Committee Member C. Randy Hutchinson – Management Committee Member
EXECUTIVE PERSONNEL	Michael R. Kansler – President, Executive VP & Chief Executive Officer Terence A. Burke – VP & Secretary Steven C. McNeal – VP & Treasurer Paul A. Castanon – Assistant Secretary Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear Investment Company, LLC
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	1340 Echelon Parkway Jackson, Mississippi 39213
MANAGERS:	C. Randy Hutchinson – Management Committee Member Michael R. Kansler – Management Committee Member
EXECUTIVE PERSONNEL:	Terence A. Burke – VP & Secretary Amy A. Blaylock – Assistant Secretary Paul A. Castanon – Assistant Secretary Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear Vermont Investment Company, LLC
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	1340 Echelon Parkway Jackson, Mississippi 39213
MANAGERS:	C. Randy Hutchinson – Management Committee Member Michael R. Kansler – Management Committee Member
EXECUTIVE PERSONNEL	Terence A. Burke – VP & Secretary Paul A. Castanon – Assistant Secretary Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents.**

NAME:	Entergy Nuclear Operations, Inc. [NRC Licensed Entity]
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	1340 Echelon Parkway Jackson, Mississippi 39213
DIRECTORS:	C. Randy Hutchinson Michael R. Kansler
EXECUTIVE PERSONNEL	<p>Michael R. Kansler – Chief Executive Officer John McGaha – President, Planning, Development & Oversight John T. Herron – Senior VP, Entergy Nuclear Operations C. Randy Hutchinson – Senior VP, Business Development Robert D. Sloan – Executive VP, General Counsel & Secretary Michael A. Balduzzi, Jr. – Senior VP, Chief Operating Officer, ENO Kevin Bronson – VP Operations, Pilgrim Wanda Curry – VP, Chief Financial Officer, Nuclear Fred R. Dacimo – VP Operations, Indian Point Energy Center Peter T. Dietrich – VP Operations, JAF Danny R. Keuter – VP, Development, Planning & Innovation Oscar Limpias – VP, Engineering Steven C. McNeal – VP & Treasurer Stewart B. Minahan – VP Operations, Cooper Christopher J. Schwarz – VP Operations, Palisades Theodore A. Sullivan – VP Operations, Vermont Yankee Amy A. Blaylock – Assistant Secretary Terence A. Burke – Assistant Secretary Paul A. Castanon – Assistant Secretary Mary Ann Valladares – Assistant Treasurer Patricia A. Galbraith – Tax Officer Rory L. Roberts – Tax Officer Paul Hinnenkamp – VP, Business Development Cliff Eubanks – VP, Project Management Joseph DeRoy – VP, Operations Support Bruce Williams – VP, Oversight</p>

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear Generation Company [NRC Licensed Entity]
STATE OF INCORPORATION:	Massachusetts
BUSINESS ADDRESS:	1340 Echelon Parkway Jackson, Mississippi 39213
DIRECTORS:	Michael R. Kansler – Chairman C. Randy Hutchinson
EXECUTIVE PERSONNEL	Michael R. Kansler – Chief Executive Officer & President Robert D. Sloan – Executive VP & Secretary John T. Herron – Senior VP & Chief Operating Officer Michael A. Balduzzi, Jr. – VP, Operations, Pilgrim NPS Wanda Curry – VP, Chief Financial Officer, Nuclear Terence A. Burke – VP & Secretary Steven C. McNeal – VP & Treasurer Amy A. Blaylock – Assistant Secretary Paul A. Castanon – Assistant Secretary James W. Snider – Assistant Secretary Patricia A. Galbraith – Tax Officer Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear FitzPatrick, LLC [NRC Licensed Entity]
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	268 Lake Road East Lycoming, New York 13093
MANAGERS:	Michael R. Kansler – Management Committee Member
EXECUTIVE PERSONNEL	Michael R. Kansler – Chief Executive Officer & President John T. Herron – Senior VP & Chief Operating Officer Robert D. Sloan – Executive VP, General Counsel & Secretary Wanda Curry – VP, Chief Financial Officer, Nuclear Peter T. Dietrich – VP, Operations Steven C. McNeal – VP & Treasurer Paul A. Castanon – Assistant Secretary Mary Ann Valladares – Assistant Treasurer Patricia A. Galbraith – Tax Officer Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear Vermont Yankee, LLC [NRC Licensed Entity]
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	320 Governor Hunt Road Vernon, Vermont 05302
MANAGERS:	Michael R. Kansler – Management Committee Member
EXECUTIVE PERSONNEL	Michael R. Kansler – Chief Executive Officer & President Robert D. Sloan – Executive VP, General Counsel & Secretary John T. Herron – Senior VP & Chief Operating Officer Wanda Curry – Vice President, Chief Financial Officer, Nuclear Operations Steven C. McNeal – VP & Treasurer Theodore A. Sullivan – VP, Operations Paul A. Castanon – Assistant Secretary Mary Ann Valladares – Assistant Treasurer Patricia A. Galbraith – Tax Officer Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents.**

NAME:	Entergy Nuclear Indian Point 2, LLC [NRC Licensed Entity]
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	Bleakley Avenue and Broadway Buchanan, New York 10511
MANAGERS:	Michael R. Kansler – Management Committee Member
EXECUTIVE PERSONNEL	Michael R. Kansler – Chief Executive Officer & President Robert D. Sloan – Executive VP & Secretary John T. Herron – Senior VP & Chief Operating Officer Wanda Curry – VP, Chief Financial Officer, Nuclear Operations Fred R. Dacimo – Vice President, Operations Steven C. McNeal – VP & Treasurer Paul A. Castanon – Assistant Secretary Mary Ann Valladares – Assistant Treasurer Patricia A. Galbraith – Tax Officer Rory L. Roberts – Tax Officer

ATTACHMENT 1

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear Indian Point 3, LLC [NRC Licensed Entity]
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	Bleakley Avenue and Broadway Buchanan, New York 10511
MANAGERS:	Michael R. Kansler – Management Committee Member
EXECUTIVE PERSONNEL	Michael R. Kansler – Chief Executive Officer & President John T. Herron – Senior VP & Chief Operating Officer Robert D. Sloan – Executive VP, General Counsel & Secretary Wanda Curry – VP, Chief Financial Officer, Nuclear Operations Fred R. Dacimo – Vice President, Operations Steven C. McNeal – VP & Treasurer Paul A. Castanon – Assistant Secretary Mary Ann Valladares – Assistant Treasurer Patricia A. Galbraith – Tax Officer Rory L. Roberts – Tax Officer

ATTACHMENT I

**General Corporate Information Regarding the NRC Licensed Entities
and Their Corporate Parents**

NAME:	Entergy Nuclear Palisades, LLC [NRC Licensed Entity]
STATE OF INCORPORATION:	Delaware
BUSINESS ADDRESS:	27780 Blue Star Memorial Highway Covert, Michigan 49043
MEMBER (MEMBER MANAGED LLC):	Entergy Nuclear Midwest Investment Company, LLC – Member
EXECUTIVE PERSONNEL	Michael R. Kansler – President Terence A. Burke – VP & Secretary Steven C. McNeal – VP & Treasurer Christopher J. Schwartz – VP, Operations Dana Atchison – Assistant Secretary Amy A. Blaylock – Assistant Secretary Paul A. Castanon – Assistant Secretary David Gibbs – Assistant Treasurer Patricia A. Galbraith – Tax Officer Rory L. Roberts – Tax Officer

ATTACHMENT 2

Projected Balance Sheets: 2007-2012

(Non-Proprietary Version).

Entergy Nuclear Finance Holding, LLC (Consolidated) -- Projected Balance Sheets (2007-2012)

Dollars in Thousands

Projected Balance as of December 31

Forecast as of April 2007

2007

2008

2009

2010

2011

2012

ASSETS:

Cash

Accounts Receivable

Fuel

Inventory

Notes Receivable

Net Plant

Decommissioning Trust Funds

Prepayments & Other

Total Assets**LIABILITIES:**

Accounts Payable

Accum. Def. Income Taxes

Accrued Pension Liability and Other

Notes Payable (1)

Decommissioning Liability

Other Liabilities

Total Liabilities**EQUITY:**

Member's Interest

Retained Earnings

Total Equity (1)

Total Liabilities & Equity

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Indian Point 2, LLC -- Projected Balance Sheets (2007-2012)

Dollars in Thousands

Projected Balance as of December 31

Forecast as of April 2007

2007

2008

2009

2010

2011

2012

ASSETS:

Cash

Accounts Receivable

Fuel

Inventory

Notes Receivable

Net Plant

Decommissioning Trust Funds

Prepayments & Other

Total Assets

LIABILITIES:

Accounts Payable

Accum. Def. Income Taxes

Accrued Pension Liability

Notes Payable

Decommissioning Liability

Other Liabilities

Total Liabilities

EQUITY:

Member's Interest

Retained Earnings

Total Equity

Total Liabilities & Equity

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Indian Point 3, LLC -- Projected Balance Sheets (2007-2012)

Dollars in Thousands

Projected Balance as of December 31:

Forecast as of April 2007

2007

2008

2009

2010

2011

2012

ASSETS:

Cash

Accounts Receivable

Fuel

Inventory

Notes Receivable

Net Plant (1)

Decommissioning Trust Funds

Prepayments & Other

Total Assets

LIABILITIES:

Accounts Payable

Accum. Def. Income Taxes

Accrued Pension Liability

Notes Payable

Decommissioning Liability

Other Liabilities

Total Liabilities

EQUITY:

Member's Interest

Retained Earnings

Total Equity

Total Liabilities & Equity

Entergy Nuclear Vermont Yankee, LLC -- Projected Balance Sheets (2007-2012)

Dollars in Thousands

Projected Balance as of December 31

Forecast as of April 2007

2007

2008

2009

2010

2011

2012

ASSETS:

Cash

Accounts Receivable

Fuel

Inventory

Notes Receivable

Net Plant

Decommissioning Trust Funds

Prepayments & Other

Total Assets

LIABILITIES:

Accounts Payable

Accum. Def. Income Taxes

Accrued Pension Liability

Notes Payable

Decommissioning Liability

Other Liabilities

Total Liabilities

EQUITY:

Member's Interest

Retained Earnings

Total Equity

Total Liabilities & Equity

Entergy Nuclear FitzPatrick, LLC -- Projected Balance Sheets (2007-2012)

Dollars in Thousands

Projected Balance as of December 31:

Forecast as of April 2007

2007

2008

2009

2010

2011

2012

ASSETS:

Cash

Accounts Receivable

Fuel

Inventory

Notes Receivable

Net Plant (1)

Decommissioning Trust Funds

Prepayments & Other

Total Assets

LIABILITIES:

Accounts Payable

Accum. Def. Income Taxes

Accrued Pension Liability

Notes Payable

Decommissioning Liability

Other Liabilities

Total Liabilities

EQUITY:

Member's Interest

Retained Earnings

Total Equity

Total Liabilities & Equity

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Generation Company -- Projected Balance Sheets (2007-2012)

Dollars in Thousands

Projected Balance as of December 31

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
ASSETS:						
Cash						
Accounts Receivable						
Fuel						
Inventory						
Notes Receivable						
Net Plant						
Decommissioning Trust Funds						
Prepayments & Other						
Total Assets						
LIABILITIES:						
Accounts Payable						
Accum. Def. Income Taxes						
Accrued Pension Liability						
Notes Payable						
Decommissioning Liability						
Other Liabilities						
Total Liabilities						
EQUITY:						
Member's Interest						
Retained Earnings						
Total Equity						
Total Liabilities & Equity						

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Palisades, LLC -- Projected Balance Sheets (2007-2012)

Dollars in Thousands

Projected Balance as of December 31

Forecast as of April 2007

2007

2008

2009

2010

2011

2012

ASSETS:

Cash

Accounts Receivable

Fuel

Inventory

Notes Receivable

Net Plant

Decommissioning Trust Funds

Prepayments & Other

Total Assets

LIABILITIES:

Accounts Payable

Accum. Def. Income Taxes

Accrued Pension Liability and Other

Notes Payable

Decommissioning Liability

Other Liabilities

Total Liabilities

EQUITY:

Member's Interest

Retained Earnings

Total Equity

Total Liabilities & Equity

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

ATTACHMENT 3

Projected Income Statements: 2007-2012:

(Non-Proprietary Version)

Entergy Nuclear Finance Holding, LLC (Consolidated) -- Projected Income Statements (2007-2012)

Dollars in Thousands

Forecast as of April 2007

Entergy Nuclear MDC

2007 2008 2009 2010 2011 2012

Projected Capacity Factor

Average Contract Price \$/MWh

Average Market Price \$/MWh

Power Sales - Contract

Power Sales - Market

Total Revenue

Operation & Maintenance

O&M

Outage

Insurance

Other

Fuel

DOE Charges

Amortization

Plant Depreciation

Other

Interest Income

Interest Expense

Decommissioning

Administrative & Other

Total Operating Expenses

Operating Profit

Income Taxes

Net Income

Note: Assumes 01/01/08 Close

Total Operating Expenses

Add:

Ongoing Capital Expenditures

Less:

Plant Depreciation

Variable Outside Goods & Services

(25% of 25% of O&M)

Fuel

Outage

Annual Fixed Operating Expenses

6 Months' Operating Expenses

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Indian Point 2, LLC -- Projected Income Statements (2007-2012)

Dollars in Thousands

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
Indian Point 2 MDC						
Projected Capacity Factor						
Average Contract Price \$/MWh						
Average Market Price \$/MWh						
Power Sales - Contract						
Power Sales - Market						
Total Revenue						
Operation & Maintenance						
O&M						
Outage						
Insurance						
Other						
IP-1						
Fuel						
DOE Charges						
Amortization						
Plant Depreciation						
Other						
Interest Income						
Interest Expense						
Decommissioning						
Administrative & Other						
Total Operating Expenses						
Operating Profit						
Income Taxes						
Net Income						
Note: Assumes 01/01/08 Close						
Total Operating Expenses						
Add:						
Ongoing Capital Expenditures						
Less:						
Plant Depreciation						
Variable Outside Goods & Services						
(25% of 25% of O&M)						
Fuel						
Outage						
Annual Fixed Operating Expenses						
6 Months' Operating Expenses						

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Indian Point 3, LLC -- Projected Income Statements (2007-2012)

Dollars in Thousands

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
IP3 MDC						
Projected Capacity Factor						
Average Contract Price \$/MWh						
Average Market Price \$/MWh						
Power Sales - Contract						
Power Sales - Market						
Total Revenue						
Operation & Maintenance						
O&M						
Outage						
Insurance						
Other						
Fuel						
DOE Charges						
Amortization						
Plant Depreciation						
Other						
Interest Income						
Interest Expense						
Decommissioning						
Administrative & Other						
Total Operating Expenses						
Operating Profit						
Income Taxes						
Net Income						
Note: Assumes 01/01/08 Close						
Total Operating Expenses						
Add:						
Ongoing Capital Expenditures						
Less:						
Plant Depreciation						
Variable Outside Goods & Services (25% of 25% of O&M)						
Fuel						
Outage						
Annual Fixed Operating Expenses						
6 Months' Operating Expenses						

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Vermont Yankee, LLC -- Projected Income Statements (2007-2012)

Dollars in Thousands

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
Vermont Yankee MDC						
Projected Capacity Factor						
Average Contract Price \$/MWh						
Average Market Price \$/MWh						
Power Sales - Contract						
Power Sales - Market						
Total Revenue						
Operation & Maintenance						
O&M						
Outage						
Insurance						
Other						
Fuel						
DOE Charges						
Amortization						
Plant Depreciation						
Other						
Interest Income						
Interest Expense						
Decommissioning						
Administrative & Other						
Total Operating Expenses						
Operating Profit						
Income Taxes						
Net Income (1)						
Note: Assumes 01/01/08 Close						
Total Operating Expenses						
Add:						
Ongoing Capital Expenditures						
Less:						
Plant Depreciation						
Variable Outside Goods & Services (25% of 25% of O&M)						
Fuel						
Outage						
Annual Fixed Operating Expenses						
6 Months' Operating Expenses						

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Vermont Yankee, LLC -- Cash Flow Statements (2007-2012)

Dollars in Thousands

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
OPERATING ACTIVITIES						
Net Income						
Non-Cash Items Included in Net Income:						
Depreciation, Amortization, Decommissioning and Deferred Income Taxes						
Other						
NET CASH FLOW PROVIDED BY (USED IN) OPERATING ACTIVITIES						
INVESTING ACTIVITIES						
Construction Expenditures						
Nuclear Fuel Purchase						
Decommissioning Trust Contributions and Realized Changes in Trust Assets						
NET CASH FLOW PROVIDED BY (USED IN) INVESTING ACTIVITIES						
FINANCING ACTIVITIES						
Proceeds from Issuance of:						
Long-Term Debt						
Retirement of:						
Long-Term Debt						
Notes from Parents / Associated Companies						
Other						
NET CASH FLOW PROVIDED BY (USED IN) FINANCING ACTIVITIES						
Net Increase (Decrease) in Cash and Cash Equivalents						
Cash and Cash Equivalents at Beginning of Period						
CASH AND CASH EQUIVALENTS AT END OF PERIOD						

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear FitzPatrick, LLC -- Projected Income Statements (2007-2012)

Dollars in Thousands

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
Fitzpatrick MDC						
Projected Capacity Factor						
Average Contract Price \$/MWh						
Average Market Price \$/MWh						
Power Sales - Contract						
Power Sales - Market						
Total Revenue						
Operation & Maintenance						
O&M						
Outage						
Insurance						
Other						
Fuel						
DOE Charges						
Amortization						
Plant Depreciation						
Other						
Interest Income						
Interest Expense						
Decommissioning						
Administrative & Other						
Total Operating Expenses						
Operating Profit						
Income Taxes						
Net Income						
Note: Assumes 01/01/08 Close						
Total Operating Expenses						
Add:						
Ongoing Capital Expenditures						
Less:						
Plant Depreciation						
Variable Outside Goods & Services						
(25% of 25% of O&M)						
Fuel						
Outage						
Annual Fixed Operating Expenses						
6 Months' Operating Expenses						

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Generation Company -- Projected Income Statements (2007-2012)

Dollars in Thousands

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
Pilgrim MDC						
Projected Capacity Factor						
Average Contract Price \$/MWh						
Average Market Price \$/MWh						
Power Sales - Contract						
Power Sales - Market						
Total Revenue						
Operation & Maintenance						
O&M						
Outage						
Insurance						
Other						
Fuel						
DOE Charges						
Amortization						
Plant Depreciation						
Other						
Interest Income						
Interest Expense						
Decommissioning						
Administrative & Other						
Total Operating Expenses						
Operating Profit						
Income Taxes						
Net Income						
Note: Assumes 01/01/08 Close						
Total Operating Expenses						
Add:						
Ongoing Capital Expenditures						
Less:						
Plant Depreciation						
Variable Outside Goods & Services						
(25% of 25% of O&M)						
Fuel						
Outage						
Annual Fixed Operating Expenses						
6 Months' Operating Expenses						

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Palisades, LLC -- Projected Income Statements (2007-2012)

Dollars in Thousands

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
Palisades MDC						
Projected Capacity Factor						
Average Contract Price \$/MWh						
Average Market Price \$/MWh						
Power Sales - Contract						
Power Sales - Market						
Total Revenue						
Operation & Maintenance						
O&M						
Outage						
Insurance						
Other						
Big Rock ISFI						
Fuel						
DOE Charges						
Amortization						
Plant Depreciation						
Other						
Interest Income						
Interest Expense						
Decommissioning						
Administrative & Other						
Total Operating Expenses						
Operating Profit						
Income Taxes						
Net Income						
Note: Assumes 01/01/08 Close						
Total Operating Expenses						
Add:						
Ongoing Capital Expenditures						
Less:						
Plant Depreciation						
Variable Outside Goods & Services						
(25% of 25% of O&M)						
Fuel						
Outage						
Annual Fixed Operating Expenses						
6 Months' Operating Expenses						

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Finance Holding, LLC (Consolidated) -- Projected Income Statements (2007-2012)
Sensitivity (10% Reduction in Revenue)

Dollars in Thousands

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
Entergy Nuclear MDC						
Projected Capacity Factor						
Average Contract Price \$/MWh						
Average Market Price \$/MWh						
Power Sales - Contract						
Power Sales - Market						
Total Revenue						
Operation & Maintenance						
O&M						
Outage						
Insurance						
Other						
Fuel						
DOE Charges						
Amortization						
Plant Depreciation						
Other						
Interest Income						
Interest Expense						
Decommissioning						
Administrative & Other						
Total Operating Expenses						
Operating Profit						
Income Taxes						
Net Income						
Note: Assumes 01/01/08 Close						
Total Operating Expenses						
Add:						
Ongoing Capital Expenditures						
Less:						
Plant Depreciation						
Variable Outside Goods & Services						
(25% of 25% of O&M)						
Fuel						
Outage						
Annual Fixed Operating Expenses						
6 Months' Operating Expenses						

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Energy Nuclear Indian Point 2, LLC -- Projected Income Statements (2007-2012)
Sensitivity (10% Reduction in Revenue)

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
Indian Point 2 MDC						

Projected Capacity Factor

Average Contract Price \$/MWh
 Average Market Price \$/MWh

Power Sales - Contract
 Power Sales - Market

Total Revenue

Operation & Maintenance

O&M
 Outage
 Insurance
 Other
 IP-1

Fuel

DOE Charges
 Amortization

Plant Depreciation

Other

Interest Income
 Interest Expense
 Decommissioning
 Administrative & Other

Total Operating Expenses

Operating Profit

Income Taxes

Net Income

Note: Assumes 01/01/08 Close

Total Operating Expenses

Add:

Ongoing Capital Expenditures

Less:

Plant Depreciation
 Variable Outside Goods & Services
 (25% of 25% of O&M)
 Fuel
 Outage

Annual Fixed Operating Expenses

6 Months' Operating Expenses

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Indian Point 3, LLC -- Projected Income Statements (2007-2012)
Sensitivity (10% Reduction in Revenue)

Dollars in Thousands

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
IP3 MDC						
Projected Capacity Factor						
Average Contract Price \$/MWh						
Average Market Price \$/MWh						
Power Sales - Contract						
Power Sales - Market						
Total Revenue						
Operation & Maintenance						
O&M						
Outage						
Insurance						
Other						
Fuel						
DOE Charges						
Amortization						
Plant Depreciation						
Other						
Interest Income						
Interest Expense						
Decommissioning						
Administrative & Other						
Total Operating Expenses						
Operating Profit						
Income Taxes						
Net Income						
Note: Assumes 01/01/08 Close						
Total Operating Expenses						
Add:						
Ongoing Capital Expenditures						
Less:						
Plant Depreciation						
Variable Outside Goods & Services						
(25% of 25% of O&M)						
Fuel						
Outage						
Annual Fixed Operating Expenses						
6 Months' Operating Expenses						

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Vermont Yankee, LLC -- Projected Income Statements (2007-2012)
Sensitivity (10% Reduction in Revenue)

Dollars in Thousands

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
Vermont Yankee MDC	605	605	605	605	605	605

Projected Capacity Factor

Average Contract Price \$/MWh

Average Market Price \$/MWh

Power Sales - Contract

Power Sales - Market

Total Revenue

Operation & Maintenance

O&M

Outage

Insurance

Other

Fuel

DOE Charges

Amortization

Plant Depreciation

Other

Interest Income

Interest Expense

Decommissioning

Administrative & Other

Total Operating Expenses

Operating Profit

Income Taxes

Net Income

Note: Assumes 01/01/08 Close

Total Operating Expenses

Add:

Ongoing Capital Expenditures

Less:

Plant Depreciation

Variable Outside Goods & Services

(25% of 25% of O&M)

Fuel

Outage

Annual Fixed Operating Expenses

6 Months' Operating Expenses

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Energy Nuclear FitzPatrick, LLC -- Projected Income Statements (2007-2012)

Sensitivity (10% Reduction in Revenue)

Dollars in Thousands

Forecast as of April 2007

	2007	2008	2009	2010	2011	2012
Fitzpatrick MDC						
Projected Capacity Factor						
Average Contract Price \$/MWh						
Average Market Price \$/MWh						
Power Sales - Contract						
Power Sales - Market						
Total Revenue						
Operation & Maintenance						
O&M						
Outage						
Insurance						
Other						
Fuel						
DOE Charges						
Amortization						
Plant Depreciation						
Other						
Interest Income						
Interest Expense						
Decommissioning						
Administrative & Other						
Total Operating Expenses						
Operating Profit						
Income Taxes						
Net Income						
Note: Assumes 01/01/08 Close						
Total Operating Expenses						
Add:						
Ongoing Capital Expenditures						
Less:						
Plant Depreciation						
Variable Outside Goods & Services						
(25% of 25% of O&M)						
Fuel						
Outage						
Annual Fixed Operating Expenses						
6 Months' Operating Expenses						

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Generation Company – Projected Income Statements (2007-2012)
Sensitivity (10% Reduction in Revenue)

Dollars in Thousands

Forecast as of April 2007

2007 2008 2009 2010 2011 2012

Pilgrim MDC

Projected Capacity Factor

Average Contract Price \$/MWh

Average Market Price \$/MWh

Power Sales - Contract

Power Sales - Market

Total Revenue

Operation & Maintenance

O&M

Outage

Insurance

Other

Fuel

DOE Charges

Amortization

Plant Depreciation

Other

Interest Income

Interest Expense

Decommissioning

Administrative & Other

Total Operating Expenses

Operating Profit

Income Taxes

Net Income

Note: Assumes 01/01/08 Close

Total Operating Expenses

Add:

Ongoing Capital Expenditures

Less:

Plant Depreciation

Variable Outside Goods & Services

(25% of 25% of O&M)

Fuel

Outage

Annual Fixed Operating Expenses

6 Months' Operating Expenses

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Entergy Nuclear Palisades, LLC -- Projected Income Statements (2007-2012)

Sensitivity (10% Reduction in Revenue)

Dollars in Thousands

Forecast as of April 2007

2007 2008 2009 2010 2011 2012

Palisades MDC

Projected Capacity Factor

Average Contract Price \$/MWh

Average Market Price \$/MWh

Power Sales - Contract

Power Sales - Market

Total Revenue

Operation & Maintenance

O&M

Outage

Insurance

Other

Big Rock ISFI

Fuel

DOE Charges

Amortization

Plant Depreciation

Other

Interest Income

Interest Expense

Decommissioning

Administrative & Other

Total Operating Expenses

Operating Profit

Income Taxes

Net Income

Note: Assumes 01/01/08 Close

Total Operating Expenses

Add:

Ongoing Capital Expenditures

Less:

Plant Depreciation

Variable Outside Goods & Services

(25% of 25% of O&M)

Fuel

Outage

Annual Fixed Operating Expenses

6 Months' Operating Expenses

FORECAST STATEMENTS / ACTUAL RESULTS MAY VARY

Attachment 4

10 CFR 2.390 AFFIDAVIT OF MICHAEL R. KANSLER

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of)	
)	
Entergy Nuclear Operations, Inc.)	
)	
Pilgrim Nuclear Power Station	)	Docket Nos. 50-293
Indian Point Nuclear Generating Unit No. 1	)	50-003
Indian Point Nuclear Generating Unit No. 2	)	50-247
Indian Point Nuclear Generating Unit No. 3	)	50-286
James A. FitzPatrick Nuclear Power Plant	)	50-333
Vermont Yankee Nuclear Power Station	)	50-271
Palisades Nuclear Plant	)	50-255

AFFIDAVIT

I, Michael R. Kansler, President & Chief Executive Officer of Entergy Nuclear Operations, Inc. (ENO), hereby affirm and state:

1. I am authorized to execute this affidavit on behalf of ENO.
2. ENO is providing information in support of an Application for Order Approving Indirect Transfer of Control of Licenses. The documents being provided in Attachment 2A and 3A contain proprietary financial information and financial projections related to the ownership and operation of the generation assets operated by ENO. These documents constitute proprietary commercial and financial information that should be held in confidence by the NRC pursuant to 10 CFR § 2.390(a)(4) because:
 - i. This information is and has been held in confidence by ENO.
 - ii. This information is of a type that is customarily held in confidence by ENO and there is a rational basis for doing so because the information contains sensitive financial information concerning projected revenues and operating expenses of ENO.
 - iii. This information is being transmitted to the NRC voluntarily and in confidence.
 - iv. This information is not available in public sources and could not be gathered readily from other publicly available information.
 - v. Public disclosure of this information would create substantial harm to the competitive position of ENO by disclosing its internal financial projections.

Attachment 5

Form of SUPPORT AGREEMENT

Between

Entergy Nuclear Finance Holding, LLC

and

Entergy Nuclear Generation Company,
Entergy Nuclear FitzPatrick, LLC,
Entergy Nuclear Vermont Yankee, LLC,
Entergy Nuclear Indian Point 2, LLC,
Entergy Nuclear Indian Point 3, LLC, and
Entergy Nuclear Palisades, LLC

THIS SUPPORT AGREEMENT, dated as of _____, 2007 between Entergy Nuclear Finance Holding, LLC, a Delaware corporation ("Parent"), and Entergy Nuclear Generation Company, Entergy Nuclear FitzPatrick, LLC, Entergy Nuclear Vermont Yankee, LLC, Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, and Entergy Nuclear Palisades, LLC (individually, "Subsidiary Licensee" and collectively, "Subsidiary Licensees"),

WITNESSETH:

WHEREAS, through its intermediate subsidiary companies, Parent is the indirect owner of 100% of the outstanding shares of the Subsidiary Licensees;

WHEREAS, the Subsidiary Licensees are the corporate entities that hold the NRC licenses for Pilgrim, Indian Point 2 and 3, FitzPatrick, Vermont Yankee, and Palisades (individually, each a "Facility," and collectively the "Facilities"); and

WHEREAS, Parent and the Subsidiary Licensees desire to take certain actions to assure the ability of the Subsidiary Licensees to pay the pro rata expenses of maintaining the Facilities safely and protecting the public health and safety (the "Operating Expenses") and to meet Nuclear Regulatory Commission ("NRC") requirements during the life of each Facility (the "NRC Requirements").

NOW, THEREFORE, in consideration of the mutual promises herein contained, the parties hereto agree as follows:

1. *Availability of Funding.* From time to time, upon request of Subsidiary Licensees, Parent shall provide or cause to be provided to Subsidiary Licensees such funds as the Subsidiary Licensees determine to be necessary to pay Operating Expenses and meet NRC Requirements; provided, however, in any event the aggregate unreimbursed amount which Parent is obligated to provide under this Agreement at any one time shall not exceed \$700 million.
2. *No Guarantee.* This Support Agreement is not, and nothing herein contained, and no action taken pursuant hereto by Parent shall be construed as, or deemed to constitute, a direct or indirect guarantee by Parent to any person of the payment of the Operating Expenses or of any liability or obligation of any kind or character whatsoever of the Subsidiary Licensees. This Agreement may, however, be relied upon by the NRC in determining the financial qualifications of each Subsidiary Licensee to hold the operating license for a Facility.
3. *Waivers.* Parent hereby waives any failure or delay on the part of the Subsidiary Licensees in asserting or enforcing any of their rights or in making any claims or demands hereunder.
4. *Amendments and Termination.* This Agreement may not be amended or modified at any time without 30 days prior written notice to the NRC. This Agreement shall terminate at such time as Parent is no longer the direct or indirect owner of any of the shares or other ownership interests in a Subsidiary Licensee. This Agreement shall also terminate with respect to the Operating Expenses and NRC Requirements applicable to a Facility whenever such Facility permanently ceases commercial operations and certification is made as to the permanent removal of fuel from the reactor vessel.
5. *Successors.* This Agreement shall be binding upon the parties hereto and their respective successors and assigns.
6. *Third Parties.* Except as expressly provided in Sections 2 and 4 with respect to the NRC, this Agreement is not intended for the benefit of any person other than the parties hereto, and shall not confer or be deemed to confer upon any other such person any benefits, rights, or remedies hereunder.
7. *Other Financial Support Arrangements.* This Agreement supersedes any other support arrangement relating to NRC requirements, if any exists prior to the date hereof, between Parent or any other affiliate that is a signatory hereto, and a Subsidiary Licensee to provide funding when necessary to pay Operating

Expenses and meet NRC Requirements for the Facilities, and any such other financial support arrangement is hereby voided, revoked and rescinded. As such, the total available funding provided for in this Agreement shall be limited as set forth in Section 1 herein and shall not be cumulative with any other financial support arrangement for purposes of meeting NRC requirements that is subject to the jurisdiction of the NRC. For avoidance of doubt, the parties agree that this Section 7 does not apply to financial guarantees or commitments made to third parties, even where such agreements may relate to compliance with NRC requirements. A list of the financial support arrangements rescinded by this paragraph is provided as Schedule A.

8. *Governing Law.* This Agreement shall be governed by the laws of the State of Delaware.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed and delivered by their respective officers thereunto duly authorized as of the day and year first above written.

ACKNOWLEDGED AND AGREED

Entergy Nuclear Finance Holding, LLC

By:

Name: _____

Title: _____

Entergy Corporation

By:

Name: _____

Title: _____

Entergy International Holdings LTD

By:
Name: _____
Title: _____
Entergy International LTD LLC

By:
Name: _____
Title: _____

Entergy Nuclear Generation Company

By:
Name: _____
Title: _____

Entergy Nuclear FitzPatrick, LLC

By:
Name: _____
Title: _____

Entergy Nuclear Vermont Yankee, LLC

By:
Name: _____
Title: _____

Entergy Nuclear Indian Point 2, LLC

By:
Name: _____
Title: _____

Entergy Nuclear Indian Point 3, LLC

By:

Name: _____

Title: _____

Entergy Nuclear Palisades, LLC

By:

Name: _____

Title: _____

Schedule A

Guarantor	Guaranty on behalf of	Amount	Claim
Entergy International LTD LLC	Entergy Nuclear Generation Company	\$50M	Guarantee to NRC for financial assurance to provide for safe plant operation and for decommissioning, through working credit line.
Entergy International LTD LLC	Entergy Nuclear Indian Point 2, LLC	\$35M	Guarantee to NRC for financial assurance to provide for safe plant operation and for decommissioning, through working credit line.
Entergy International Holdings LLC	Entergy Nuclear Vermont Yankee, LLC	\$35M	Guarantee to NRC for financial assurance to provide for safe plant operation and for decommissioning, through working credit line.
Entergy Corporation	Entergy Nuclear Vermont Yankee, LLC	\$35M	If the financial assurance line is below \$35M at the point that it is determined that ENVY will cease operations, ETR will make additional funds available to ENVY, up to \$35M.
Entergy Corporation	Entergy Nuclear Vermont Yankee, LLC	\$25M	If the financial assurance line is below \$25M at the point that it is determined that ENVY will cease operations, ETR will make additional funds available to ENVY, up to \$25M.
Entergy International LTD LLC	Entergy Nuclear FitzPatrick, LLC & Entergy Nuclear Indian Point 3, LLC	\$50M	Guarantee to NRC for financial assurance to provide for safe plant operation and for decommissioning, through working credit line.
Entergy Global, LLC	Entergy Nuclear FitzPatrick, LLC	\$20M	Guarantee to NRC for financial assurance to provide for safe plant operation and for decommissioning, through working credit line.
Entergy Global, LLC	Entergy Nuclear Indian Point 3, LLC	\$20M	Guarantee to NRC for financial assurance to provide for safe plant operation and for decommissioning, through working credit line.
Entergy Global, LLC	Entergy Nuclear Palisades, LLC	\$25M	Guarantee to NRC for financial assurance to provide for safe plant operation through working credit line.

Exhibit U

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PRELIMINARY STATEMENT

This memorandum of law is submitted on behalf of Dr. David Egilman in response to petitioner Eli Lilly and Company's ("Eli Lilly" or "petitioner") memorandum of law in support of its request to modify and extend the Court's mandatory injunction entered January 3, 2007. As Eli Lilly concedes, and as has been noted by this Court, Dr. Egilman is not a party to the instant proceedings, nor is he a subject of petitioner's request for a mandatory injunction. (See Petitioner's Proposed Order for Mandatory Injunction .) Indeed, although Eli Lilly has threatened for more than a month to file charges of contempt against Dr. Egilman, no such charges have been forthcoming. Instead, Eli Lilly has mounted yet another attempt to erode Dr. Egilman's due process rights by asking this Court to prematurely decide issues of fact central to its anticipated contempt motion and irrelevant to its request for an injunction.¹ Specifically, in its papers currently before the Court, Eli Lilly requests that this Court make certain factual findings and legal conclusions which will inevitably prejudice Dr. Egilman's defense against the threatened contempt motion. For several reasons, petitioner's request should be denied.

There are four areas implicated by Eli Lilly's brief which, if decided in petitioner's favor, will have the effect of seriously prejudicing Dr. Egilman's ability to defend against a future contempt motion: (1) the request that the Court find that Dr. Egilman violated CMO-3 when he produced documents to Jim Gottstein in response to Mr. Gottstein's subpoena dated December 6, 2006; (2) Eli Lilly's contention that it acted in good faith when it designated every single one of the millions of documents produced in this matter as "confidential" and subject to the protective order at issue in this case, CMO-3; (3) petitioner request that the Court make certain findings of

¹ We have previously detailed Eli Lilly's prior attempts to use proceedings to which Dr. Egilman was not a party to bootstrap a finding of contempt against our client. (See January 16, 2007, Letter from Alexander A. Reinert to the Court, at 3-4; December 28, 2006, Letter from Alexander A. Reinert to the Court, at 3-4.)

fact regarding Dr. Egilman's actions and intentions which are not supported by admissible evidence and which have no bearing on petitioner's request for an injunction; and (4) Eli Lilly's request that the Court draw adverse factual inferences based on Dr. Egilman's invocation of his right to silence. Because neither the relevant law nor the admissible evidence supports Eli Lilly's premature requests, Dr. Egilman respectfully requests that the Court make no legal or factual findings which relate to Eli Lilly's anticipated motion for contempt against Dr. Egilman.

ARGUMENT

I. ELI LILLY HAS FAILED TO ESTABLISH THAT DR. EGILMAN ACTED IN CONTEMPT OF CMO-3

Eli Lilly asks this Court to adopt several factual findings to the effect that Dr. Egilman violated CMO-3 "in [c]oncert with [o]thers." (Eli Lilly And Co.'s Mem. Of Points And Authorities Concerning Its Request To Modify And Extend The Court's January 3, 2007 Temporary Mandatory Injunction ("Lilly Br.") at 4.) Indeed, Eli Lilly asks this court to find, without factual support, that Dr. Egilman "selectively leaked" documents to affect settlement discussions and "prejudice Lilly's right to a fair trial," (Proposed Revised Findings of Fact ("Proposed Findings") ¶¶ 18, 19), that Dr. Egilman agreed with Alex Berenson "on a scheme to bypass CMO-3 and get the protected documents to the *New York Times*," (*id.* ¶ 24), and that "Dr. Egilman had violated CMO-3 by sending Mr. Gottstein documents that he had received pursuant to the confidentiality provisions of CMO-3" (*id.* ¶ 42).² While petitioner does not explicitly ask this Court to find that Dr. Egilman acted in contempt of CMO-3, if the Court adopts Eli Lilly's

² One of the principal grounds for Eli Lilly's factual findings with regard to Dr. Egilman is his assertion of his Fifth Amendment right to silence. (See Proposed Findings ¶¶ 16-22, 27-28, 37 & n.1; Lilly Br. 4 n.3.) Unfortunately for petitioner, as detailed below, Dr. Egilman's assertion of his right to silence in this context does not

factual findings, it is hard to imagine what additional facts petitioner would present in support of its anticipated contempt motion. For several reasons, petitioner's request should be denied.

A. Eli Lilly Fails to Address the Standard of Proof for Establishing Contempt, and Accompanying Procedural Protections

As this Court is aware, any party seeking to establish contempt bears a "heavy" burden. See Air-Products and Chemicals, Inc. v. Inter-Chemicals, Ltd., No. 03 Civ. 6140, 2005 WL 196543, *3 (E.D. Pa. Jan. 27, 2005); cf. Perez v. Danbury Hosp., 347 F.3d 419, 423 (2d Cir. 2003) (district court's contempt power is "narrowly circumscribed," necessitating a more "exacting" appellate review than other discretionary decisions); see also Jan. 17, 2007 Tr., at 246 (noting that contempt is a "quagmire"). To establish civil contempt, petitioner bears the burden of presenting "clear and convincing" evidence that Dr. Egilman has violated a "clear and unambiguous" judicial order. Fonar Corp. v. Deccaidd Servs., Inc., 983 F.2d 427, 429 (2d Cir. 1993); Hess v. New Jersey Transit Rail Operations, Inc., 846 F.2d 114, 115 (2d Cir. 1988) (explaining that "[n]o one may be held in contempt for violating a court order unless the order is clear and specific and leaves no uncertainty in the minds of those to whom it is addressed"); Littlejohn v. BIC Corp., 851 F.2d 673, 683-84 (3d Cir. 1988); Lesco v. Masone, No. 05 Civ. 3207, 2006 WL 2166862, *5 (E.D.N.Y. July 27, 2006). To establish criminal contempt, which results in the imposition of punitive sanctions,³ Eli Lilly must establish beyond a reasonable doubt that Dr. Egilman violated a similarly specific judicial order. Mackler Productions, Inc. v. Cohen, 225 F.3d 136, 142 (2d Cir. 2000); United States v. NYNEX Corp., 8 F.3d 52, 54 (D.C. Cir. 1993) (requiring willful violation of specific order).

give Lilly free rein to imagine a set of facts which are "not inconsistent," (Lilly Br. 4 n.3) with evidence which has been submitted in this proceeding. See *infra* Part III.B.

³ To be considered a "criminal" contempt proceeding, it is not necessary that a Court impose restrictions on the contemnor's liberty, such as jail or prison time. Indeed, fines as little as \$1000 have been considered sufficient

Because of the serious nature of contempt charges, certain procedural protections must be satisfied prior to issuing a judgment of contempt. In civil contempt proceedings, the alleged contemnor is entitled to notice of the grounds for the contempt and an opportunity to be heard, but is not obliged to present any evidence should the movant fail in establishing any of the three elements of contempt. Perez, 347 F.3d at 423 (movant has burden of proof); Electrical Workers Pension Trust Fund v. Gary, 340 F.3d 373, 379 (6th Cir. 2003) (burden of proof and production rests with movant); see generally International Union, United Mine Workers of America v. Bagwell, 512 U.S. 821, 826-34 (1994) (discussing difference in protections provided for criminal versus civil contempt). In the criminal contempt context, even more protections apply, including “the right to a public trial, the assistance of counsel, the presumption of innocence, the privilege against self-incrimination, and the requirement of proof beyond a reasonable doubt.” Mackler Productions, Inc. v. Cohen, 225 F.3d 136, 142 (2d Cir. 2000); see also Bloom v. Illinois, 391 U.S. 194 (1968) (criminal procedural protections apply to criminal contempt proceedings). In no event may the movant rely on unsworn assertions to establish the critical elements of civil or criminal contempt. Mackler Productions, 225 F.3d at 146 (it is error to rely on unsworn assertions to establish sanctions in contempt). And to support claims for damages, the movant must provide concrete evidence of harm. Mingoia v. Crescent Wall Sys., No. 03 Civ. 7143, 2005 WL 991773, *5 (S.D.N.Y. April 26, 2005).

For these reasons, courts have emphasized the importance early on of indicating whether the contempt proceedings are criminal or civil in nature, so that the appropriate procedural and substantive protections may be provided to the alleged contemnor. In re Jessen, 738 F. Supp. 960, 962 (W.D.N.C. 1990); cf. Ashcraft v. Conoco, Inc., 1998 WL 404491, *2 n.2 (E.D.N.C.,

to trigger the due process protections associated with criminal prosecution. Hess v. New Jersey Transit Rail

Jan. 21, 1998), rev'd on other grounds, 218 F.3d 288 (4th Cir. 2000). This is because if the civil/criminal determination affects both the remedy that a court may impose and the procedural protections that must be followed throughout the proceeding. Hess v. New Jersey Transit Rail Operations, Inc., 846 F.2d 114, 115 (2d Cir. 1988) (sanction of as little as \$1000 considered exercise of criminal contempt power because purpose was to punish for past violations).

B. Eli Lilly's Request that the Court Find that Dr. Egilman Violated CMO-3 Disregards Its Burden and Dr. Egilman's Due Process Rights

Eli Lilly ignores each of these basic principles in asking the Court to find that Dr. Egilman willfully violated CMO-3. For instance, although petitioner has consistently indicated that it seeks to obtain punitive sanctions for Dr. Egilman's alleged violation of CMO-3, (see, e.g., December 26, 2006, Letter from Nina M. Gussack to the Court, at 1), Eli Lilly seeks here to use Dr. Egilman's invocation of his right to silence to establish certain facts which will inevitably prejudice any future criminal contempt proceeding. (See Proposed Findings ¶¶ 16-22, 27-28, 37 & n.1; Lilly Br. 4 n.3.) In its haste to prematurely convince this Court that Dr. Egilman acted in contempt of CMO-3, Eli Lilly makes no effort to square its desire to pursue criminal sanctions against Dr. Egilman, which triggers the protections of the Fifth Amendment, Mackler Productions, 225 F.3d at 142, with its request that the Court hold Dr. Egilman's silence against him.⁴

Moreover, Eli Lilly has asked this Court to find that Dr. Egilman violated CMO-3 without even attempting to satisfy its burden of establishing that Dr. Egilman violated a "clear and specific" order. Hess, 846 F.2d at 115. After all, Eli Lilly concedes that Dr. Egilman complied with that part of CMO-3 which required him to notify petitioner that he had been

Operations, Inc., 846 F.2d 114, 115 (2d Cir. 1988).

served with a subpoena requesting disclosure of “confidential” documents. (Proposed Findings ¶ 38; Lilly Br. 5.) Therefore, Eli Lilly must establish that CMO-3 clearly and specifically communicated what constituted a “reasonable opportunity” for Eli Lilly to object to production of the documents. (Proposed Findings, Ex. 2, at ¶ 14.)

Eli Lilly cannot claim that it did not have notice of the anticipated disclosure. Nor can petitioner claim that Dr. Egilman’s failure to notify Pepper Hamilton directly – a failing not of Dr. Egilman’s making but of the protective order that had been drafted by Eli Lilly – prejudiced its rights, because it asserts that it “promptly” provided notice of the subpoena to its outside counsel, and that these counsel “took immediate steps to determine who had retained” Dr. Egilman.⁵ (Lilly Br. 5.) Although Eli Lilly does not detail the steps it took, given the stated importance of the documents, one would expect that petitioner had a reasonable opportunity to make its objection known to Dr. Egilman before he disclosed the documents to Mr. Gottstein.⁶ In any event, the factual record is simply insufficient at this time to make that determination, although we note in passing that in litigating the issues currently before the Court, Eli Lilly has adopted the position that one or two days’ notice to address complex legal issues – such as the propriety of Orders to Show Cause or mandatory injunctions – is sufficient for other parties. (See, e.g., Eli Lilly’s Proposed Order to Show Cause Issued to Dr. David Egilman (submitted on

⁴ The significance of Dr. Egilman’s Fifth Amendment rights in this proceeding is addressed more fully in Part III.B of this brief.

⁵ Eli Lilly makes the bald assertion that it could not contact Dr. Egilman directly, because of his status as an expert, but it is far from clear that any ethical rule prohibited Mr. Armitage from contacting Dr. Egilman about a matter that had no connection to Dr. Egilman’s consultation with The Lanier Law Firm. In any event, there was no arguable prohibition on contacting Mr. Gottstein, whose contact information was provided in the material sent to Mr. Armitage. (Jan. 17, 2007, Tr. 129.)

⁶ Eli Lilly has refused to make its General Counsel available for a deposition to determine what steps were taken to make petitioner’s objections known to Dr. Egilman. Eli Lilly appears to base its argument in favor of contempt on the ground that Richard Meadow testified that he contacted Dr. Egilman and informed him “not to do anything.” (Proposed Findings, Ex. 3, ¶ 9.) Notwithstanding the fact that there is no evidence that Mr. Meadow told Dr. Egilman that Eli Lilly intended to move to prevent disclosure, or had moved to prevent disclosure, because

December 26, 2006, and calling for a response within 24 hours).)

Moreover, Dr. Egilman's actions with respect to the subpoena were consistent with the language of CMO-3, which only contained one defined time limit where an individual intends to disclose confidential documents. Specifically, CMO-3, drafted by Eli Lilly, provides only three days' notice to petitioner where disclosure of confidential information is to be made to a customer or competitor of Eli Lilly. (Proposed Findings, Ex. 2, at ¶ 6.). If, after three days has passed, no motion is filed objecting to the proposed disclosure, then CMO-3 is not violated. Given that Eli Lilly asserts that the principal purpose of the confidentiality designations in this case is to protect its competitive advantage, it defies reason for Eli Lilly to simultaneously argue that the notice provided in the instant case did not afford it sufficient opportunity to raise an objection to disclosure.

Even if the Court determines now that Eli Lilly did not have a reasonable opportunity to object to Dr. Egilman's disclosure, this does not end the inquiry, because petitioner must still show that CMO-3 specifically defines what is meant by "a reasonable opportunity to object." In contempt proceedings, whether criminal or civil, ambiguities must be resolved in "favor of the party charged with contempt." Air-Products and Chemicals, Inc. v. Inter-Chemicals, Ltd., No. 03 Civ. 6140, 2005 WL 196543, *3 (E.D. Pa. Jan. 27, 2005). For instance, where a protective order fails to spell out specific steps to be taken with protected documents, it is error to find even an attorney, judged to be better able to decipher ambiguous court orders, see United States v. Cutler, 58 F.3d 825, 835 (2d Cir. 1995), in contempt for revealing confidential information, Littlejohn v. BIC Corp., 851 F.2d 673, 686 (3d Cir. 1988). And where it is not apparent from the Order what kind of conduct is prohibited, then the Order will not be considered sufficiently

Mr. Meadow's telephone call occurred after a Eli Lilly had had a reasonable opportunity to object to disclosure, it

clear and specific to support a contempt finding. NYNEX Corp., 8 F.3d at 55-57.

Notably, court orders which were more clear and specific than CMO-3 have been found insufficiently clear to justify contempt in other contexts. For instance, where a district court ordered a litigant to “stay out of the facilities up here on this floor unless you get prior permission. That’s the jury room, also;” this was not considered sufficiently clear and unambiguous to support contempt for a defendant who was found in the jury room after the Order was issued. United States v. O’Quinn, 913 F.2d 221, 222 (5th Cir. 1990) (per curiam). And the Second Circuit has held that the phrase “bonafide offer of settlement” is “vague and imprecise” and therefore will not support a conviction for contempt. Hess v. New Jersey Transit Rail Operations, Inc., 846 F.2d 114, 115 (2d Cir.1988). Just as in Hess, in which the Court could not decipher what kind of settlement offer would be a “bonafide” one, here it is impossible to state precisely what is meant by “reasonable opportunity to object” as used in CMO-3. Similarly, the Second Circuit has held that an order that prohibited a party from using certain software was insufficient to support contempt where the order “never defined precisely what constituted ‘Maintenance Software.’” Fonar Corp. v. Deccaid Servs., Inc., 983 F.2d 427, 429 (2d Cir. 1993); see also John Paul Mitchell Sys. v. Quality King Distributors, Inc., No. 99 Civ. 9905, 2001 WL 910405, *7 (S.D.N.Y. Aug. 13, 2001) (order, which prevented Quality King from “movement, transfer, or other distribution” of a product, did not clearly prohibit company from purchasing and receiving products (and thereby “moving” the products to its own warehouse), nor did it prohibit company from aiding the sale of product by another company, because Order simply forbid the company “from itself distributing the products”). The Court noted that even if the defendant could be charged with actual knowledge of what the term

has no bearing on the issue of Dr. Egilman’s alleged contempt.

“Maintenance Software” meant, it would not matter, because the Order must be “clear and unambiguous” in a more objective sense. Fonar Corp., 983 F. 2d at 429. And this Circuit has seen numerous incidents in which even attorneys, expected to “comply with less specific orders than laymen,” see Cutler, 58 F.3d at 835, have not been sanctioned for violating confidentiality, say, of settlement discussions, despite a clear prohibition of such disclosures. Calka v. Kucker Kraus & Bruh, 167 F.3d 144, 145 (2d Cir. 1999) (per curiam) (declining to impose sanction for attorney who violated confidentiality of CAMP proceedings); E-Z Bowz, L.L.C. v. Professional Prod. Res. Co., No. 00 Civ. 8670, 2003 WL 22416174, *3 (S.D.N.Y. Oct. 23, 2003) (declining to impose sanctions on attorney which violated court’s confidentiality order regarding settlement discussions); Concerned Citizens of Bell Haven v. The Belle Haven Club, No. 99 Civ. 1467, 2002 WL 32124959, *5-6 (D. Conn. Oct. 25, 2002) (declining to impose sanction on party which publicly disclosed confidential settlement discussions).

The imprecision of CMO-3 is reinforced by those courts, in other legal contexts, that have noted the difficulty of interpreting the term “reasonable opportunity.” Three Boys Music Corp. v. Bolton, 212 F.3d 477, 482 (9th Cir. 2000) (in copyright protection case, noting that “reasonable opportunity” is something more than “bare possibility,” but distinguishing the two will sometimes “present a close question”) (internal quotation marks omitted); Morgan v. Account Collection Technology, LLC, No. 05 Civ. 2131, 2006 WL 2597865, *4 (S.D.N.Y. Sept. 6, 2006) (noting that courts have not agreed on what constitutes a “reasonable opportunity” to file for class certification prior to a Rule 68 offer of judgment). To be sufficiently clear for purposes of contempt, there must have been “nothing ambiguous about [Dr. Egilman’s] obligations” under CMO-3. JSC Foreign Economic Ass’n v. International Development & Trade Servs., Inc., No. 03 Civ. 5562, 2006 WL 1148110, *5 (S.D.N.Y. April 28, 2006). Eli Lilly has

made no argument here that the CMO-3 unambiguously defined what constituted a “reasonably opportunity to object” to Dr. Egilman’s disclosure of documents to Mr. Gottstein.⁷ Instead, petitioner attempts to tar Dr. Egilman with testimony from Mr. Gottstein that he thought that Dr. Egilman thought that the documents should be publicly disseminated. (Jan. 16, 2007, Tr. at 26.) Putting aside the question of whether Mr. Gottstein’s speculation amounts to clear and convincing evidence, or evidence beyond a reasonable doubt, of Dr. Egilman’s motives, the CMO-3 does not prohibit individuals subject to the protective order from having a particular state of mind with respect to the disclosure of “confidential” documents; it prohibits disclosure of such documents without following the procedures laid out by CMO-3. If anything, however, Mr. Gottstein’s testimony establishes that Dr. Egilman considered himself to be bound by the terms of the protective order, and sought to meet its terms as he interpreted them. (Id. at 27-30, 49-51; Jan. 17, 2007, Tr. at 75, 121-22, 133.) Whether Dr. Egilman simultaneously hoped that the documents would be publicly disseminated is irrelevant here, where Dr. Egilman did not violate a clear and specific court order upon disclosure of the documents to Mr. Gottstein. See United States v. NYNEX Corp., 8 F.3d 52, 55 (D.C. Cir. 1993) (in criminal contempt case, criticizing failure to distinguish between the need for violation to be willful and for the order to be clear and reasonably specific).

II. ELI LILLY HAS FAILED TO ESTABLISH ITS OWN COMPLIANCE WITH CMO-3

Aside from Eli Lilly’s failure to establish that Dr. Egilman acted in contempt of CMO-3,

⁷ Similarly, Eli Lilly’s apparent contention that the CMO-3 “clearly and unambiguously,” Fonar Corp., 983 F.2d at 429, called for Dr. Egilman to notify the Pepper Hamilton law firm rather than Eli Lilly itself is questionable. The CMO-3 refers nowhere to the Pepper Hamilton law firm and instead simply directs subpoena recipients to

petitioner also has failed to abide by this Court's direction that it provide an explanation for why the documents disclosed by Dr. Egilman should be considered "confidential." Paragraph 3 of CMO-3 defines confidential material as "any information that the producing party in good faith believes is properly protected under [Fed. R. Civ. P.] 26(c)(7)." (See Proposed Findings, Ex. 2.) Rule 26(c)(7), in turn, allows for the issuance of orders when necessary to protect "a trade secret or other confidential research, development, or commercial information." Fed. R. Civ. P. 26(c)(7). The Federal Rules recognize a "presumptive right of public access to discovery in all civil cases," absent a showing of good cause for a protective order pursuant to Rule 26(c).

Loussier v. Universal Music Group, Inc., 214 F.R.D. 174, 176-177 (S.D.N.Y. 2003); see also In re "Agent Orange" Product Liability Litigation, 821 F.2d 139, 145-46 (2d Cir. 1989).⁸ As the Supreme Court has recognized when drawing analogies between FOIA disclosures and the Federal Rules, "there is no absolute privilege for trade secrets and similar confidential information." Federal Open Market Committee of Federal Reserve System v. Merrill, 443 U.S. 340, 362 (1979) (quoting 8 C. Wright & A. Miller, Federal Practice and Procedure § 2043, p.

300 (1970).) Accordingly, the proponent of a protective order under Rule 26(c)(7) must show both that the confidentiality of trade secrets or commercial information is threatened, and that good cause exists to shield it from the public. Eli Lilly fails to satisfy either of these standards, despite the Court's direction at the January 17, 2007, proceedings to "be very specific" about "which of the documents that were exposed are documents, one, that constitute trade secrets or embarrassment of the other language under the rules and how their release has harmed you."

contact the party responsible for the confidentiality designation, which Eli Lilly has conceded was done immediately by Dr. Egilman.

⁸ In endorsing the protective order, in fact, the Court explicitly recognized that the public "has a right to know" about the subject documents, except to the extent that disclosure would undermine petitioner's ability to market Zyprexa in a competitive environment. (See Proposed Findings, Ex. 1, at 10-11.) The Court's concern was

(Jan. 17, 2007, Tr. at 242; see also id. at 243 (“[Y]ou are going to as quickly as possible tell them . . . which of the documents released you are going to specifically rely on, because I cannot, I believe, deal with the case on the ground that I know that in the millions of pages that we now have in our depository, there are some documents that should not have been released.”).)

In New York, “[t]he subject of the trade secret must be secret” and “known only in the particular business in which it is used.” DDS, Inc. v. Lucas Aerospace Power Transmission Corp., 182 F.R.D. 1, 4 (N.D.N.Y. 1998) (internal quotation marks and citation omitted). Federal courts in the Second Circuit look to six non-exclusive factors to determine whether information satisfies this test: “(1) the extent to which the information is known outside the business; (2) the extent to which it is known by employees and others involved in the business; (3) the measures taken to guard the information's secrecy; (4) the value of the information to the business or to its competitors; (5) the amount of time, money, and effort expended in development of the information; and (6) the ease or difficulty of duplicating or properly acquiring the information.” Chembio Diagnostic Systems, Inc. v. Saliva Diagnostic Systems, Inc., 236 F.R.D. 129, 136 (E.D.N.Y. 2006). In satisfying this test, “there must be a specific demonstration of the facts as they relate to all of the factors, a specific articulation of the harm, and no reliance upon stereotypical and conclusory statements that the information is confidential.” Sherwin-Williams Co. v. Spitzer, No. 04 Civ. 185, 2005 WL 2128938, *12 (N.D.N.Y. Aug. 24, 2005); Traveler's Ins. Co. v. Allied-Signal Inc. Master Pension Trust, 145 F.R.D. 17 (D. Conn. 1992) (denying motion for protective order for failure to “identify with particularity any serious harm that would result from public disclosure of the documents”). Moreover, as this Court has noted, “[a]n important factor in determining whether disclosure will cause competitive harm is whether the

not, as Eli Lilly seeks to imply, that psychiatric patients would somehow be harmed by disclosure. (See id.) If

information that the party seeks to protect is current or stale.” In re Agent Orange Product Liability Litigation, 104 F.R.D. 559, 575 (E.D.N.Y. 1985) (collecting cases indicating that information from one to 15 years old is entitled to less protection).

Eli Lilly has not sought to address these standards, or the Court’s direction that it be “very specific” about which documents that were released are protected, because it simply cannot do so. The entirety of Eli Lilly’s argument for the nondisclosure of the materials that were disclosed to Mr. Gottstein is based on a declaration from Gerald Hoffman, who reviewed an unspecified subset of documents more than one year ago. (Ex. A to Lilly Br. at 6.) Eli Lilly relies on Mr. Hoffman’s stale declaration, arguing that there is “substantial overlap” between the documents reviewed by Mr. Hoffman and the documents disclosed by Dr. Egilman. (Lilly Br. 10 n.8.) This is not the specific identification or argument required by the Court, nor does it purport even to meet the Court’s requirement that Eli Lilly be specific about how it has been harmed by the disclosure. Instead, Eli Lilly states without elaboration that the documents protect “confidential, and often draft or preliminary research and development information; strategic planning documents; employee training techniques; regulatory strategy; product development; competitor analyses; market research; potential marketing plans and strategies, or otherwise confidential material.” (Lilly Br. 10.) And Mr. Hoffman, in turn, states that each of the documents “contains information related to: confidential research and development information; strategic plans; marketing plans, strategies; competitive analyses; market research; clinical trials and non-clinical trials; or interactions with key regulators or publishers” and “reveals something about Lilly’s internal organization and structure, qualifies as intelligence data, and if disseminated would be useful to Lilly’s competitors in the atypical antipsychotic marketplace.”

anything, the continued suppression of the subject documents will harm psychiatric patients and their doctors.

(Ex. A to Lilly Br. ¶ 9.)

Notwithstanding Mr. Hoffman's broad brush strokes, however, even Eli Lilly appears to concede that disclosure of some of the documents he reviewed do not, as Mr. Hoffman previously swore under oath, constitute trade secrets or otherwise confidential business information. (Lilly Br. at 12 n. 10 (abandoning claim of confidentiality as to specific documents).) Thus, it is hard to take at face value Eli Lilly's attempt to rely upon his declaration now, when there is no evidence that he reviewed the documents disclosed by Dr. Egilman to Mr. Gottstein, or that his initial determination of confidentiality is reliable. Similarly, Eli Lilly can hardly argue that certain of the documents which have been identified – e.g., press releases and published newspaper articles – cannot be disclosed without disclosing confidential information. (See Proposed Findings, Ex. 11.)

Not only does Mr. Hoffman's declaration fail to meet this Court's direction from the January 17, 2007, hearing, but it also fails to meet the burden of any movant seeking to establish that particular documents are eligible for protection under Rule 26(c)(7). For instance, that a party treats particular documents as confidential "does not mean they are automatically entitled to be subject to a protective order." Houbigant, Inc. v. Development Specialists, Inc., No. 01 Civ. 7388, 2003 WL 21688243, *2 (S.D.N.Y. Jul 21, 2003) (finding that documents relating to audit methodology are privileged, but requiring party to review documents to determine which are properly considered protected material). And reliance on conclusory assertions of confidentiality will doom an application for protective order under Rule 26(c)(7). See Salter v. I.C. System, Inc., No. 04 Civ. 1566, 2005 WL 3941662, *1 (D. Conn. May 3, 2005) (citing Cuno Inc. v. Pall Corp., 117 F.R.D. 506, 508 (E.D.N.Y.1987) (denying defendant's motion for protective order where "motion simply alleges that 'the documents have at all times been

maintained as internal proprietary documents and contain valuable confidential technical information”)).

Moreover, the standard for businesses seeking a protective order is high. While natural persons may seek a protective order to protect against embarrassment, “protective orders are not available . . . to protect businesses from annoyance or embarrassment,” unless the harm can be shown to have a specific monetizable value. Wilcock v. Equidev Capital L.L.C., No. 99 Civ. 10781, 2001 WL 913957, *1 (S.D.N.Y. Aug. 14, 2001) (names of businesses’ clients are not confidential, based solely on speculation that “contacts with clients would be embarrassing or would result in the loss of those clients”). Conclusory allegations of harm, “unsubstantiated by specific examples or articulated reasoning, do not satisfy the Rule 26(c) test.” Application of Akron Beacon Journal, No. 94 Civ. 1402, 1995 WL 234710, *10 (S.D.N.Y. April 20, 1995) (internal quotation marks omitted). Businesses must make a “specified showing of significant harm” to the business’ competitive position; otherwise the good cause requirement would be “effectively undermine[d] . . . , as businesses would be able to claim good cause for any internal documents that portrayed the business in an unflattering light.” Id. at *11. Even if certain documents “might injure [Eli Lilly’s] commercial standing, that does not mean the are entitled to protection under a Rule 26(c) protective order. Littlejohn v. BIC Corp., 851 F.2d 673, 685 (3d Cir. 1988). As the Third Circuit has noted, “because release of information not intended by the writer to be for public consumption will almost always have some tendency to embarrass, an applicant for a protective order whose chief concern is embarrassment must demonstrate that the embarrassment will be particularly serious.” Cipollone v. Liggett Group, Inc., 785 F.2d 1108, 1121 (3d Cir. 1986). Therefore, to the extent that Mr. Hoffman seeks to protect against “damaging Lilly’s reputation and bolstering competitors’ market shares,” (Ex. A to Lilly Br. ¶

22), this is not a legitimate grounds for finding a document confidential.⁹

III. MANY OF THE FACTUAL FINDINGS PROPOSED BY ELI LILLY SHOULD BE REJECTED

A. Eli Lilly Asks This Court to Make Factual Findings Regarding Dr. Egilman Which Are Unsupported By The Record

Many of the factual findings that Eli Lilly asks this Court to make are based exclusively on Dr. Egilman's invocation of his Fifth Amendmen rights. (Proposed Findings ¶¶ 16-21.) We explain below, infra Part III.B, why petitioner's reliance upon Dr. Egilman's silence is misplaced. Even as to those factual findings which petitioner claims are supported by other evidence, however, they reflect faulty reasoning. Eli Lilly asks this Court to find, for instance, that Dr. Egilman executed an endorsement of CMO-3 prior to receiving Zyprexa documents from The Lanier Law Firm, (Proposed Findings ¶ 9) although no documentary evidence has been introduced to support this assertion. Similarly, there is no evidence that Dr. Egilman was informed of the multiple protective orders entered in this case prior to receiving the Zyprexa documents. (Id. ¶ 8.) Instead, the evidence presented by petitioner establishes only that Dr. Egilman executed a modified endorsement of CMO-3 after he received the Zyprexa documents. (Compare Proposed Findings, Exs. B & C to Ex. 3 with Proposed Findings ¶ 10.)

In addition, many of petitioner's proposed factual findings can only be supported by inadmissible hearsay. Petitioner's proposal that Dr. Egilman "needed to find a way" to transfer

⁹ Nor do the published newspaper articles in which the contents of Eli Lilly's documents have been revealed offer a compelling argument for why Eli Lilly designated as confidential the released documents. These articles have focused principally on two aspects of the documents released by Dr. Egilman to Mr. Gottstein: (1) Eli Lilly's awareness, and suppression, of information linking weight gain and diabetes to Zyprexa; and (2) Eli Lilly's illegal off-label marketing of Zyprexa for non-FDA-approved uses. Documents which reveal these facts ought not be protected by a Rule 26(c) Order. See Jack B. Weinstein, *Secrecy in Civil Trials: Some Tentative Views*, 9 J.L. & Pol'y 53, 61 (2000) (secrecy order which protects "those who engage in misconduct, conceal the cause of injury

documents to the New York Times, for instance, appears to be loosely based upon vague hearsay statements attributed by Mr. Gottstein to Alex Berenson. (Proposed Findings ¶ 22, citing Jan. 17, 2007, Tr. 96.) Similarly, Eli Lilly's proposal that Dr. Egilman and Mr. Berenson "agreed on a scheme to bypass CMO-3" either because Dr. Egilman understood that the documents were properly protected or because of concerns about timing of the release is remarkable, given that it is not supported by the portion of the transcript to which petitioner refers, which contains only inadmissible hearsay testimony. (Id. ¶ 24, citing Jan. 17, 2007, Tr. 96-98.) And petitioner's assertion that "Mr. Berenson told Dr. Egilman to contact Mr. Gottstein . . . and use him as the conduit for getting the protected documents to The New York Times" is similarly based on inadmissible hearsay. (Id. ¶ 25.)

Moreover, many of petitioner's proposed findings of fact are not supported by anything but rabid conjecture. For instance, there is no support in the material referenced in Proposed Revised Findings of Fact ¶ 30 for the proposition that Dr. Egilman played a role in determining what case Mr. Gottstein initiated prior to issuing the subpoena. Similarly, nothing in Mr. Gottstein's December 17, 2006, letter supports the inference that "he and Dr. Egilman worked in concert to issue a secret 'amended' subpoena," (Proposed Findings ¶ 47), nor did Eli Lilly elicit any testimony from Mr. Gottstein that he colluded with Dr. Egilman to issue the second subpoena. And accepting arguendo the dubious admissibility of Mr. Gottstein's testimony as to Dr. Egilman's understanding and intentions, Mr. Gottstein never testified that Dr. Egilman "understood and intended" that Mr. Gottstein would distribute the documents "as quickly as possible." (Proposed Findings ¶ 60.) Similarly, the excerpts of testimony relied upon for Proposed Revised Factual Finding ¶ 63 refer only to Mr. Gottstein's understanding, not Dr.

from the victims, or render potential victims vulnerable . . . defeats a function of the justice system - to reveal

Egilman's.

B. Eli Lilly Improperly Seeks to Use Dr. Egilman's Invocation of His Fifth Amendment Right to Silence

Perhaps more troubling than petitioner's treatment of the record in this case is Eli Lilly's attempt to rely in this proceeding on Dr. Egilman's invocation of his right to silence. The Fifth Amendment permits adverse inferences against (1) parties when (2) "they refuse to testify in response to probative evidence offered against them." Mitchell v. United States, 526 U.S. 314, 327 (1999). Eli Lilly, on the other hand, seeks to use Dr. Egilman's invocation of his right to silence against other parties, and not based on Dr. Egilman's refusal to answer specific questions supported by probative evidence, but as a freewheeling opportunity for Eli Lilly to paint whatever picture it deems to be "not inconsistent" with the facts that have been presented. (See Proposed Findings ¶¶ 16-22, 27-28, 37 & n.1; Lilly Br. 4 n.3.). This poses several problems which are not acknowledged by petitioner.

1. Dr. Egilman's Silence Cannot Be Held Against the Respondents in This Proceeding

First, because Eli Lilly seeks to use Dr. Egilman's invocation of his right to silence against others, it must demonstrate a sufficiently close relationship between Dr. Egilman and the parties to be enjoined. The Second Circuit has held that, in determining whether a non-party's invocation of a Fifth Amendment privilege may be used to draw an adverse inference against a party to a proceeding, four non-exclusive factors should be considered: (1) the nature of the relationships between the party and non-party; (2) the "degree of control which the party has vested in the non-party witness in regard to the key facts" at issue in the litigation; (3)

important legal/factual issues to the public").

convergence of interests between party and non-party; and (4) whether non-party was a “key figure in the litigation and played a controlling role in respect to any of its underlying aspects.” LiButti v. United States, 107 F.3d 110, 123-24 (2d Cir. 1997). The fundamental question in undertaking this inquiry is “whether the adverse inference is trustworthy under all of the circumstances and will advance the search for the truth.” Id. at 124.

Using this analysis, courts have held that an ex-employees’ claim of privilege could be held against an employer as “vicarious admissions,” id. at 121 (internal quotation marks omitted), and that a father’s invocation of his Fifth Amendment privilege is admissible against his daughter where the relationship was strong and where they had “precisely the same interest,” id. at 124. But where there is no formal or informal relationship with a non-party who has asserted his Fifth Amendment privilege, courts have permitted no adverse inference to be drawn even if the non-party has played a central role in the case. Willingham v. County of Albany, 2006 WL 1979048, *5 (N.D.N.Y. July 12, 2006). And even if the relationship has been shown to be very strong, if one party has chosen to subject herself to deposition, but the non-party has not, courts have held that that in and of itself demonstrates a sufficient disparity of interest to refuse to hold the non-party’s assertion of a Fifth Amendment privilege against the party which agreed to testify. Kontos v. Kontos, 968 F. Supp. 400, 408 (S.D. Ind. 1997) (one sister’s invocation of Fifth Amendment privilege inadmissible against other sister).

Here, Eli Lilly has made no attempt to establish, with respect to any of the four LiButti factors, that Dr. Egilman is sufficiently entwined with the parties to this proceeding such that his silence should be used to draw adverse inferences here. The instant proceeding seeks the continuation of an injunction only against the natural persons Terri Gottstein, Dr. Peter Breggin, Dr. David Cohen, Bruce Whittington, Laura Ziegler, Judi Chamberlin, Vera Sharav, Robert

Whittaker, Will Hall, Eric Whalen, and David Oaks, and against the websites www.joysoup.net, www.mindfreedom.org, www.ahrp.org, www.ahrp.blogspot.com, and zyprexa.pbwiki.com.

Whatever the role that Eli Lilly argues that Dr. Egilman has played in this litigation, petitioner has not shown that he communicated with any of the parties to this proceeding, nor has Dr. Egilman been shown to have any formal or informal relationship with them. Therefore, it is simply inappropriate for Eli Lilly to attempt to use his invocation of his right to silence against the parties to this proceeding. Lorusso v. Borer, No. 03 Civ. 504, 2006 WL 473729, *11 n.9 (D. Conn. Feb 28, 2006) (finding that it was inappropriate to use invocation of Fifth Amendment privilege against third party where there was “neither an agency relationship between the party and non-party concerned, nor any other close or intimate association between them, nor even a congruence of interests”).

2. The Court Should Exercise Its Discretion to Reject Eli Lilly’s Request for an Adverse Inference

Even were the Court to conclude that Dr. Egilman’s relationship with the third parties against whom Eli Lilly seeks an injunction was sufficiently close, the Court still should exercise its discretion not to find an adverse inference from his invocation of his Fifth Amendment rights. Here, because Eli Lilly has indicated that it will seek criminal sanctions against Dr. Egilman, the Court should exercise its discretion not to rely in any way on Dr. Egilman’s invocation of his Fifth Amendment rights. In general, where a party is simultaneously forced to defend against criminal and civil liability, courts take pains to protect Fifth Amendment rights by staying the civil proceeding until the criminal proceeding is complete so that the party will not be forced to choose between asserting his Fifth Amendment rights and fully defending himself in the civil action. For instance, in Sampson v. City of Schenectady, 160 F.Supp.2d 336 (N.D.N.Y. 2001), the Court declined to draw an adverse inference from a defendant’s invocation of the Fifth

Amendment in response to a question at a deposition. The Court first noted that the drawing of an adverse inference “is a harsh remedy that is normally employed to counter a defendant’s desire to obstruct discovery or abuse the privilege against self-incrimination.” Id. at 351.¹⁰ The Court found that, because the defendant had stated that he would go forward with a deposition once his criminal trial concluded, it would be unduly harsh to use his invocation of his Fifth Amendment rights against him in the civil proceeding. Id.

Of course, here, because of the unique framework of contempt motions, which permits litigants to seek criminal and civil remedies in the same proceeding, Eli Lilly has put Dr. Egilman in an untenable situation. Clearly petitioner seeks to establish certain facts in this proceeding which will later be used against Dr. Egilman in a hybrid criminal/civil contempt proceeding. In such a circumstance, it would be manifestly unfair for the Court to rely on Dr. Egilman’s invocation of his constitutional right to silence to find facts which later will be used by Eli Lilly to support both criminal and civil penalties. In any event, just like the defendant in Sampson, here Dr. Egilman would be in a different position if criminal contempt proceedings were initiated first, or not at all, so that he could freely defend himself in the civil contempt proceeding.

This case is emblematic of the problem where one party has the opportunity to “manipulat[e] simultaneous civil and criminal proceedings,” thus exacerbating “the risk to individuals’ constitutional rights.” Sterling Nat. Bank v. A-1 Hotels Intern., Inc., 175 F. Supp. 2d 573, 578 (S.D.N.Y. 2001). The Second Circuit identified this “dilemma” for litigants who are accused in parallel civil and criminal proceedings, such as forfeiture proceedings, noting that

¹⁰ The Court also relied on the fact that the defendant had answered the civil complaint and denied certain allegations. Id. at 351. Of course, here, where Eli Lilly has yet to file a motion seeking contempt, Dr. Egilman has not had an opportunity to file any responsive pleading.

district courts must make “special efforts” in such cases to preserve both the Fifth Amendment privilege and the interest of all parties in the “opportunity to litigate a civil case fully.” United States v. Certain Real Property and Premises Known as: 4003-4005 5th Ave., 55 F.3d 78, 83-84 (2d Cir. 1995). The options available to district courts include “entry of a protective order prohibiting the use of the civil litigant's responses in any criminal proceeding in that district, a stay of discovery or the civil action until parallel criminal proceedings have run their course, and attempts to arrange for immunity to ensure that a civil litigant will not be prosecuted for his or her statements.” Id. at 84 n.6 (citations omitted). Courts in this Circuit have even granted a parties’ request to stay the deadline for filing a responsive pleading in a civil case, where a parallel criminal proceeding remained open. Philip Morris Inc. v. Heinrich, No. 95 Civ. 0328, 1998 WL 167333, *1 (S.D.N.Y. April 8, 1998) (“If the Court orders Siegel to answer the Complaint and he asserts his Fifth Amendment privilege in his answer, he would be forced to suffer the consequence that a trier of fact may draw an adverse inference from his assertion of the privilege.”)

Where, as with the anticipated contempt motion against Dr. Egilman, there are “overlapping issues in the criminal and civil cases, . . . the risk of impairing the party’s Fifth Amendment rights presents a stronger case for staying discovery.” American Express Business Finance Corp. v. RW Professional Leasing Servs. Corp., 225 F. Supp. 2d 263, 265 (E.D.N.Y. 2002); Savalle v. Kobyluck, Inc., No. 00 Civ. 675, 2001 WL 1571381, *2 (D. Conn. Aug. 15, 2001) (“Although requiring a defendant to choose between waiving his Fifth Amendment rights and suffering the adverse inference which results in the civil case from invoking his privilege does not violate due process, forcing the defendant to make this choice greatly increases the potential prejudice facing him in the absence of a stay.”). This would prevent the party from

being in “the uncomfortable position between choosing to waive their Fifth Amendment privilege, risking self-incrimination, or to invoke it, not only preventing them from adequately defending their position but subjecting them to adverse inferences.” American Express, 225 F. Supp. 2d at 265. However, here, where Eli Lilly has not even begun proceedings against Dr. Egilman, but is seeking to lay an established factual foundation for its anticipated contempt motion, the Court should exercise its discretion to refuse to draw any adverse inference from Dr. Egilman’s invocation of his Fifth Amendment rights. When Eli Lilly finally brings its contempt motion, the Court should then address whether to consider petitioner’s request for criminal sanctions first, thus eliminating the pressure on Dr. Egilman to choose between asserting his constitutional rights and fully defending himself in the civil proceeding. For instance, even where a court was convinced that a party’s “dilatory tactics in resolving his criminal case for more than two years” cautioned against continuing a stay of a parallel civil proceeding, the court nonetheless protected the party’s Fifth Amendment right by giving the party “the opportunity to revoke the privilege prior to trial [in the civil proceeding] in order to avoid the adverse inference.” Savalle, 2001 WL 1571381, at *3. Dr. Egilman should have the opportunity to argue that similar measures be taken when Eli Lilly finally institutes its contempt proceedings.

3. Eli Lilly Seeks to Rely on an Adverse Inference to Establish Facts That Are Not Supported By Any Other Independent Evidence

Even were the Court to be satisfied that due process does not forbid an adverse inference to be drawn in this proceeding from Dr. Egilman’s invocation of his Fifth Amendment rights, Eli Lilly goes beyond all reasonable bounds by suggesting that the inference may support completely new facts which are “not inconsistent” with other facts adduced through this proceeding. It is well-established that the adverse inference requested by Eli Lilly may only be relied upon to “confirm matters supported by other independent evidence” and that liability may

not be imposed “based solely upon the adverse inference.” United States v. Incorporated Village of Island Park, 888 F. Supp. 419, 431-32 (E.D.N.Y. 1995). Here, no specific questions have been put to Dr. Egilman to which he has raised a Fifth Amendment objection; instead he has simply exercised his right to silence in the face of promises by Eli Lilly to seek criminal sanctions for his alleged violation of CMO-3.

Without relying on any other independent evidence, however, petitioner asks this Court to make certain factual findings based solely on Dr. Egilman’s invocation of his Fifth Amendment rights. One must remember that the overriding purpose of reliance on the adverse inference in the Fifth Amendment context is the advancement of truth. LiButti, 107 F.3d at 123-24. Thus, an adverse inference is only appropriate where the Fifth Amendment is asserted in response to the presentation of “probative evidence.” Mitchell, 526 U.S. at 327. Where a party seeks to draw adverse inferences with a sweeping scope, and with no support from corroborating admissible evidence, it cannot be said that relying on the adverse inference alone is likely to advance the search for truth. Emerson v. Wembley USA Inc., 433 F. Supp. 2d 1200, 1213 (D. Colo. 2006) (refusing adverse inference where plaintiff sought an inference based on all questions the witness refused to answer). This is especially the case where the inference has no foundation in any other evidence, and Eli Lilly is simply using a “fruitless deposition as a crutch to prop up [its] claims.” Id. at 1214.

As this Court indicated when counsel first stated that Dr. Egilman intended to assert his Fifth Amendment right to silence at the deposition proposed by Eli Lilly, to the extent an adverse inference can be drawn, it should be limited to issues of credibility. (Jan. 17, 2007, Tr. 247); see also Orena v. United States, 956 F. Supp. 1071, 1094 (E.D.N.Y. 1997) (“Lack of credibility as a witness is not, in itself, affirmative proof of what the witness denies.”). Dr. Egilman’s

credibility, however, is not relevant to the instant proceeding – there is no dispute that he received the subpoena from Mr. Gottstein, that he communicated it to Eli Lilly, and that he disclosed documents to Mr. Gottstein in response to the subpoena. The question in this proceeding is whether the injunction prohibiting further dissemination of these documents should be continued against certain individuals, who have no connection to Dr. Egilman. In such a circumstance, there is no basis for relying on Dr. Egilman's invocation of his right to silence to support petitioner's request that the injunction continue.

CONCLUSION

For the foregoing reasons, Dr. Egilman respectfully requests that the Court make no legal or factual findings which relate to Eli Lilly's anticipated motion for contempt against Dr. Egilman.

Dated: New York, New York
February 7, 2007

Respectfully submitted,

KOOB & MAGOOLAGHAN

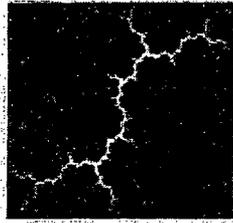
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~~EXHIBIT~~

Exhibit V



Synapse
Energy Economics, Inc.

**FINANCIAL INSECURITY: The Increasing Use
of Limited Liability Companies and Multi-
Tiered Holding Companies to Own Nuclear
Power Plants**

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Prepared for:
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August 7, 2002

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Foreword

Where Have All the Safeguards Gone

In nuclear power's first two decades, accident insurance requirements were seriously inadequate. Decommissioning costs were overlooked entirely. The 1979 accident at Three Mile Island undermined much nuclear complacency. In the early 1980s Congress and the U.S. Nuclear Regulatory Commission made serious efforts to address these shortcomings.

The nuclear self-insurance requirement – known as the Price-Anderson Act – was increased from \$560 million to the current \$9.3 billion, and each plant was required to set up a dedicated decommissioning trust fund to assure that funds would be available to clean up a closed plant.

With the passage of two more decades, renewed complacency has eroded these safeguards.

This report dissects a troublesome set of developments on the cusp between economic and safety regulation, namely the rearrangement of nuclear power plant ownership into the limited liability subsidiaries of a few large companies. Because this arrangement has occurred during an era of lax and dispirited regulation, some important issues have not been pursued effectively. As a result, the consolidation of nuclear ownership – although probably a positive development if carried out wisely – now risks the shifting of accident and decommissioning costs from the plant owners to the general public because the relatively secure financial backing of substantial utility companies has in many cases been replaced by a limited liability subsidiary whose only asset is an individual nuclear power plant.

With years of reckless undermining of economic and financial regulation now exposed in a series of catastrophic financial collapses, investigators turning over rocks keep finding the same agents of decay: demands for short term “performance” in the private sector compounded by regulatory cutbacks, underqualified commission appointments, Congressional hearings harassing public protection initiatives, pressure to deregulate more and faster—a ruinous mixture of money, pressure, overconfidence, complexity and ideology.

During all those years, health and safety regulation got the same debilitating treatment from Congress and the Presidency as its financial counterparts. How long before those chickens come home to roost, and where will the roosting be?

Even in the best of times, regulation tends to be reactive, responding to events or to applications. Rarely does a regulatory commission develop a set of affirmative requirements to guide those who seek its permits. Certainly neither the Nuclear Regulatory Commission nor the several economic regulators with jurisdiction over nuclear plants ever developed a comprehensive policy to guide those seeking to transfer nuclear plant ownership. Such a policy might have required a showing that the protection of the public was in no way diminished by these transfers. Or such a requirement might have been imposed as a condition of approving the transfers.

But it was not.

In the absence of any such requirement, public protection has depended on the acumen of a Nuclear Regulatory Commission unversed in financial matters and of economic regulators unversed in health and safety issues. As has happened in financial and in utility restructuring circles, fundamental safeguards have been circumvented.

Regulating in this way is like driving drunk. On any one occasion, there may be no consequences at all. But in the nuclear field the possibilities include the undermining of the scheme that assures compensation in the event of nuclear accidents and an increased likelihood that some of the costs of decommissioning nuclear power plants will be borne by the general public. Taxpayers, utility customers and powerplant neighbors who thought themselves protected by firm requirements may one day wear the stunned expressions of Enron retirement plan holders or WorldCom investors.

Clever advisors in several professions have no doubt been well rewarded for achieving these "deregulations." As they were at Global Crossing. As they were at Qwest. As they were at Andersen Consulting. But in the nuclear realm as in the others, they have been more clever than wise. The consequences remain to be revealed. We will be fortunate if the only harm is another blow to public confidence.

Peter Bradford¹

¹ Visiting Lecturer in Energy Policy and Environmental Protection, Yale University; Former Chair, New York State Public Service Commission and Maine Public Utilities Commission; Former Commissioner, U.S. Nuclear Regulatory Commission; Past President, National Association of Regulatory Utility Commissioners.

Introduction

In recent years corporations have increasingly owned and operated nuclear power plants through multiple tiered holding companies, which frequently include limited liability companies ("LLCs"). LLCs are new organizational forms whose liability is limited to the specific assets they directly own. More than 25 nuclear power plants are today owned by such LLCs and additional corporate reorganizations can be expected. The use of complex organizational structures involving LLCs can shield the parent corporations and their shareholders from liabilities incurred by both direct and indirect subsidiaries. In so doing, the use of multi-tiered holding companies and LLCs to own and operate nuclear power plants raises several concerns regarding security, safety and potential federal and consumer liabilities.

Nuclear power plants were traditionally constructed and operated mainly by integrated investor-owned utilities under "cost-of-service regulation" through which necessary funds were provided to operate and decommission the plants safely. Starting in the mid-1990s, however, many nuclear power plant owners began to reorganize and to sell their nuclear units to unaffiliated companies or corporate affiliates. Some of these corporate reorganizations were required or encouraged as part of state efforts to deregulate the electric utility industry and to implement industry restructuring. Other reorganizations were adopted by plant owners, on their own initiative, in order to minimize tax liabilities, maximize flexibility in corporate ownership and management, and to protect corporate assets. According to the U.S. General Accounting Office ("GAO"), the U.S. Nuclear Regulatory Commission ("NRC") has reviewed more than 60 license transfer requests in recent years, affecting more than half of the nuclear plants in the nation.²

Synapse Energy Economics, Inc. ("Synapse") was asked by the STAR Foundation and Riverkeeper, Inc. to survey the increasing use of complex corporate ownership structures and LLCs to own and operate nuclear power plants and to review the NRC's oversight of these developments. Synapse also was asked to identify those areas in which changes need to be made to assure that there are adequate funds available to meet NRC-imposed requirements, including post September 11, 2001 security-related requirements and Price-Anderson Act nuclear accident insurance obligations and to assure that decommissioning funds are adequate and are protected. This Report presents our findings.

Data Sources

Synapse has used publicly available documents from the following sources in the preparation of this Report: the U.S. GAO, the U.S. NRC, corporate filings at the U.S. Securities and Exchange Commission, company websites, nuclear industry publications, utility filings at state regulatory commissions and answers to post-hearing questions that arose out of the January 23, 2002 Price-Anderson Act Hearings. The specific documents on which this Report is based are identified in footnotes or the list of references.

² *Nuclear Regulation: NRC's Assurance of Decommissioning Funding During Utility Restructuring Could be Improved*, U.S. GAO Report, GAO-02-48, December 2001, at page 21.

This Report also relies on detailed publicly available information about the Entergy Corporation that Synapse obtained as a result of its work in Vermont Public Service Board Docket No. 6545 in which Entergy's proposed acquisition of the Vermont Yankee nuclear plant has been examined.

Conclusion

Over the last ten years, the ownership of an increasing number of nuclear power plants has been transferred to a relatively small number of very large corporations. These large corporations have adopted business structures that create separate limited liability subsidiaries for each nuclear plant, and in a number of instances, separate operating and ownership entities that provide additional liability buffers between the nuclear plant and its ultimate owners. The limited liability structures being utilized are effective mechanisms for transferring profits to the parent/owner while avoiding tax payments. They also provide a financial shield for the parent/owner if an accident, equipment failure, safety upgrade, or unusual maintenance need at one particular plant creates a large, unanticipated cost. The parent/owner can walk away, by declaring bankruptcy for that separate entity, without jeopardizing its other nuclear and non-nuclear investments. This report examines the recent trend towards the use of limited liability corporations in the nuclear industry, often as part of multi-tiered holding companies, and identifies numerous concerns related to the use of such business structures.

Summary of Findings

The above conclusion is based on the following findings:

Finding No. 1 - Nuclear power plant ownership and operation has become increasingly consolidated in a small number of very large corporations.

Finding No. 2 – Complex, holding companies, often including Limited Liability subsidiaries, are increasingly being used to own nuclear power plants.

Finding No. 3 – Limited Liability Companies are relatively new business structures that can enhance a parent corporation's ability to transfer funds from its subsidiaries and to shield assets from liability for financial risks.

Finding No. 4 – There continue to be significant financial and other risks associated with nuclear power plant ownership and operations.

Finding No. 5 – The NRC has expressed concern that deregulation can adversely affect the safety of operating nuclear power plants by increasing the pressure on licensees to reduce costs.

Finding No. 6 – The NRC has expressed concern that the use of holding company structures can reduce the assets that would be available for the safe operation and decommissioning of a nuclear power plant. However, the NRC does not adequately protect against the risk that an LLC subsidiary will transfer all of its operating profits to its parent company or engage in risky loans to or questionable deals with affiliated companies.

Finding No. 7 - The NRC's reviews of the financial qualifications of new nuclear power plant owners are inconsistent and may be too limited to ensure that subsidiaries will have adequate funds to safely operate and decommission their nuclear plants and pay retrospective Price-Anderson Act premiums.

Finding No. 8 – The financial guarantees that the NRC requires from prospective nuclear power plant owners may not be adequate to assure that plants are operated and decommissioned safely and that plant owners will be able to pay retrospective Price-Anderson Act insurance premiums in the event of a nuclear accident.

Finding No. 9 - The NRC has proposed to significantly reduce its review of a non-electric utility licensee's financial qualifications when it evaluates an application to renew a nuclear plant's operating license.

Finding No. 10 – The NRC does not require that parent corporations guarantee that funds will be provided to safely operate and decommission the nuclear power plants owned by their subsidiary companies.

Finding No. 11 – Taxpayers may be at risk if nuclear plant owning subsidiaries are unable to continue making safety-related or decommissioning expenditures or pay retrospective Price-Anderson Act premiums.

Finding No. 12 – The NRC has no statutory authority to require a licensee in bankruptcy to continue making safety-related or decommissioning expenditures or to pay retrospective Price-Anderson Act premiums.

Finding No. 13 – Case law indicates that it could be very difficult to hold a parent corporation responsible for the liabilities incurred by nuclear power plant-owning LLC subsidiaries in a multi-tiered holding company.

Finding No. 14 – The NRC has expressed serious doubts as to its ability to hold a parent corporation responsible for the liabilities incurred by a subsidiary.

Finding No. 15 – Shielding parent corporations from nuclear power plant operating, accident insurance, and decommissioning risks is unfair and economically inefficient.

Recommendations

1. Parent corporations should be required to guarantee that plant-owning subsidiaries and affiliates will be provided whatever funds are needed to safely operate and decommission their nuclear power plants.
2. Parent corporations should be held fully responsible for the unmet liabilities incurred by both direct and indirect nuclear power plant owning subsidiaries.
3. Congress should adopt legislation to assure that costs related to (1) safety and security (2) decommissioning assets and (3) Price-Anderson nuclear accident responsibilities receive priority in bankruptcy proceedings.
4. Reactor owners should be required to guarantee payment of their nuclear accident insurance responsibilities under the Price-Anderson Act through surety bonds,

letters of credit, sinking funds, or other comparable financial instruments that will be bankruptcy remote. This will assure that public liability claims will be paid up to the limits of the Price-Anderson Act without concern about the financial condition of the industry and without requiring a taxpayer bailout.

5. The Nuclear Regulatory Commission should not eliminate the current legal requirement that non-utility corporations must disclose their financial qualifications when applying to re-license nuclear power plants, as the agency has proposed in a recent rulemaking. Instead, the NRC should bolster its disclosure requirements concerning the character of the legal relationships between a parent corporation and its subsidiaries in the event of a bankruptcy, business failure or accident.

Finding No. 1 - Nuclear power plant ownership and operation has become increasingly consolidated in a small number of very large corporations.

In the past, a relatively large number of utilities around the nation owned nuclear power plants or, at least, were joint owners with other companies. However, as a result of industry restructuring, nuclear power plant ownership has become increasingly consolidated in a small number of large corporations. In fact, as shown in Table No. 1 below, ten corporations currently own all or part of 70 of the 103 nuclear power plants in the U.S.

**Table No. 1
Concentration of Nuclear Power Plant Ownership**

<u>Parent Corporation</u>	<u>Number of Operating Nuclear Units Owned (in whole or in part)</u>
Exelon Corporation	19
Entergy Corporation	10 ³
Duke Energy	6
Dominion Resources, Inc.	6
Southern Company	6
TVA	5
Progress Energy	5
FPL Group	5 ⁴

³ Includes the Vermont Yankee Nuclear Station.

⁴ Includes the Seabrook Nuclear Station.

Constellation Energy Group, Inc.	4
FirstEnergy	4

The six largest owners alone own part or all of 52 nuclear units, or one-half of all of the operating nuclear power plants in the nation.

At the same time, the Nuclear Management Company ("NMC") holds the NRC-issued operating licenses for eight nuclear plants in the Midwest. However, each of the utilities involved in NMC continues to own its own plants, is entitled to the energy generated by the plants, and retains the financial obligations for the plants safe operation, maintenance and decommissioning.

This industry consolidation may yield significant benefits in terms of economics, safety and reliability. However, it also raises the possibility that simultaneous extended outages of more than one nuclear plant will leave a "fleet" owner without needed revenues to fund safety-related expenses or capital expenditures at its other facilities. At the same time, the increasing consolidation of ownership also raises the possibility that an owner will have to bear Price-Anderson Act retrospective burdens measured in the hundreds, not tens, of millions of dollars, possibly without adequate revenues from which to make such payments.⁵

In fact, there have been numerous instances where two or more of a company's nuclear plants have been out of service at the same time for six months or longer due to problems that arose as a result of an emphasis on reducing costs, deficiencies in the utility's safety culture, management problems, or generic or plant-specific technical issues. For example:

- Two of the three units at the Palo Verde Nuclear Generating Station were shut down at the same time for approximately twelve months starting in March 1989. During this same twelve month period, the third Palo Verde unit was shut down for numerous outages, including one outage that lasted approximately four months.
- The two units at the South Texas nuclear plant were both shut down for the twelve month period February 1993 to February 1994.
- All five of TVA's operating nuclear power plants were shut down in 1985. The first unit to be restarted, Sequoyah Unit 1, re-commenced commercial operations in May 1989.
- Northeast Utilities' Millstone Units 2 and 3 were shut down for multi-year outages between March 1996 and June 1998. Millstone Unit 1 was shutdown in November 1995 and permanently retired in 1997.

⁵ In the event of an accident at one of the nation's nuclear power plants, the Price-Anderson Act requires nuclear plant owners to make "retrospective" (i.e., post-accident) payments after the initial \$200 million tier of insurance is exhausted. Under the Act's present terms, and given the number of operating plants, this obligation is a maximum of \$88.085 million per unit with a maximum of \$10 million per year. Consequently, an owner of multiple units could face retrospective obligations of hundreds of millions of dollars in total and tens of millions per year.

-
- Commonwealth Edison experienced numerous simultaneous extended outages among the eight units at its Dresden, LaSalle, Quad Cities, and Zion nuclear stations. For example, during the first six months of 1996, the utility had at least three units shut down at any one time for extended outages of longer than three months in duration. Commonwealth Edison had at least four units shut down at any one time for extended outages during the last six months of 1996, except for a short period at the end of August and early September. The utility also experienced simultaneous outages of at least six months in length at its two unit Zion nuclear station from October 1993 through April 1994 and at its two unit LaSalle Station from September 1996 through 1998.
 - Both units at the D.C. Cook Nuclear Plant in Michigan were shutdown from September 1997 through June 2000.
 - Both units at the Salem Nuclear Station were shutdown for more than two years between July 1995 and August 1997.
 - Both units at the Brunswick nuclear plant were shutdown for the twelve month period April 1992 through April 1993.
 - Both units at the Calvert Cliffs nuclear plant were shut down at the same time for more than one year starting in May 1989.

Finding No. 2 - Complex, multi-tiered holding companies, often including limited liability subsidiaries, are increasingly being used to own nuclear power plants.

Except for those power plants owned by municipal utilities and the Yankee Nuclear Plants in the Northeast, nuclear units historically were directly owned by integrated investor-owned utility companies which owned other generating facilities and had significant transmission and distribution assets as well. Over the past five to ten years, however, corporations have established multiple tiered holding companies through which they indirectly own nuclear power plants. Except for the Exelon Corporation, these new nuclear power plant owning subsidiaries generally own only a single asset, i.e., an individual nuclear power plant, or both units at a multiple unit site.⁶

⁶ The nuclear industry's interest in single asset nuclear generating companies is not new. It dates back to the 1960s, perhaps even to the 1950s, when the plans were developed for the ownership of the Yankee Rowe and Connecticut Yankee nuclear plants. Then, in the late 1980s and early 1990s, some companies, including Middle South Utilities (subsequently renamed "Entergy") and General Public Utilities, reorganized, creating specific corporate entities to operate *but not own* their nuclear power plants. In one notable case in Michigan, however, the Consumers Power Company proposed transferring a poorly performing nuclear plant, Palisades, to a new corporate entity, PGCo, created for the sole purpose of owning and operating the plant. This ill-conceived proposal was designed to shift nuclear-related risks away from the Company, placing them instead upon consumers and the public. For more information, see Bruce Biewald, "Do We Really Need Nuclear Generating Companies?," in *Public Utilities Fortnightly*, June 7, 1990. and the Direct Testimony of Bruce Biewald, submitted on behalf of the Attorney General of Michigan, April 19, 1989 in Michigan Public Service Commission Case No. U-9172.

The corporate subsidiaries included in these complex ownership chains are increasingly chartered as Limited Liability Companies ("LLCs"). As we will discuss in Finding No. 3 below, LLCs are relatively new business structures that enhance a parent corporation's ability both to transfer funds from its nuclear-power plant owning subsidiaries and to shield its other assets from liability from the financial risks associated with its nuclear operations.

The following examples illustrate the accelerating trend in the nuclear industry to use multiple tiered holding companies and LLC subsidiaries to own and operate nuclear plants. It is important to note that each of the parent corporations listed in these examples also has numerous other subsidiaries unrelated to its nuclear power plant ownership.

Exelon Corporation

Exelon Corporation was formed in 2000 by the merger of Unicom (Commonwealth Edison Company's parent) and PECO Energy Company. Commonwealth Edison's 10 operating nuclear plants have been transferred to Exelon Generation Company, LLC, ("EGC") which is a wholly owned subsidiary of Exelon Ventures Company, LLC, which, in turn, is a wholly-owned subsidiary of Exelon Corporation. PECO's Limerick and Peach Bottom nuclear plants also have been transferred to EGC, as has PECO's ownership interest in the two Salem Nuclear Plants.

PECO also owned 50 percent of the AmerGen Energy Company, LLC, ("AmerGen") which had acquired and operated three nuclear power plants in the U.S.: Three Mile Island Unit 1, Clinton, and Oyster Creek. PECO's interests in AmerGen have been transferred to EGC, LLC. Consequently, through EGC, LLC, Exelon Corporation owns and operates part or all of 16 nuclear plants and owns part of another three units.

The current organizational structure through which Exelon owns these nuclear assets is illustrated in Attachment No. 1 to this Report.

Entergy

Entergy Corporation was a pioneer in establishing separate corporate entities to own and operate nuclear power plants. Entergy today owns and operates ten nuclear units through an extensive network of wholly-owned subsidiaries.

Entergy currently owns five nuclear units in the South through five wholly-owned retail public utility companies and another wholly-owned subsidiary, System Energy Resources, Inc.⁷

Entergy also has purchased another five nuclear units in the Northeast including its just completed purchase of the Vermont Yankee nuclear plant. As shown in Attachment No. 2 to this Report, Entergy owns each of these units through a multi-tiered series of subsidiaries, many of which are limited liability companies. For example, the Indian

⁷ Entergy Arkansas, Inc., Entergy Gulf States, Inc., Entergy Louisiana, Inc., Entergy Mississippi, Inc., and Entergy New Orleans, Inc.

Point 2, Indian Point 3, and Fitzpatrick nuclear units are each owned by a separate LLC.⁸ In the case of Indian Point 2, the immediate owner is Entergy Nuclear IP2, LLC. This company is, in turn, owned by Entergy Nuclear Investment Company III, Inc., which is a wholly-owned subsidiary of Entergy Nuclear Holding Company #3 that, in turn is a wholly-owned subsidiary of Entergy Nuclear Holding Company. Entergy Nuclear Holding Company, Inc., is a direct subsidiary of Entergy Corporation.⁹

The structure through which Entergy owns the Indian Point 3 and Fitzpatrick units is even more complex because each of the LLCs that owns these plants is, in turn, 50 percent owned by two other indirect Entergy subsidiaries, Entergy Nuclear New York Investment Company I and Entergy Nuclear New York Investment Company II. As shown in Attachment No. 2, these two Entergy Nuclear New York Investment Companies are themselves subsidiaries of Entergy Nuclear Holding Company #1 which, in turn, is a wholly-owned subsidiary of Entergy Corporation.

Another Entergy subsidiary, Entergy Nuclear Operations, Inc. ("ENO") operates Entergy's nuclear units in the Northeast.¹⁰ Additional services are provided by other Entergy subsidiaries such as Entergy Services, Inc. (management, administrative and support services) and Entergy Nuclear Fuels Company (nuclear fuel planning, procurement and related services).

Entergy has provided the following explanation for this tiered holding company structure:

Entergy Nuclear Holding Company, a first tier of Entergy Corporation, has been established with the intent that it will ultimately hold all the subsidiaries associated with Entergy's nuclear operations. This will consolidate all of Entergy's unregulated nuclear operations under a single holding company, while still supporting the operational and financing demands of the individual plants. *The use of holding companies below Entergy Nuclear Holding Company allows Entergy to segregate various types of financing, investment and business activities, and by doing so, enables Entergy to better manage and control risks associated with these activities.*¹¹ (Emphasis added)

Remarkably, Entergy has indicated that only two of all of the subsidiaries included in Attachment 2 -- ENO and Entergy Nuclear Generation Company, which owns and operates the Pilgrim Nuclear Station -- have any employees other than officers.¹² The

⁸ Although the wholly-owned subsidiary that currently owns Entergy's Pilgrim Station is not an LLC, Entergy has said that it will seek to change the form of that subsidiary to an LLC in the near future.

⁹ Entergy has said that ultimately all of subsidiaries associated with Entergy's nuclear operations will be owned by Entergy Nuclear Holding Company. Rebuttal Testimony of Connie Wells, Entergy Nuclear Vermont Yankee, LLC, in Vermont Public Service Board Docket No. 6545, at page 9.

¹⁰ Entergy's nuclear units in the South are operated by yet another subsidiary, Entergy Operations, Inc.

¹¹ Rebuttal Testimony of Entergy Nuclear Vermont Yankee witness Connie Wells in Vermont Public Service Board Docket No. 6545, dated February 25, 2002, at page 9.

¹² Entergy response to Department of Public Service Information Request No. 2-10 in Vermont Public Service Board Docket No. 6545.

rest of the listed subsidiaries are merely paper organizations. In addition, the subsidiaries listed on Attachment 2 share many of the same individuals as officers.¹³

The NRC requires licensees of deregulated nuclear plants to provide certain financial guarantees that a unit would have sufficient funding to enable the licensee to continue to maintain the unit in a safe manner in case of an extended outage or a premature shutdown. Entergy's financial guarantees for its deregulated units in the Northeast are provided by two subsidiaries not listed in Attachment 2 -- Entergy International Holdings, LTD LLC and Entergy Global Investments, Inc. Both of these subsidiaries are themselves holding companies.¹⁴

As shown in Attachment No. 3, Entergy also has a very extensive network of other subsidiaries, in addition to those that own and operate its deregulated nuclear units in the Northeast.

Dominion

Dominion Resources, Inc. ("DRI") owns the two operating nuclear power plants at Millstone Point in Connecticut through a multi-tiered chain of subsidiaries. As shown on Attachment No. 4, DRI owns Dominion Energy Holdings, Inc. which, in turn, owns Dominion Energy Inc., LLC which owns Dominion Nuclear, Inc.. Dominion Nuclear, Inc. then owns Dominion Nuclear Marketing I, Inc, Dominion Marketing II, Inc, and Dominion Marketing III, LLC that together own Dominion Nuclear Connecticut, the direct owner of the Millstone nuclear station.¹⁵

Dominion also owns the four nuclear units at its North Anna and Surry stations in Virginia through the Dominion Generation Corporation which is a wholly-owned subsidiary of Dominion Energy Holdings, Inc. Dominion Generation Corporation also will own the fossil and hydro facilities that were formerly owned by Virginia Power Company.

Constellation

Constellation Energy Group, Inc. ("Constellation") purchased 100 percent of the Nine Mile Point Unit No. 1 nuclear plant and 82 percent of Nine Mile Point Unit No. 2 nuclear plant in 2001. Both of these units are located in upstate New York, near the City of Oswego. When Constellation sought NRC approval to transfer the units' licenses it also requested approval to complete a complex fourteen step corporate realignment. The nuclear-related results of this proposed realignment are shown on Attachment No. 5. The direct owner of the two Nine Mile Point nuclear plants is Nine Mile Point Nuclear Station, LLC, which is a wholly owned subsidiary of Constellation Nuclear Power Plants,

¹³ Synapse has learned greater detail about Entergy's current holding company structure through its involvement on behalf of the Vermont Department of Public Service in Vermont Public Service Board Docket No. 6545.

¹⁴ Entergy response to Department of Public Service Information Request No. 1-42(c) in Vermont Public Service Board Docket No. 6545.

¹⁵ Dominion's August 17, 2001 letter to the NRC concerning the Millstone Nuclear Power Station Corporate Restructuring.

Inc, which, in turn, is a wholly owned subsidiary of Constellation Nuclear, LLC. Constellation's other two nuclear plants are owned by another subsidiary of Constellation Nuclear Power Plants, Inc, Calvert Cliffs Nuclear Power Plant, LLC. Constellation also has numerous other nuclear-related subsidiaries. Constellation Nuclear, LLC is, in turn, a subsidiary of Constellation Energy Group, Inc.

The parent corporation resulting from this corporate realignment will be BGE Corporation which will own Constellation Energy Group, Inc., as an immediate subsidiary.

Other Companies

The owners of fleets of nuclear power plants are not the only corporations that have established multi-tiered holding companies to own their nuclear plants. For example, as part of its proposed reorganization to recover from bankruptcy, Pacific Gas & Electric is seeking permission to transfer its two Diablo Canyon Nuclear Plants to a new LLC subsidiary, Diablo Canyon LLC. As shown on Attachment No. 6, this subsidiary would, in turn be a wholly owned subsidiary of Electric Generation, LLC, which in turn is a subsidiary of the Newco Energy Corporation, a wholly owned subsidiary of PG&E Corporation.¹⁶

Another example is Public Service Enterprise Group ("PSEG") which owns and operates the Salem and Hope Creek nuclear plants and is part owner of the Peach Bottom Nuclear generation station through a line of wholly-owned subsidiaries that includes PSEG Power, LLC, and its wholly-owned subsidiary, PSEG Nuclear.

Finding No. 3 - Limited Liability Companies are relatively new business structures that are used to shield the assets of a parent corporation from liability for financial risks.

The fundamental purpose and rationale for the creation of a "corporation" is to allow investors to pool their resources to engage in a business activity while limiting the financial consequences or "liability" of each individual investor. The most typical arrangement is for an investor to purchase stock or "shares" in the corporation. The money or other value paid for the shares is the limit of that investor's personal liability. The corporation's total liability is limited to the value of its investors' shares, plus any insurance policies that may be applicable.

Partnerships, an alternative form of business organization, are characterized by the inability of the partners to limit their individual liability. Each partner is wholly and personally responsible for all debts of the business. This onerous feature of partnerships has led to the development of many variations on the partnership model, particularly the limited partnership, as a way to shield some or all of the partners from unlimited liability.

Looking only at the liability issue, one might wonder why partnerships are ever chosen as a business structure. There are two primary reasons: streamlined management and lower

¹⁶ PG&E's November 30, 2001 Application to the NRC for License Transfers and Conforming Administrative License Amendments.

taxes. A corporation is required to have articles of incorporation, a board of directors, and a management structure separate from the board of directors. Partnerships can be much more flexible with the same individual, or group of individuals, performing both day-to-day management and decision-making functions. Tax policy significantly favors partnerships by allowing all business profits to flow directly to the partners where they are taxed on their business income along with any other personal income. Corporations, because they are considered a separate entity, must pay corporate taxes before profits can flow to its investors, who then pay taxes on their corporate income on an individual basis. This is commonly called the "double taxation" feature of corporations.¹⁷

The dilemma facing entrepreneurs who want to start a business is whether the business structure should be designed to protect their existing personal assets by limiting their liability (a corporation) or whether the business structure should be designed to allow them to maximize their income from this single venture through lower taxes (a partnership). As discussed below, the nuclear industry seeks to achieve both liability protection and maximum income through the use of new limited liability corporate structures.

Limited Liability Subsidiaries

Limited liability companies (LLCs) are relatively new business structures that combine features of corporations and partnerships. An LLC has the same limited liability of corporations, but has the management flexibility of a partnership. Most significantly, pursuant to an IRS ruling in 1988, an LLC is considered a partnership for federal income tax purposes.

The first LLCs in the United States were formed in Wyoming in 1977 for foreign corporations that wanted to invest in very risky mineral exploration and development. Since 1977, LLC statutes have been enacted in all fifty states. They have proven to be a particularly attractive business structure for investments in high-risk ventures. LLCs can be formed by individuals, partnerships, or corporations. They can be managed by the LLC members (owners) or by an elected group of members, or by a single member. The management choice also acts to specify the members who can legally bind the LLC through contracts with outside entities.¹⁸

LLCs have become a very attractive business structure for corporations that acquire nuclear power plants. By creating a separate LLC for each nuclear plant, the profits from each plant's operations can flow back to the parent corporation without any intervening tax liability. The parent corporation's liability for each plant is limited to the investment the parent corporation made in initially setting up the LLC. Also, there can be more than one LLC between the parent corporation and the most risky component of the overall

¹⁷ For general background on business structures, see any of a number of law school texts on business organizations. The information above is derived from "Organizing Limited Liability Companies: The Trend Continues", Richard M. Fijolek, Practising Law Institute (1997); "A Limited Liability Company Checklist", Jerome P. Friedlander, II, Federal Lawyer (March/April 1995); and "The ABCs of LLCs, Steven Audereth, Vermont Bar Journal and Law Digest (February, 1995).

¹⁸ See above, Friedlander and Audereth.

investment. For example, the technical support services for several nuclear plants can be consolidated into a separate LLC that contracts with all the individual plant LLCs. If one nuclear plant becomes unprofitable and goes into bankruptcy proceedings, in theory, only the single plant LLC assets are in jeopardy; the technical services LLC can continue to provide services to all the other single plant LLCs.

A particular concern regarding the use of LLCs is the situation where a parent corporation inserts several layers of LLCs between itself and the entity operating a high-risk business. Each of those intervening LLCs can act as a barrier to extending liability to the parent corporation that contains most of the assets. As noted in the case studies in Finding No. 2 of this Report, this approach appears to have been embraced by the parent corporations that recently have been purchasing nuclear plants. If a nuclear plant was unable to cover its liabilities, it might require several separate litigations, or a very large and complex single litigation, to pierce all the corporate veils back to the parent corporation with the bulk of the assets.

Finding No. 4 –There continue to be significant financial and other risks associated with nuclear power plant ownership and operations.

The restructuring of electricity markets has meant increased risks for owners of any deregulated electric generation facilities, whether their plants are fossil-fired or nuclear. Revenues which used to be based on traditional "cost of service" concepts and stable rates are now based instead on the actual sales from a power plant at market prices that are sometimes volatile.

At the same time, there are significant nuclear-related risks that could have a material adverse effect on nuclear power plant owners. For example, a recent Prospectus issued by Exelon Corporation for the sale of \$700 million of notes by Exelon Generation Company, LLC specifically identified the following risks associated with owning and operating nuclear power plants:

We may incur substantial cost and liabilities due to our ownership and operation of nuclear facilities. The ownership and operation of nuclear facilities involve certain risks. These risks include: mechanical or structural problems; inadequacy or lapses in maintenance protocols; the impairment of reactor operation and safety systems due to human error; the costs of storage, handling and disposal of nuclear materials; limitations on the amounts and types of insurance coverage commercially available; and uncertainties with respect to the technological and financial aspects of decommissioning nuclear facilities at the end of their useful lives. The following are among the more significant of these risks:

Operational risk. Operations at any nuclear generation plant could degrade to the point where we have to shut down the plant. If this were to happen, the process of identifying and correcting the causes of the operational downgrade to return the plant to operation could require significant time and expense, resulting in both lost revenue and increased fuel and purchased power expense to meet our supply commitments. For plants operated by us but not wholly

owned by us, we could also incur liability to the co-owners. We may choose to close a plant rather than incur substantial costs to restart the plant.

Regulatory risk. The NRC may modify, suspend or revoke licenses and impose civil penalties for failure to comply with the Atomic Energy Act, the regulations under it or the terms of the licenses of nuclear facilities. Changes in regulations by the NRC that require a substantial increase in capital expenditures or that result in increased operating or decommissioning costs could adversely affect our results of operations or financial condition.

Nuclear accident risk. Although the safety record of nuclear reactors generally has been very good, accidents and other unforeseen problems have occurred both in the United States and elsewhere. The consequences of an accident can be severe and include loss of life and property damage. Any resulting liability from a nuclear accident could exceed our resources, including insurance coverages.

These same risks apply to other nuclear plants including those owned and operated by multi-tiered holding companies and LLCs.

The industry's expressed desire to build new nuclear plants also can be expected to increase the financial pressures on licensees as they may have to further reduce O&M expenditures at existing plants in order to fund the construction of new ones.

Finding No. 5 - The NRC has expressed concern that deregulation can adversely affect the safety of operating nuclear power plants by increasing the pressure on licensees to reduce costs.

Although it has been said that an efficient and economical plant is often a safe plant,¹⁹ the NRC has expressed concern that the transition to economic deregulation can adversely affect nuclear power plant safety and may not provide the same degree of assurance that adequate funds would be provided for safe operation and decommissioning.²⁰

The NRC has further explained the impact that increased competition can have on nuclear power plant economics and safety:

As described in SECY-97-253, traditional "cost-of-service" regulation, under which virtually all NRC power reactor licensees have operated, has typically been effective in providing necessary funds for licensees to operate and decommission their nuclear plants safely. With the advent of greater competition within the electric utility industry, pressures to reduce costs and improve efficiency have increased and will almost certainly intensify as deregulation proceeds. Moreover, with deregulation of the generation sector of the industry, traditional cost-of-service regulation is likely to essentially disappear for most generators. Thus, the concept of electric utility, as

¹⁹ NRC Staff Requirements Memorandum, SECY-98-153, dated June 29, 1998, at page 3.

²⁰ NRC Final Policy Statement on the Restructuring and Economic Deregulation of the Electric Utility Industry (62 Fed. Reg. 44071; August 19, 1997)

currently defined in 10 CFR 50.2 may in the future no longer be meaningful for a large number of, if not all, power reactor licensees. Electricity rates set by competition in a free market may not provide the same degree of assurance of adequate funds for safe operation and decommissioning as traditional cost-of-service ratemaking. In SECY-97-253, the staff cited the example of the "Independent Safety Assessment of Maine Yankee Atomic Power Company" (NRC Staff Report: Ellis W. Merschoff, Team Lead; October 1996), which concluded, "Economic pressure to be a low-cost energy producer has limited available resources to address corrective actions and some plant improvement upgrades.

When the NRC issued its Final Policy Statement on the Restructuring and Economic Deregulation of the Electric Utility Industry (62 *Fed. Reg.* 44071; August 19, 1997), specific safety concerns with respect to rate deregulation and restructuring were identified. For example, the final policy statement discussed such safety concerns as reductions in expenditures for manpower and training and other reductions in operations and maintenance (O&M) and capital additions budgets. The issues of on-line maintenance and increased fuel burnup were also addressed.

In addition, with respect to specific plants such as Maine Yankee, Millstone, and others, the inspection process has identified several manifestations of inappropriate responses to competitive pressures. These include: increased need for corrective actions; maintenance operator work-arounds; temporary modification and procedure revision backlogs; decreased performance in operator licensing and requalification programs; increased frequency of significant operational and occupational safety events; decreased plant and system reliability; increased volume and acrimony of allegations; and increased frequency of regulatory violations and resulting penalties.

As deregulation proceeds, cost pressures may increase these types of reductions in safety margins at plants. Moreover, because the impact of budgetary reductions can cut across all plant safety-related programs, other impacts in addition to those previously identified may occur as a result of deregulation. For example a merchant plant with no assets other than the nuclear plant itself could be unable to make necessary safety expenditures after an extended outage if it did not have an adequate financial cushion to pay costs incurred during the outage. In such a situation, it is not clear that a transition from indefinite shutdown to permanent shutdown and decommissioning would be sufficiently smooth to prevent funding shortages from causing safety problems during the shutdown transition period. That is, given the requirements in 10 CFR 50.82 with respect to: (1) the limitation on the use of the trust fund for legitimate decommissioning activities; and (2) the timing of significant decommissioning trust fund withdrawals, a licensee could run out of funds for operational safety expenses before it was able to draw on its decommissioning trust fund. This, in turn, could force the NRC to

make the decision for the licensee to permanently cease operations and initiate decommissioning pursuant to 10 CFR 50.82.²¹

The nuclear industry itself has acknowledged the safety and economic risks associated with economic deregulation. For example, a former President of the industry's American Nuclear Society told the Society's Winter 2001 meeting that "Safety is the highest priority because of the impact on cost that would result from an NRC-forced shutdown" and that there is now "actually a higher focus on safety than before."²² However, he also noted the challenges that come from deregulation and restructuring:

With restructuring comes challenges for plant operators and regulators, Quinn continued. These challenges for operators include management focus on economics, not safety; pressure on workers to keep plants operating (because of volatility of electricity prices); pressure to reduce preventative maintenance; deferral of equipment replacements; and less investment for safety backfits. For the regulator, these include increased workload (because of mergers, license transfers, etc.); pressure to avoid requiring shutdowns of plants; and increased political pressure to reduce the regulatory burden. Challenged also is the nuclear technology infrastructure. According to Quinn, there is less cooperation among competing nuclear utilities, and less safety research and technical support for the plants.²³

Finding No. 6 - The NRC has expressed concern that the use of holding company structures can reduce the assets that would be available for the safe operation and decommissioning of a nuclear power plant. However, the NRC does not adequately protect against the risk that an LLC subsidiary will transfer all of its operating profits to its parent company or engage in risky loans to or questionable deals with affiliates.

The NRC Staff has expressed concern that the use of holding company structures can lead to a diminution of the assets necessary for the safe operation and decommissioning of a licensee's nuclear power plant.²⁴ In fact, as early as March 1993 the NRC Staff expressed concern that:

Current and potential organizational structures of many power reactor licensees and their corporate affiliates are complex and evolving. The staff believes that the public health and safety implications of such structures warrant further examination. A licensee subsidiary without assets other than

²¹ NRC Staff Requirements Memorandum, SECY-98-153, dated June 29, 1998, at pages 2 and 3.

²² ANS Winter Meetings: Nuclear Power - Attracting Notice, A Brighter Outlook, Nuclear News, August 2001, starting at page 34.

²³ Ibid.

²⁴ Safety Evaluation by the NRC's Office of Nuclear Reactor Regulation "Related to Proposed Corporate Restructuring of Commonwealth Edison Company," October 5, 2000, at page 3.

the licensed reactor could renege on its decommissioning obligations if forced to shut down prematurely. Given that corporate law generally limits the liability of stockholders, the NRC may not have recourse to the assets of a parent company if its subsidiary defaults absent legally enforceable commitments by owners. Case law with respect to bankruptcy proceedings is also ambiguous. Although bankruptcy courts have generally directed bankruptcy trustees to make justifiable, legally required expenditures to protect public health and safety, it is not clear that these expenditures will always have a high priority relative to other claims. The staff believes that it should evaluate possible ways to increase assurance of decommissioning funds availability. An increased degree of confidence may be appropriate to assure that the problems that the Office of Nuclear Material Safety and Safeguards has had with some of its licensees abandoning materials sites prior to cleanup will not be experienced for power reactor licensees.²⁵

The NRC Staff consequently requested that the NRC Commissioners approve publication of an advance notice of proposed rulemaking to explore alternatives to mitigate the potential impact on safety of power reactor licensee ownership arrangements and to consider whether increase assurance of funding availability for decommissioning activities was needed.

A licensee subsidiary without assets other than the licensed reactor could renege on its decommissioning obligations if forced to shut down prematurely.

NRC Staff, March 1993

Unfortunately, the NRC Commissioners disapproved this request and, instead, asked for additional information on the staff proposal. In response to a Commission question on how many reactor licensees could try to set up a corporate veil to avoid decommissioning costs, the NRC Staff noted:

Potentially, any investor-owned utility could establish a holding company to which it could transfer the bulk of its assets over time. If forced to shut down prematurely, a licensee with assets limited essentially to the shut down reactor could declare bankruptcy and renege on any unfunded decommissioning obligation. If a bankrupt licensee had insufficient assets, a bankruptcy court might be powerless to order that assets of a parent company be used to fund decommissioning, even if the court wished to do so.²⁶

In the years since 1994, the NRC has not developed or adopted any policy limiting the transfer of operating profits from the subsidiary that directly owns a nuclear plant. Nor

²⁵ *Issuance of An Advance Notice of Proposed Rulemaking on the Potential Impact on Safety of Power Reactor Licensee Ownership Arrangements, SECY-93-075, March 24, 1993, at page 1.*

²⁶ *Response to Staff Requirements Memorandum of April 28, 1993, Which Disapproved Issuance of An Advance Notice of Proposed Rulemaking on the Potential Impact on Safety of Power Reactor Licensee Ownership Arrangements, SECY-94-280, at pages 4 and 5*

does the NRC have any policy limiting the types or magnitudes of the loans that such an operating subsidiary can make to affiliated companies.

At most, the NRC merely conditions license transfer approvals to new holding company structures upon a requirement that the licensee not transfer to its proposed parent or any other affiliated company significant assets for the production, transmission or distribution of electric energy without first notifying the NRC. The NRC has defined "significant assets" to be facilities having a "depreciated book value exceeding 10% of the company's consolidated net utility plant."²⁷

The NRC also does not have a specific policy statement or procedure on how limited liability companies or other types of licensees use financial assurance funds in the forms of lines of credit for plant operation.²⁸ Nor does the NRC have any specific policy statement or procedure that controls how it would consider approval of requests of limited liability companies to reduce, replace, or withdraw available lines of credit that are subject to NRC conditions. Instead, the NRC has said that it will review such requests on a case-by-case basis.²⁹

The NRC has explained its policy for addressing situations where a licensee has drawn upon the lines of credit provided by a parent or affiliated companies. In such situations, the NRC would:

evaluate the reasons behind [the licensee's] drawing on the lines of credit. The staff cannot provide a detailed discussion of potential agency actions until it learns the specific reasons for the usage of such funds. Generally, if drawings on the lines of credit were made to cover short-term cash flow deficiencies that did not appear to have any significant safety ramifications, the NRC would not likely need to take any specific action. If drawing on the lines of credit were to indicate serious longer-term financial problems that appeared to potentially adversely impact protection of public health and safety, the NRC would monitor the effects of any degradation on protection of public health and safety and act appropriately.³⁰

The NRC's failure to have any policy limiting the transfer of operating profits from the subsidiary that directly owns a nuclear plant or the types or magnitudes of the loans that such an operating subsidiary can make to affiliated companies is all the more significant because the new holding companies also may have not set policies governing these matters. For example, Entergy has said that there are no written procedures governing the distribution of operating profits from the subsidiaries that are the direct owners of its

²⁷ For example, see the October 5, 2000 Safety Evaluation by the NRC Office of Nuclear Reactor Regulation of the proposed corporate restructuring of PECO Energy Company, at page 3.

²⁸ Enclosure 1 to the NRC's December 13, 2001 letter to Christine Salembier, Commissioner, Vermont Department of Public Service, on the subject of "Vermont Yankee Nuclear Power Station – Lines of Credit Associated with Vermont Yankee License Transfer."

²⁹ Ibid.

³⁰ Ibid.

nuclear units.³¹ These subsidiaries either make distributions to their immediate parent companies or make loans to affiliated companies depending on the specific cash requirements of the parent companies or the affiliates.

Vermont Department of Public Service witness Andrea Crane has explained to the Vermont Public Service Board why it should be concerned about the ability of a parent corporation to drain the funds available to a nuclear power plant-owning subsidiary:

...in addition to being concerned about the availability of capital for ENVY's³² operations, there is also a concern that Entergy Corp. may threaten the long-term financial viability of ENVY by using ENVY's earnings to fund other Entergy Corp. operations, leaving insufficient funds in ENVY for nuclear operations. Therefore, in addition to raising concerns about the availability of sufficient operating and capital funds, I am also concerned about the need to retain capital in ENVY. The Board should avoid a repeat of the situation that transpired in PG and E ... whereby funds were transferred from a successful operating entity to the holding company, leaving the operating company in dire financial straits.³³

Ms. Crane also expressed concern about the absence of formal Entergy corporate policies governing the transfer of profits and inter-affiliate transactions:

The lack of direct control over its internally generated funds, and the vagueness of the corporate policy, does not provide an appropriate level of financial assurance for the ownership and operation of a nuclear power plant. It leaves open the possibility that Entergy Corp could require 100% of operating earnings as dividends from its subsidiaries, including ENVY, if it needed funds to meet other priorities or emergencies, leaving the owners of the nuclear plants without sufficient capital to pursue their own immediate priorities.³⁴

³¹ Entergy Response to Department of Public Service Information Request No. 2-36 in Vermont Public Service Board Docket No. 6545.

³² ENVY is Entergy Nuclear Vermont Yankee LLC, which is the Entergy Corporation subsidiary that will own the Vermont Yankee nuclear plant if the purchase is approved by the Vermont Public Service Board.

³³ Direct Testimony of Andrea Crane on behalf of the Vermont Department of Public Service, Vermont Public Service Board Docket No. 6545, at page 9.

³⁴ Direct Testimony of Andrea Crane on behalf of the Vermont Department of Public Service, Vermont Public Service Board Docket No. 6545, at page 28.

Finding No. 7 - The NRC's reviews of the financial qualifications of new nuclear power plant owners are inconsistent and may be too limited to ensure that subsidiaries will have adequate funds to safely operate and decommission their nuclear plants and pay retrospective Price-Anderson Act premiums.

Before it allows a nuclear power plant operating license to be transferred, the NRC conducts reviews of the financial qualifications of the prospective owner. The NRC's regulations specify the types of information that a prospective licensee must provide and the nature of the review that must be conducted by the NRC staff.

However, the applicable NRC regulation, 10 CFR 50.33(f), is inconsistent in that on the one hand it says that "the applicant shall submit information that demonstrates the applicant possesses or has reasonable assurance of obtaining the funds necessary to cover estimated operation costs for the **period of the license.**" (emphasis added) But the regulation then merely requires applicants to submit estimates for total annual operating costs for only the first 5 years of operation of the facility. Although the NRC can ask for information for subsequent years, this regulation can mean that the NRC will only review five years of operating cost data when the new owner may be seeking transfer of a license which will continue in effect for another 25 years or longer.

In reviewing the financial qualifications of a prospective licensee, the NRC requires that the new owner either meet a supply and demand test or show that it has an investment grade rating or equivalent from at least two bond-rating organizations. The supply and demand test examines whether the prospective licensee will earn sufficient revenues (either from the sale of electric power from the nuclear plant or from other sources) to cover expected operational expenses at the plant.³⁵ This analysis is based on the applicant's uncertain and speculative estimates of total operating revenues and costs for the first full five years following the expected completion of the license transfer.³⁶ At the same time, it is very unlikely that the new corporate subsidiaries that actually will own the transferred plant will have issued any securities that had received investment grade or equivalent ratings from any bond-rating organizations.

If a prospective licensee is unable to meet either the supply and demand test and or the bond rating criteria test, the NRC will consider its ability to fund a six-month outage. Although assuring the funding for a six-month outage is not required where a prospective licensee meets either of the NRC's two primary tests, in those cases where a prospective licensee voluntarily guarantees the funds to pay for a six-month outage, the Commission will accept that commitment and impose a licensee condition prohibiting the applicant from voiding or diminishing those guarantees.

The U.S. General Accounting Office ("GAO") has evaluated the NRC's review of the financial qualifications of prospective licensees to safely operate and decommission

³⁵ NUREG-1577, Revision 1, at Section III.1.b.

³⁶ It also appears that the NRC does not consider the need to pay retrospective Price-Anderson Act premiums when it considers a prospective licensee's financial qualifications to safely operate and decommission a nuclear power plant.

nuclear power plants. The GAO concluded that for the most part, the NRC's reviews of new owners financial qualifications have enhanced the level of assurance that they will safely own and operate their plants in a deregulated environment and not need to shut them down prematurely.³⁷

However, the GAO also found that the NRC did not always adequately verify the new owners' financial qualifications.³⁸ In particular, the GAO concluded that when the NRC reviewed the financial qualifications of Exelon to safely own and operate the largest fleet of nuclear plants in the U.S., it did not require the same additional guarantees from the parent or affiliated companies that the new owner would have sufficient revenues to cover the plants' operating costs as it had required from other proposed license transfers.³⁹ The NRC also did not validate the information submitted by the new owner to demonstrate that the company was financially qualified.⁴⁰ In fact, the GAO concluded that the NRC had eventually transferred the licensees to Exelon Generation Company on the basis of projected financial information that both the affected companies and the NRC knew to be inaccurate.⁴¹

The NRC's review of financial qualifications continues after a license is transferred. Each licensee is required to submit an annual financial report, pursuant to 10 CFR 50.71(b) and a decommissioning funding status report is required every two years.⁴² The NRC Staff also monitors the general financial status of nuclear plant licensees by screening the trade and financial press reports, and other sources of information.⁴³

However, it is unclear whether the NRC has the staff resources or the expertise to conduct adequate reviews of licensee's financial qualifications. For example, the NRC's Executive Director for Operations informed the Commissioners in April 1997 that the expertise of the NRC Staff in matters of finance and economic analysis were "limited."⁴⁴ At the same time, the size of the NRC Staff has been reduced by approximately ten percent since 1997.⁴⁵

The NRC has expressed confidence in its Staff's ability to identify financial distress and has quoted approvingly a Staff member who said "severe financial distress from any of the licensees is something that's not going to be hidden from view very long."⁴⁶ However, the suddenness of ENRON's collapse and the apparent absence of public warnings of that

³⁷ *Nuclear Regulation: NRC's Assurances of Decommissioning Funding During Utility Restructuring Could be Improved*, GAO-02-48, December 2001, at page 6.

³⁸ *Ibid.*, at page 4.

³⁹ *Ibid.*, at page 21.

⁴⁰ *Ibid.*, at pages 21 and 31-32.

⁴¹ *Ibid.*, at page 33.

⁴² 10 CFR 50.75(f)(1).

⁴³ NUREG-1577, Rev 1, Section III.1.d., at page 5.

⁴⁴ NRC SECY-97-071, April 2, 1997.

⁴⁵ NUREG-1350, Vol. 13, Figure 4.

⁴⁶ *In the Matter of Power Authority of the State of New York and Energy Nuclear Fitzpatrick*, 53 N.R.C. 488, June 21, 2001.

company's severe financial distress prior to that collapse suggest that the NRC may not have any warning about a licensee's impending financial problems.

Finally, the NRC recently has indicated its intention to reduce the regulatory burden on licensees by eliminating the requirement that licensees include financial qualifications information in license renewal applications.⁴⁷ This would mean that there would be no assessment of the financial qualifications of a licensee to safely operate a nuclear power plant for up to an additional twenty years beyond the expiration of its existing NRC-issued license.

In conclusion, there are a number of reasons to have serious concerns about the quality of the NRC's review of the financial qualifications of licensees and prospective licensees.

Finding No. 8 - The financial guarantees that the NRC requires from prospective nuclear power plant owners may not be adequate to assure that plants are operated and decommissioned safely and that plant owners will be able to pay deferred Price-Anderson Act insurance premiums in the event of a nuclear accident.

The NRC has generally accepted guarantees from prospective nuclear power plant licensees in the range of \$55 to \$75 million to pay for a six-month outage. However, in a number of cases the licensee has not offered and the NRC has not required the licensee to make any such guarantee.⁴⁸ For example, there appears to be guarantees in place for only three of the nuclear units owned by Exelon Generation Company, LLC. These are the three units that were originally 50 percent owned by PECO Energy Company and were transferred to Exelon Generation Company, LLC as part of the merger between Unicom and PECO Energy. The guarantees that were in place when the plants were owned by PECO Energy and British Energy were transferred along with the plants. However, it does not appear that there is any guarantee in place for the other 16 nuclear plants that are currently owned by Exelon Generation, Company, LLC.

There is no evidence that these limited \$55 to \$75 million guarantees will provide sufficient funds to enable power plant owners to safely shutdown their nuclear plants in case of a serious event or significant problem and to maintain the plant in a safe shutdown condition until the problem is addressed or the licensee is able to gain access to the plant's decommissioning trust fund. For example, a substantial number of nuclear power plants have been shutdown since January 1996 for outages that lasted far longer than six months:

⁴⁷ FedNet Government News, June 5, 2002.

⁴⁸ As we will discuss in Finding No. 9, Constellation has guaranteed that its nuclear power plant-owning subsidiaries, Nine Mile Point LLC and Calvert Cliffs Nuclear Plant LLC will receive whatever cash is needed to protect the public health and safety.

Table No. 2
Nuclear Power Plant Outages
Since June 1995
That Lasted Nine Months or Longer

<u>Plant</u>	<u>Period Shutdown</u>	<u>Outage Duration</u>
Beaver Valley 2	December 1997 - September 1998	9 months
Clinton	September 1996 - May 1999	32 months
Cook Unit 1	September 1997 - December 2000	39 months
Cook Unit 2	September 1997 - June 2000	33 months
Indian Point 2	February 2000 - December 2000	10 months
Kewaunee	September 1996 - June 1997	9 months
LaSalle Unit 1	September 1996 - August 1998	23 months
LaSalle Unit 2	September 1996 - April 1999	31 months
Millstone Unit 2	February 1996 - May 1999	39 months
Millstone Unit 3	March 1996 - June 1998	27 months
Point Beach Unit 1	February 1997 - December 1997	10 months
Point Beach Unit 2	October 1996 - August 1997	10 months
Salem Unit 1	May 1995 - April 1998	35 months
Salem Unit 2	June 1995 - August 1997	26 months

Indeed, as Table No. 1 (in Finding No. 1 above) and Table No. 2 reveal, it is not unusual for more than one unit at a single site to be shutdown for an extended outage at the same time. These simultaneous extended outages could significantly increase the financial pressures on the units' owner in a deregulated environment when its cash flow depends on the actual sales from the plant rather than on regulated rates for an entire utility.

Moreover, it is not unreasonable to expect that a nuclear unit might be shutdown for more than six months before the ultimate parent corporation makes the decision to permanently retire the unit. After all, the full extent of the plant's problems and the expense and time it would take to repair and restart the unit might not be apparent until the plant had been shut down for a substantial period of time.

This could mean that all of the funds guaranteed by an affiliate or the parent corporation could be exhausted before the licensee would be able to gain access to the unit's decommissioning fund. For example, Millstone Unit 1 was shutdown for 31 months before Northeast Utilities decided in July 1998 to permanently retire the plant. Commonwealth Edison Company's Zion Units 1 and 2 were shutdown for eleven and sixteen months, respectively, before the Company decided in January 1998 to

permanently retire both plants. The Maine Yankee plant was shut down for eight months before its Board of Directors decided in August 1997 to permanently retire it.

But even if an outage were shorter than six months, the maintenance and/or capital expenditures required to repair a plant and restore it to service may be significantly higher than the company had projected in its application to the NRC. The limited funds pledged by a parent corporation or an affiliate could be inadequate under such circumstances.

Finding No. 9 – The NRC has proposed to significantly reduce its review of a non-electric utility licensee’s financial qualifications when it evaluates an application to renew a nuclear plant’s operating license.

The NRC has proposed to eliminate the requirement that non-electric utility power reactor licensees submit financial qualifications information in their license renewal applications.⁴⁹ At the same time, the NRC also has proposed to require the submission of such information when utilities reorganize and operate as "non utility" generators.

The NRC's proposal to require financial reviews when a utility recognizes with a new financial structure is important. However, the decision to reduce disclosure obligations on nuclear power plant owners when they seek renewal of operating licenses for up to 20 years creates the potential for added risk of non-performance in critical areas.

A formal and rigorous review at the time of license renewal for aging nuclear reactors is a particularly appropriate time to evaluate the financial requirements. It is at this point that a business plan can be evaluated over the proposed lifetime of a licensee's facility. The financial resources needed to address the safe and secure operations, make capital improvements to a complex 30 year old machine, meet added license conditions required after the events of September 11, 2001, and to meet decommissioning and public liability obligations under the Price Anderson Act, must be juxtaposed against the economic conditions in the electricity markets and the availability of capital and insurance.⁵⁰

The NRC's justification for not requiring a financial qualifications review at the time of relicensing is that it can monitor licensees when changes take place in licensee's financial qualifications. These day-to-day or limited annual reviews are not substitutes for a

⁴⁹ June 4, 2002 Federal Register, at Vol. 67, No. 104, pp. 38427.

⁵⁰ The wisdom of looking into the future was underscored in the case of USEC, Inc, which has an NRC Certificate under 10 CFR Part 76 to operate uranium enrichment plants. The NRC conducted a financial review of the USEC, Inc. Certificate when it was issued in 1998 using the threshold of a current investment grade credit rating. The NRC determined USEC was reliable and economic based on its BBB+ investment grade debt rating. However, the NRC did not look beyond the 5 year term of the certificate to evaluate USEC's financial qualifications or the company's ability to operate with an unsustainable business model. If it had, it could have readily foreseen that USEC's financial condition would deteriorate over time due to a number of factors including the declining value of its sales contract, lower market prices, increasing unit costs of output and lack of competitive technology to enrich uranium for nuclear power reactors. These factors led to multiple credit downgrades and subsequent NRC doubts about whether USEC's economic resources were sufficient to be recertified for another 5 years.

formal, rigorous and disciplined review examining all a licensee's financial ability to fulfill its obligations for safely and securely operating an aging reactor in a competitive marketplace.

Historically, the ratemaking process for a utility corporation had provided reasonable assurance that a license applicant would have funds necessary to operate a reactor. In these circumstances, a licensee could be assumed of obtaining all of the reasonable funds it needed to continue operating its aging power plant. However, non-utility generators now lack the same assured funding, and as utilities diversify into telecommunications, trading operations and high-risk financial activities, the risk that there will be insufficient capital grows. To provide a green light for 20 years of operation without a rigorous review of a licensee's financial resources and business plans invites unwelcome surprises.

Finding No. 10 - The NRC does not require that parent corporations guarantee that funds will be provided to safely operate and decommission the nuclear power plants owned by their subsidiary companies.

The NRC does not require that a parent corporation guarantee the funds that may be needed to operate and decommission safely the nuclear power plants owned by subsidiaries. Instead, the NRC Staff has included conditions requiring a parent guarantee in the orders approving license transfers as additional assurance of financial qualifications only when such a guarantee has been offered by the applicant.⁵¹

For example, in its reviews of the financial qualifications of Entergy Corporation to own the Pilgrim, Indian Point 2, Indian Point 3, Fitzpatrick, and Vermont Yankee nuclear plants, the NRC has accepted guarantees that would be provided through lines of credit from affiliated financial subsidiaries which may not have sufficient liquid capital when it is needed by a plant-owning affiliate. One of these credit lines is to be used for working capital, if needed. The other is not intended to be used in the normal course of business but instead would be used in the event of problems at the plant. Entergy has indicated that this line of credit would be used to pay the costs between the unplanned shutdown of a plant and the availability of funds from the plant's decommissioning trust fund.⁵²

Vermont Department of Public Service witness Andrea Crane has explained the problems that can arise from the fact that neither of the Entergy subsidiaries that provide these lines of credit have any physical assets:

The result is that these two companies are only as strong as 1) their receivables from, and investment in, associated companies, and 2) Entergy Corp's commitment to provide them with additional funds, if required. Entergy Corp, therefore, has full discretion as to whether or not to provide sufficient capital to EIHL and EGI so that these two financing vehicles can

⁵¹ *In the Matter of GPU Nuclear, Inc and AmerGen Energy Company, LLC*, 51 N.R.C. 193, at Footnote No. 8.

⁵² Prefiled Direct Testimony of Michael R. Kansler, Entergy Nuclear Vermont Yankee, Vermont Public Service Board Docket No. 6545, at page 10.

meet their commitments to ENVY. If Entergy Corp should choose to walk away from EIHL and EGI, there appears to be no recourse for ENVY.⁵³

For this reason, Ms. Crane recommended that the parent Entergy Corporation be required to guarantee that the pledged funds actually would be available if needed:

Entergy Corporation should be obligated to stand behind the total financial exposure occasioned by the ownership and operation of this nuclear power plant. It is not reasonable to allow Entergy Corporation to shield itself from financial responsibility with complex financial arrangements. It certainly should not be allowed to offer guarantees from subsidiaries that do not have sufficient assets to meet their obligations on a stand-alone basis, because the parent could walk away from those subsidiaries if its own interests so dictated. If Entergy Corporation intends to stand behind the guarantees of its subsidiaries, it should have no problem in making the guarantee directly.⁵⁴

Even though the NRC had accepted the \$70 million guarantee provided by the two lines of credit from Entergy Corporation subsidiaries, in response to the concerns raised by the Ms. Crane and the Vermont Public Service Board, the parent Entergy Corporation has provided an additional financial guarantee of up to \$60 million.⁵⁵ As Entergy has explained:

The intent of that guarantee is to make sure that, in the event of a premature shutdown of the Vermont Yankee Nuclear Power Station, there will be money available to bridge the gap between shutdown and the point at which ENVY is able to access the decommissioning trust fund. Thus, if either line of credit has been drawn upon, Entergy will guarantee to make up any deficiency up to a total of \$60 million.⁵⁶

Entergy also acknowledged that the parent corporation has not provided a similar guarantee in support of **any** of the other nuclear plants its subsidiaries have acquired.⁵⁷ It further noted that state and federal regulators, including the NRC, had found the smaller guarantees by affiliated companies, not the parent corporation, to be sufficient.⁵⁸

⁵³ Direct Testimony of Andrea Crane on behalf of the Vermont Department of Public Service, Vermont Public Service Board Docket No. 6545, at page 18.

⁵⁴ Direct Testimony of Andrea Crane on behalf of the Vermont Department of Public Service, Vermont Public Service Board Docket No. 6545, at page 22.

⁵⁵ Ms. Crane subsequently testified that the revised commitments by the parent Entergy Corporation adequately addressed the concerns in her Direct Testimony. Supplemental Testimony of Andrea Crane in Support of the Memorandum of Understanding in Docket No. 6545, at page 2 of 9.

⁵⁶ Rebuttal Testimony of Connie Wells, Entergy Nuclear Vermont Yankee, LLC, in Vermont Public Service Board Docket No. 6545, at page 3, lines 8-13.

⁵⁷ *Ibid.*, at page 5, lines 1-5.

⁵⁸ *Ibid.*

Dominion has voluntarily committed \$150 million from the parent corporation, DRI, to assure that Dominion Nuclear Connecticut (the new owner of the Millstone Nuclear Station) will have sufficient funds available for meeting its operating expenses for the recently acquired Millstone Units 2 and 3.⁵⁹ Dominion has explained that the subsidiary, Dominion Nuclear Connecticut, has the right to obtain such needed funds from DRI as it determines "are necessary to protect the public health and safety, meet NRC requirements, meeting ongoing operational expenses or to maintain Units 2 and 3 safely."⁶⁰ However, it does not appear that Dominion has made the same commitment to the four nuclear plants at the Surry and North Anna sites owned by the Dominion Generation Corporation.

Constellation has guaranteed that each of its nuclear power plant-owning subsidiaries, i.e., Nine Mile Point Nuclear Station LLC and Calvert Cliffs Nuclear Plant LLC, would be provided whatever cash is needed to protect the public health and safety.⁶¹

But it does not appear that the parent Exelon Corporation has guaranteed any funds to its power plant owning and operating subsidiary Exelon Generation Company, LLC.

Finding No. 11 – Taxpayers may be at risk if nuclear plant owning subsidiaries are unable to continue making safety-related or decommissioning expenditures or pay retrospective Price-Anderson Act premiums.

In attempting to assure the Vermont Public Service Board that the former owners of the Vermont Yankee nuclear plant and their ratepayers are unlikely to be required to pay any shortfalls in decommissioning funds, Entergy has noted that the NRC has on several occasions said that the burden of paying any such shortfalls would fall on taxpayers:

NRC regulations do not specifically address the potential liability of other parties in the event that the licensed owner is unable to provide the funds required for decommissioning. In the past, the NRC indicated that any failure of the licensed owner to meet its decommissioning funding obligations would result in a burden on taxpayers -- presumably in the form of a publicly funded cleanup. See, e.g., SECY-94-280 (Nov. 18, 1984), at 4. ("Such action would either increase the potential risk to public health and safety of the decommissioning process or would shift the burden of decommissioning funding from ratepayers to taxpayers.") (emphasis added); 61 Fed. Reg. 15427, 15428 (Apr. 8, 1996)("The liability of the licensee to provide funding for decommissioning may adversely affect protection of the public health and safety. Also, a lack of decommissioning funds is a financial risk to taxpayers

⁵⁹ *Dominion August 31, 2000 Application for the transfer of the licenses for Millstone Units 1, 2 and 3*, at page 10.

⁶⁰ *Ibid.*

⁶¹ *Calvert Cliffs Nuclear Power Plant Request for a Transfer in Control*, December 20, 2000, at page 9 and *Nine Mile Point Unit Nos. 1 & 2 NRC License Transfer Application*, February 1, 2001, at page 23.

(i.e., if the licensee cannot pay for decommissioning, taxpayers would ultimately pay the bill. (emphasis added).”⁶²

In fact, there are a number of possible circumstances in which taxpayers could be asked to bear much, if not all, of the cost of a major power plant accident. First, there is no assurance that the primary tier of insurance would be available to a licensee in the event of an act of terrorism against a nuclear power plant. American Nuclear Insurers has testified that it would only have resources available to provide the primary insurance coverage to cover a single act of terrorism.⁶³ Thereafter, all licensees would be left without any primary insurance coverage. At that point, licensees might seek recourse in the courts for a finding that domestic terrorism is an "act of war." Acts of war are excluded from coverage under the Price-Anderson Act.⁶⁴

At the same time, the liabilities associated with a nuclear accident are borne by every nuclear power plant owner in the U.S. as a result of the pooling of liabilities for accidents with claims in excess of \$200 million. The maximum cost per reactor is \$88.085 million (subject to inflation adjustments) in secondary liability. As shown on Table No. 3 below, the liability for nuclear owners with multiple plants, such as Exelon (19 units) and Entergy (10 units), could approach or exceed \$1 billion.

Table No. 3
Potential Price Anderson Act Nuclear Insurance Liabilities

<u>Parent Corporation</u>	<u>Maximum Potential Annual Liability</u>	<u>Maximum Potential Total Liability</u>
Exelon Corporation	\$163.52 million	\$1,440.35 million
Entergy Corporation ⁶⁵	\$99 million	\$872.04 million
Duke Energy	\$52.50 million	\$462.45 million
Dominion Resources, Inc.	\$57.03 million	\$502.32 million
Southern Company	\$39.16 million	\$344.94 million

⁶² Legal Memorandum on the "Decommissioning Liability Associated with a Power Reactor License," Goodwin Procter LLP, February 24, 2002, submitted by Entergy Corporation to the Vermont Public Service Board as Exhibit ENVY-Wells-3 to the Prefiled Rebuttal Testimony of Connie Wells in Docket No. 6545.

⁶³ John Quattocchi, Senior Vice-President, American Nuclear Insurers, February 15, 2002 Response to Question from Senator Reid, Hearing before the Senate Committee on Environment and Public Works, January 23, 2002.

⁶⁴ The NRC's "opinion" is that claims arising out of an act of terrorism at a nuclear power plant would not be excluded under the Price Anderson Act. February 13, 2002 NRC Answer to Question No. 3 from Senator Reid, Hearing before the Senate Committee on Environment and Public Works, January 23, 2002. However, the NRC recognizes that a "question of this nature and magnitude" would likely need to be resolved by a court in the first instance.

⁶⁵ Potential Liability figures reflect Entergy ownership of the Vermont Yankee Nuclear Station.

TVA	\$60 million	\$528.51 million
Progress Energy	\$44.72 million	\$393.87 million
FPL Group ⁶⁶	\$47.33 million	\$416.91 million
Constellation Energy Group, Inc.	\$38.20 million	\$336.49 million
FirstEnergy	\$40 million	\$352.34 million

However, under the Atomic Energy Act, a licensee's secondary liability can be deferred if it would constitute an undue hardship on the licensee.⁶⁷ In such a situation, the secondary liability that would have been borne by the license would become a taxpayer funded liability. It is not unreasonable to expect that power plant owners, especially those that are thinly capitalized, will try to avail themselves of this deferral should a major accident occur.

Moreover, this Report has focused on nuclear-related issues. Nuclear power plants also contain large amounts of asbestos and large volumes of toxic chemicals. Taxpayers also could be forced to bear the costs of cleaning up for these and any other non-nuclear-related pollutants if a single asset power plant-owning subsidiary was able to successfully declare bankruptcy and a court was unwilling to hold the parent corporation liable.

Finding No. 12 - The NRC has no statutory authority to require a licensee in bankruptcy to continue making safety-related or decommissioning expenditures or to pay retrospective Price-Anderson Act premiums.

NRC regulations require any nuclear power plant licensee to immediately report any filing of a voluntary or involuntary petition for bankruptcy.⁶⁸ However, the NRC has no additional financial requirements for situations where a licensee files for bankruptcy or otherwise encounters financial difficulties. Nor does the NRC have any statutory authority to require a licensee which is in bankruptcy to continue to make safety-related or decommissioning payments or to pay retrospective Price-Anderson Act premiums. The NRC must intervene in the proceedings before the bankruptcy court and petition the court to require such payments.

The NRC has acknowledged that the license transfer requirements contained in 10 CFR 50.80 do not specifically or expressly refer to a prospective licensee's ability to meet financial protection payments that may be required under the Price-Anderson Act.⁶⁹ However, the NRC has said that 10 CFR 140.21 requires reactor licensees that are covered under the Price-Anderson system to provide annual guarantees of payments of

⁶⁶ Potential Liability figures reflect FPL Group ownership of the Seabrook Nuclear Station.

⁶⁷ Atomic Energy Act Section 170(b)(2)(A) and (2)(B).

⁶⁸ 10 CFR 50.54 (cc).

⁶⁹ NRC February 13, 2002, response to Post-Hearing Question 6 from Senator Reid.

retrospective premiums and that the NRC evaluates an applicants guarantees of payment of retrospective premiums when it considers a license transfer request.⁷⁰

The NRC has further said that it annually reviews the Price-Anderson Act guarantees for all of its power reactor licensees, including those that are LLCs.⁷¹ All of the licensees have, to date, used the cash flow method of guarantee allowed under 10 CFR 140.21; that is, a licensee may demonstrate that it has sufficient cash flow over 3 months to meet an annual \$10 million retrospective premium payment for each reactor that it owns.⁷² As long as the licensee chooses that method and is able to pass the financial test for cash flow each year, no additional guarantee is required. However, if a licensee were not able to pass the cash flow test, it would have to provide some other allowable guarantee such as surety bonds, letters of credit, revolving credit/term load arrangements, maintenance of escrow deposits of government securities, or such other type of guarantee as might be approved by the NRC.⁷³ But there is no requirement that the parent corporation provide such a guarantee, only the subsidiary, and there is no requirement that resources be available to pay the maximum of \$88.085 million per reactor.

The NRC has stated that under 10 CFR 140, a licensee is required to pay the retrospective premium, notwithstanding its financial status.⁷⁴ The NRC also has said that its has had positive experiences with bankruptcy courts that have overseen the Chapter 11 reorganizations of Public Service Company of New Hampshire (Seabrook nuclear plant), Cajun Electric Cooperative (River Bend), El Paso Electric Company (Palo Verde), and Vermont Electric Generation & Transmission Cooperative (Millstone 3).⁷⁵ According to the NRC, in each of these cases, the bankruptcy courts allowed these bankrupt licensees to pay all safety-related operational and decommissioning expenses (including, the NRC believes, Price-Anderson primary layer and on-site property insurance premium payments). The NRC also has noted that during its bankruptcy PG&E has continued to meet all safety-related expenses for its nuclear plants.

However, the NRC has acknowledged that it could potentially face a conflict with other claims in a bankruptcy proceeding “if there were an accident sufficient to trigger a retrospective premium assessment. The NRC would presumably require a licensee to pay the assessment, but the bankruptcy court could order the licensee not to pay it.”⁷⁶

In addition, the NRC’s earlier experience with the bankruptcies all involved entities that owned a number of different assets. The bankruptcy of a single-asset LLC, which owns only a single nuclear power plant, would present very different circumstances and

⁷⁰ NRC February 13, 2002, response to Post-Hearing Question 6 from Senator Reid.

⁷¹ The NRC also requires that each licensee submit an annual financial report, 10 CFR 50.71(b) and a decommissioning fund status report every two years (and annually during the last five years of operation). 10 CFR 50.71(f)(1).

⁷² A retrospective premium is insurance that is paid after an accident.

⁷³ NRC February 13, 2002, response to Post-Hearing Question 8 from Senator Reid.

⁷⁴ NRC February 13, 2002, response to Post-Hearing Question 9 from Senator Reid.

⁷⁵ NRC February 13, 2002, response to Post-Hearing Question 2 from Senator Inhofe.

⁷⁶ NRC February 13, 2002, response to Post-Hearing Question 9 from Senator Reid.

challenges. At the same time, as we will discuss later in this Report, given the multi-tiered holding companies (including LLCs) through which parent corporations now own many nuclear power plants, the NRC might have trouble “piercing the corporate veil” to require a parent of a bankrupt LLC subsidiary to make the required retrospective premium payments.

It is clear that there are no specific statutory or regulatory safeguards in place to ensure that retrospective premiums under the Price-Anderson Act will be available from bankrupt nuclear plant-owning subsidiaries or from their parent corporations. The NRC has sought legislation from Congress to ensure that decommissioning costs receive explicit priority in bankruptcy proceedings. But, so far, that legislation has not been enacted.⁷⁷ The NRC has further stated its willingness to support legislation to prioritize safety-related claims in bankruptcy proceedings and to avoid any potential conflict between NRC requirements to pay into the retrospective Price-Anderson Act premium pool and other claims in bankruptcy.⁷⁸

Finding No. 13 – Case law suggests that it would be very difficult to hold a parent corporation responsible for the liabilities incurred by nuclear power plant owning LLC subsidiaries in a multi-tiered holding company.

As mentioned earlier in this Report, the multiple layers of subsidiaries, including LLCs, that have been created by parent corporations in the nuclear industry are a cause of serious concern. Even if a court concludes that the liability of the subsidiary that actually operates the nuclear plant should be extended to business structures above it (for example, if under capitalization and profit distributions have left the subsidiary unable to cover the costs of unanticipated repairs or security improvements and the subsidiary decides to cease operations), the ability of the court to find a senior business entity with sufficient capital could be complicated by multiple layers of subsidiaries and LLCs. There may be issues of jurisdiction, applicable state or federal statutes, the role of the NRC, and other myriad issues of law and fact that would need to be resolved. Given that the presumption in every state and federal statute is for the limitation of corporate liability, the burden is always on the party trying to extend that liability to show that the law, facts, and public policy all support violating the statutory presumption.⁷⁹ Courts, in

⁷⁷ The Energy Policy Act of 2002 (HR 4), as approved by the U.S. Senate, amends the U.S. Bankruptcy Code to prevent creditors in a bankruptcy proceeding from attaching an NRC licensee's decommissioning funds until the decommissioning has been completed. The Senate enacted provision also seeks to prevent creditors from using Price-Anderson insurance and those deferred premiums held in reserve to satisfy creditors. However, neither version of the Energy Policy Act of 2002, that enacted by the House or the Senate, would require a parent corporation or other guarantor to commit resources in the event that there are not adequate resources within a bankrupt LLC to satisfy claims after a nuclear accident. Post accident liabilities could shift to taxpayers in this case.

⁷⁸ NRC February 13, 2002, response to Post-Hearing Question 9 from Senator Reid.

⁷⁹ “Piercing the Corporate Veil: An Empirical Study”, Robert B. Thompson, 76 Cornell Law Review 1036 (1991), Section II, and “Limited Liability and the Corporation”, Frank H. Easterbrook and Daniel R. Fishel, 52 U. Chi. L. Rev. 89 (1985), Section IV.

general, are reluctant to pierce the corporate veil and extend liability; when multiple corporations are involved, that reluctance only increases.

Despite the limitations on corporate liability embodied in statutes, there are numerous instances where courts have been willing to ignore those limitations under a wide range of factual circumstances. The case law varies a great deal from one state to another, but all of them involve some rationale for “piercing the corporate veil” and holding the owners of the corporation personally liable. For the purposes of this Report, it is important to note that in the nuclear power industry, the owners of a nuclear power plant-owning LLC subsidiary are most likely to be another LLC or a parent corporation. The objective of the effort to pierce the corporate veil in this situation would be to make the parent corporation responsible for the liability of the LLC subsidiary.

There is an enormous volume of litigation over the issue of extending liability through to the owners of a corporation. The case law is varied and complex and a thorough and complete review is beyond the scope of this project. What follows is a summary of the common themes that have been used by a variety of courts for extending liability.⁸⁰

Starting from a presumption that a corporation’s liability is limited, facts must be presented to justify extending liability. Some of the fact situations that have been persuasive to courts are the following:

- Corporate form is used as a front for illegal or fraudulent activity. In these cases, courts express no reluctance in holding individuals liable for the debts of the corporation since there is no public policy that seeks to support such activities under any business structure.
- Corporate form is used as a sham or a mere shell to avoid liability. In these cases, the individuals or parent corporation are aware from the start that the corporation is unlikely to ever repay its debts or liabilities and seek to acquire as much income as possible before creditors foreclose.
- Individual owners subvert the corporation for their personal gain. In these cases, the personal enrichment may or may not be based on illegal or unethical actions. If the facts establish that owners personally benefited from corporate activities (beyond the normal sharing of corporate profits), then courts are generally willing to make them personally liable. These cases often involve members of the Board of Directors or managers. Corporate owners who do not personally benefit but are aware of the enrichment of other owners can be held personally liable based on their breach of their fiduciary responsibilities to the corporation.
- Under-capitalization of the corporation. In these cases, there is a determination that at the time of incorporation, or due to subsequent management actions, there is insufficient capital available for the business activities of the corporation. Although similar to the problem of a sham corporation, the decision by the court

⁸⁰ *Id.*, Thompson at 1063-1072; Easterbrook at 109-113.

involves a more objective analysis of appropriate levels of capitalization for similar entities engaged in similar activities.

- Improper distributions of income. These cases involve decisions by the corporate management, usually the Board of Directors, to distribute corporate income to shareholders in a financially irresponsible manner that leaves the corporation unable to meet its obligations. These are very fact-specific litigations that involve a great deal of hindsight analysis. However, if the facts show a clear pattern of irresponsibility, as opposed to poor business decisions, courts will extend liability to specific individuals or the corporation in general.
- Interference in management. These cases involve situations where owners, often large stockholders in closely held corporations, become so involved in corporate management that they look more like a managing partner than just an investor. Courts will extend liability to these “investors” on the theory that they do not deserve the normal corporate protection.
- Environmental, regulatory, or public policy. These factors are often included with one or more of the above fact patterns to support extending liability. It is unusual for a court to invoke “public policy” by itself as a justification for piercing the corporate veil.

An empirical study of court decisions where piercing the veil issues were litigated indicates that courts are very reluctant to impute liability to the shareholders of public corporations. Closely-held corporations (non-public and usually with few investors) and related corporate entities (subsidiaries, affiliates, etc.) are the forms to which courts have applied extended liability.⁸¹

There is very little case law involving LLCs that specifically addresses piercing the corporate veil due to the relatively short time period (fifteen years) during which LLC structures have been developed. Consequently, there is great uncertainty as to the effect that having one or more LLCs in the ownership chain within a holding company will have on the willingness of a court to pierce the corporate veil in order to hold a parent company responsible for the liabilities of its indirect nuclear power plant owning-subsidiary.

Finding No. 14 - The NRC has expressed serious doubts as to its ability to hold a parent corporation responsible for the liabilities incurred by a subsidiary.

There are two NRC cases that involved attempts to pierce the corporate veil of the operator of a nuclear power plant. In 1995, the NRC attempted to negate a transfer of assets from a licensee which, as part of a complicated corporate restructuring, had become a subsidiary to a newly created holding company because the transfer had occurred without the prior written consent of the NRC, as required by section 184 of the Atomic Energy Act. The NRC held that it could pierce the veil of corporations that

⁸¹ *Id.*, Thompson at 1070.

violate section 184. However, before a final adjudication, this case ended in a settlement.⁸²

In 1997, the NRC tried to force a parent company to provide additional funds to the decommissioning fund for a subsidiary plant. However, prior to a final adjudication, the NRC approved a settlement that resolved the decommissioning fund issue without any specific finding as to the parent company's liability.⁸³ In accepting the settlement, the NRC expressed concern that there was a "substantial possibility of defeat if the case proceeds to trial [on a theory of] piercing the corporate veil."

Both cases were cited in a legal memorandum provided by the current owners of the Vermont Yankee Nuclear Power Corporation, which concluded that attempts to pierce the corporate veil of nuclear power plant subsidiaries were unlikely to succeed and have seldom been attempted.⁸⁴ Despite the numerous specific instances where courts have extended liability to parent corporations, there is great uncertainty as to whether or not courts would apply such extended liability to multi-layered nuclear power companies.

Finding No. 15 – Shielding parent corporations from nuclear power plant operating and decommissioning risks is unfair and economically inefficient.

To the extent that the organizational structures discussed above serve to successfully shield the parent company from risks, they are inequitable and undermine efficient decision-making.

As a matter of fairness, individuals and companies should take responsibility for cleaning up after themselves. If an unanticipated problem in operation causes a nuclear plant to experience an extended or permanent outage prior to the end of its operating license or if the decommissioning of a plant turns out to cost more than expected, then the parent company may decide to provide additional resources to the subsidiary in order to carry out the subsidiary's responsibilities. On the other hand, the parent company may not. If there are clean up costs which the subsidiary is unwilling to bear, then these may fall upon taxpayers. Considerations of fairness would have the company that profited (or expected to profit) from plant operation bear the costs of cleaning up the facility.

This is also a matter of economic efficiency. If a company is protected from significant risks associated with its decisions, then there is what economists call an "externality." A reasonable definition of externality is provided in a popular economics textbook as follows:

An externality or spillover effect occurs when production or consumption inflicts involuntary costs or benefits on others; that is, costs or benefits are

⁸² *Safety Light Corp.*, 41 N.R.C. at 457-458 (1995).

⁸³ *Sequoyah Fuels Corp. and General Atomics*, CLI-97-13, 46N.R.C. 195 (1997).

⁸⁴ Vermont Yankee Memorandum of Law Regarding Ratepayer Risk of Liability for Vermont Yankee Decommissioning Costs, Vermont Public Service Board Docket No. 6545, dated February 25, 2002, at pages 17 and 18.

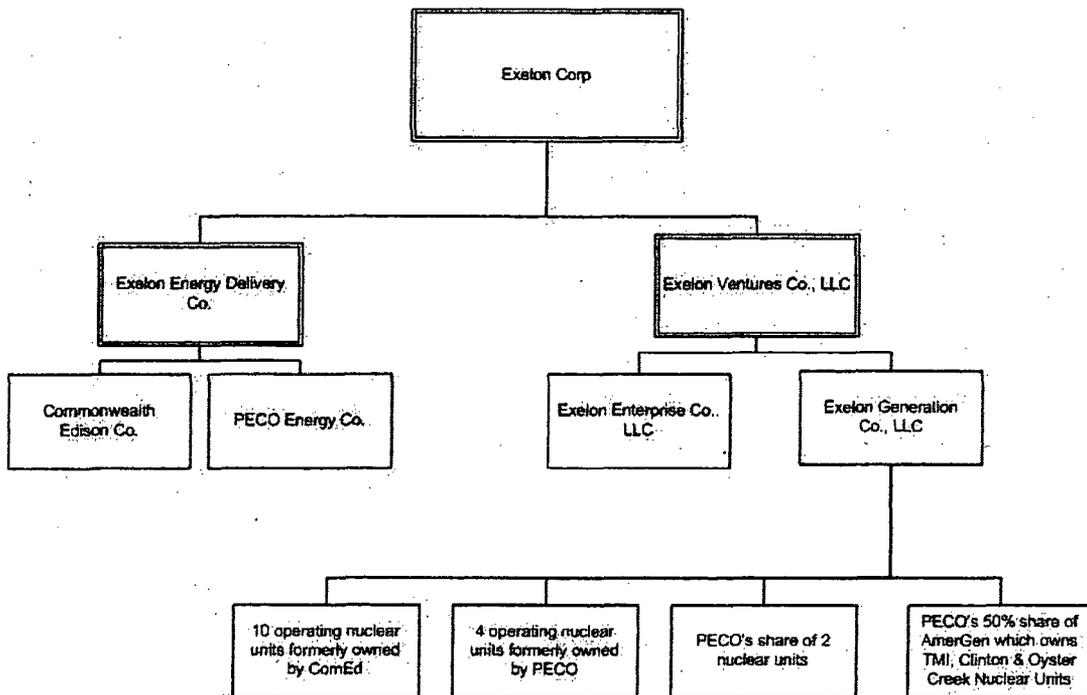
imposed on others yet are not paid for by those who impose them or receive them. More precisely, an externality is an effect of one economic agent's behavior on another's well-being, where that effect is not reflected in dollar or market transactions.⁸⁵

Where there are such externalities, private decision-making will be inefficient. A company will tend to undervalue (or value at zero) the costs associated with its action that are borne by others. In the case of a nuclear power plant, the protection from liability may, for example, cause the operator to make decisions that undervalue the potential for long-term radioactive waste storage costs. Or, faced with operating decisions that involve tradeoffs between cost and safety, the owner may undervalue safety and make choices that strike the wrong balance. In these situations, because some of the risks are "external," the market outcome may be an inappropriate decision from a societal perspective – or an inefficient allocation of resources. Government policy efforts should aim to internalize externalities, in order to promote appropriate private decision-making and efficient resource allocation.

⁸⁵ Samuelson, Paul A. and William D. Nordhaus. 1989. *Economics*, 13th Edition. McGraw-Hill, at page 770.

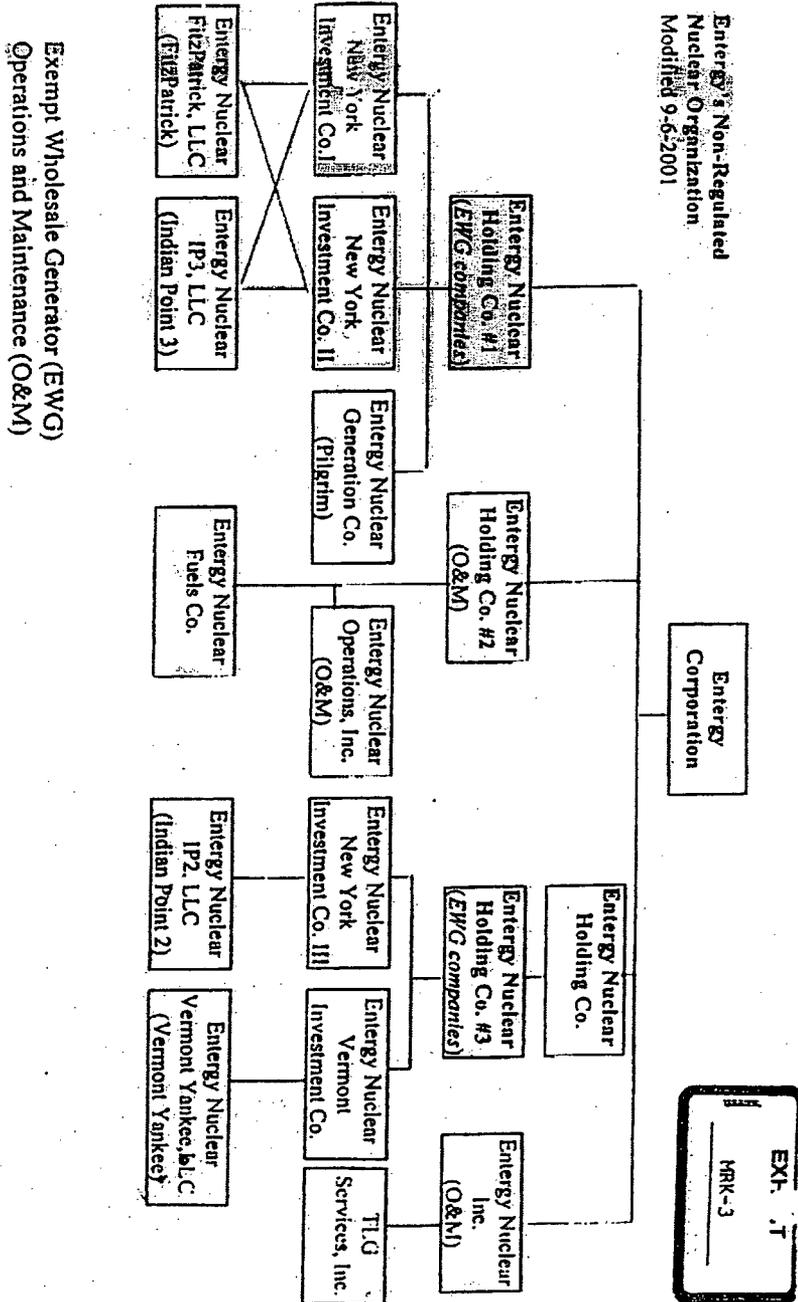
ATTACHMENT NO. 1

Exelon Corporation



ATTACHMENT NO. 2

Entergy Corporation – Non-regulated Nuclear Organization

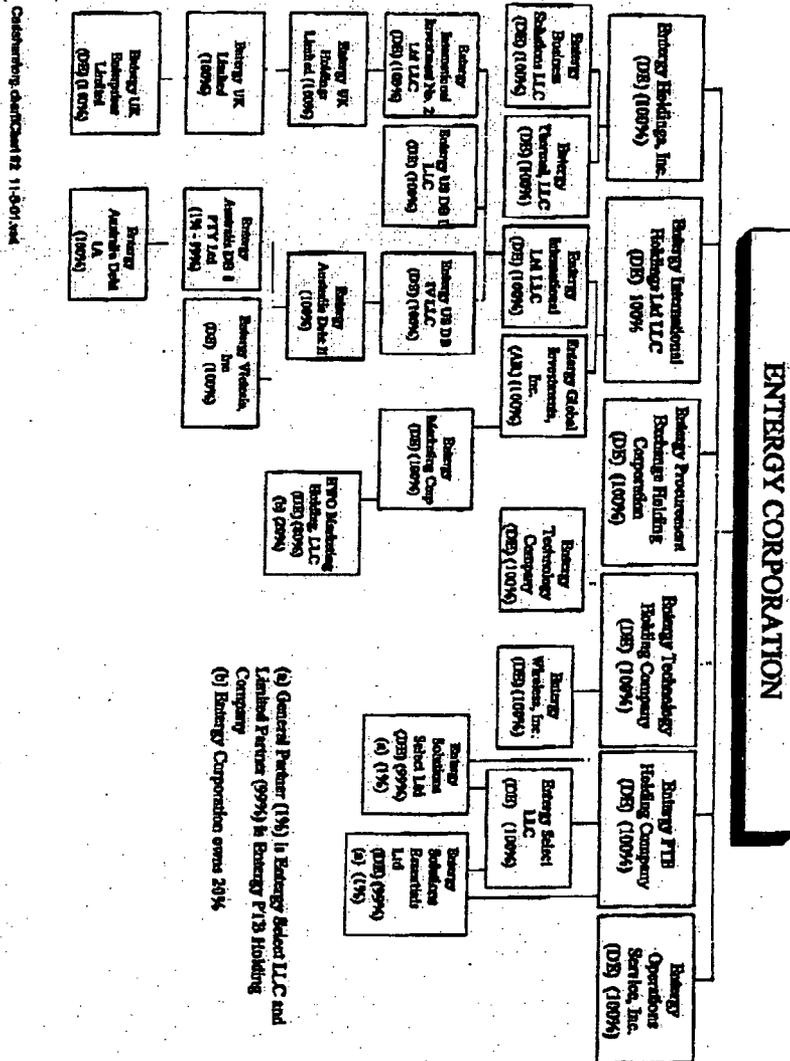


Entergy's Non-Regulated Nuclear Organization
Modified 9-6-2001

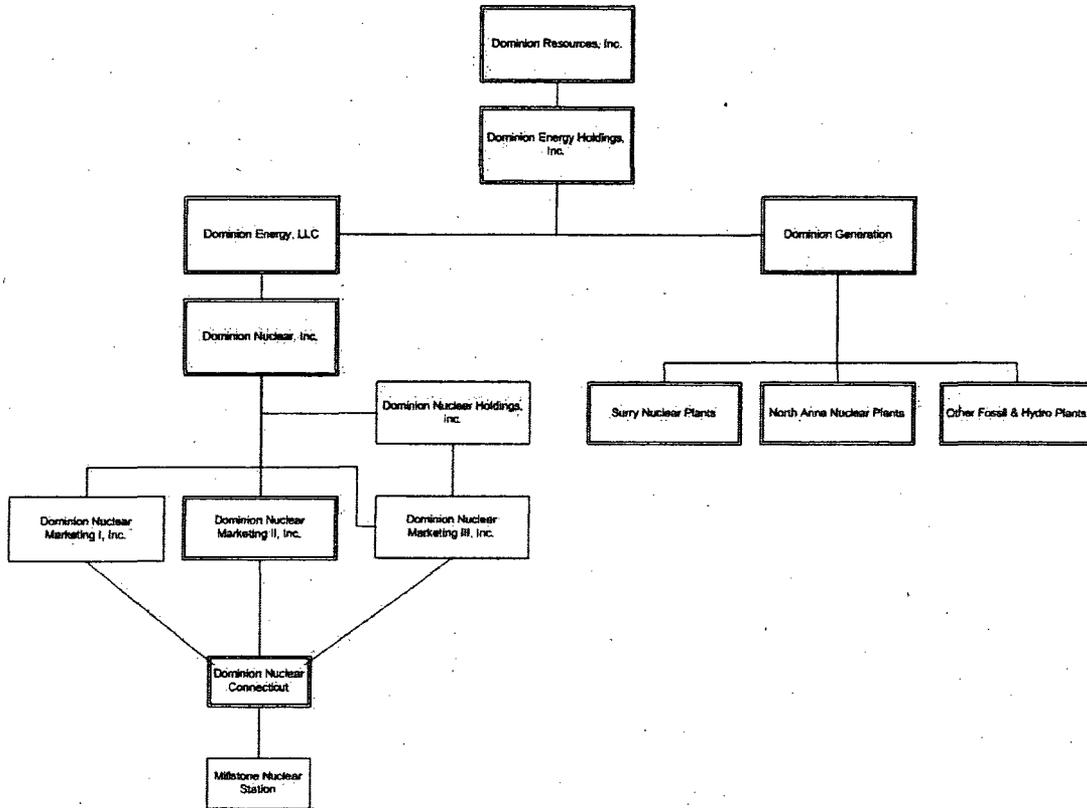
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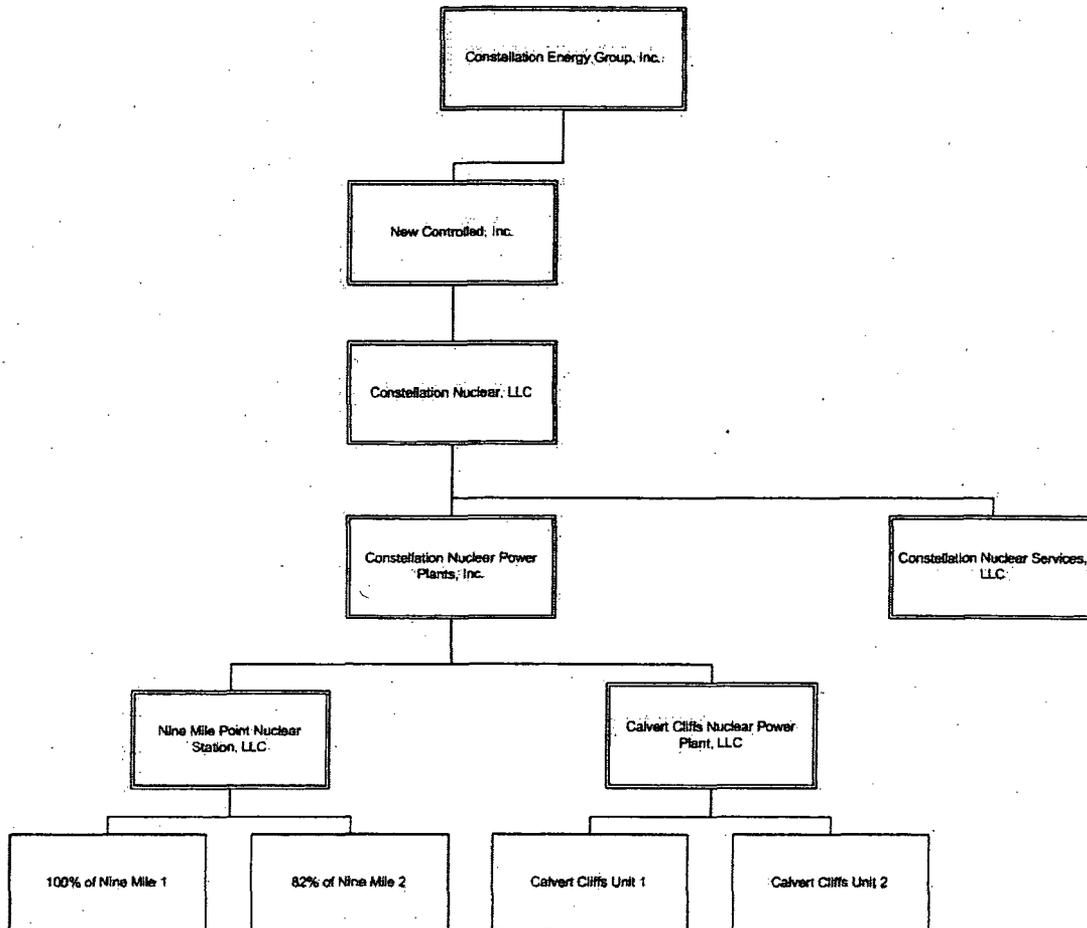
Entergy Corporation



ATTACHMENT NO. 4
Dominion Resources, Inc.



ATTACHMENT NO. 5
Constellation Energy Group



ATTACHMENT NO. 6

PG&E Corporation

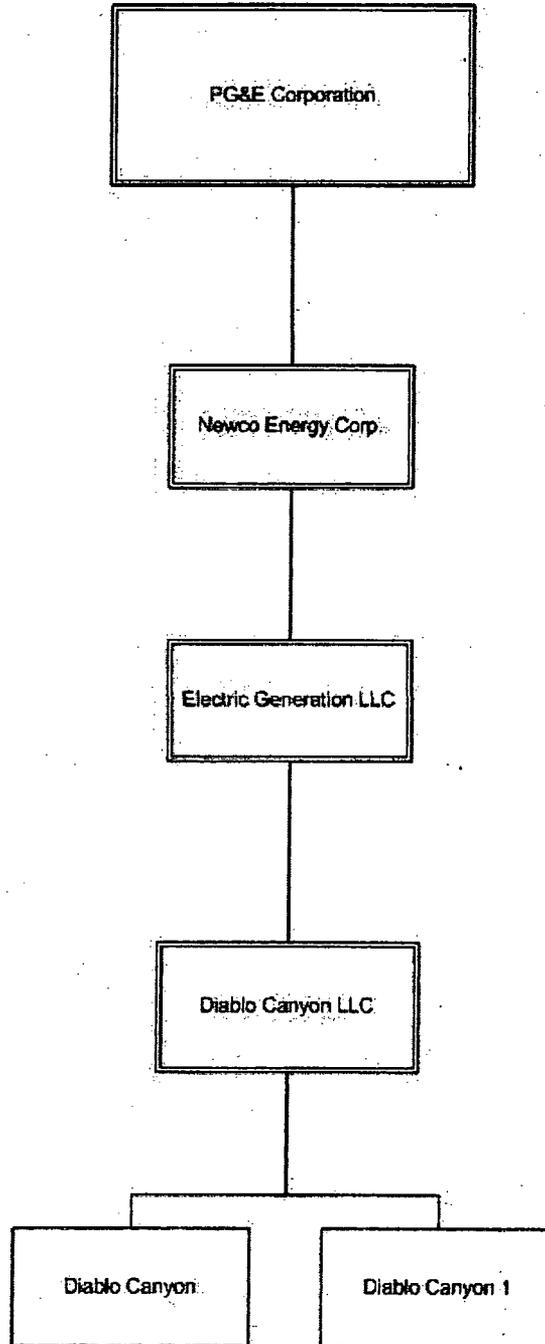


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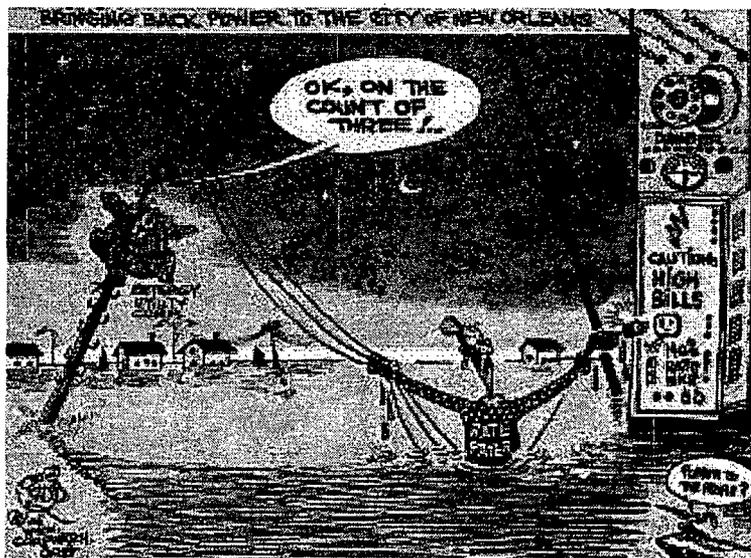
Entergy Holds New Orleans for Ransom

by Rita J. King, Special to Corp Watch
May 10th, 2006

Some New Orleanians desperately want, and fear, their utility bills.

But Tom Morgan, a DJ at New Orleans' local radio station WWOZ, hasn't seen one in months. While many residents have been hobbled by the cost of having a certified electrician reestablish electric and gas connections to their homes, some — like Morgan — have been unable to find out how much they owe and fear a gigantic bill they won't be able to pay, meaning — to add insult to injury — they face having their power cut off.

"I haven't gotten a bill since October," Morgan told CorpWatch. "I've called Entergy, but it still hasn't come. You shouldn't have to chase after people to pay your bills. A lot of people are confused and afraid."



cartoon by Khalil Bendib

Cutting and Running?

Entergy Corp. was the last Fortune 500 Company still based in New Orleans before Hurricane Katrina struck. Unless the federal government grants its wholly owned subsidiary, Entergy New Orleans, the \$718 million it seeks to maintain and rebuild its gas and electricity infrastructure damaged in the storm, the utility might not be able to continue doing business in the city it currently supplies with gas and electric. It isn't that Entergy can't afford to rebuild; it's that it would rather keep its profits and let the federal government pick up the tab.

Entergy Corp. racked up \$10 billion in revenues last year and has \$29 billion in collective assets. On paper, there is no question Entergy could comfortably cover its losses and rebuild the infrastructure of its utility business in New Orleans. On May 2, Entergy announced that its first-quarter profit rose nearly 13 percent, as higher energy prices offset disrupted sales following last year's hurricanes. Entergy CEO J. Wayne Leonard received a \$1.1 million bonus at the end of 2005, according to SEC records, which coincidentally works out to one dollar per Entergy customer in the Gulf Coast left without power in the weeks following the hurricane.

But the company's executives feel that if anyone should pay the cost of its getting back into business, it should be ratepayers and taxpayers, and not its own shareholders. And indeed, the government may have little choice but to give in to what critics characterize as blackmail or extortion – or leave a major American metropolis powerless.

Gordon Howald, utilities analyst with New York-based Natexis Bleichroeder, said he hasn't warned clients to sell off their Entergy stock. When Entergy first announced the possibility of bankruptcy, he says he thought the claim was a bluff.

"Entergy is a pretty successful company making a lot of money and here you have all these people who have lost their homes," he said. "Months later, they're still bickering. As time goes on, it becomes more difficult to get recovery, and ratepayers will have to pick up the rest."

Using the Federal Government as Insurance

The story of Entergy in New Orleans is a cautionary tale, critics say, of privatizing utilities as critical as gas and electricity in major population centers. Although Entergy is regulated by the New Orleans City Council, and its customer base is the local citizenry, as a publicly held company it ultimately answers first to its shareholders who want to maximize their profits. To that end Entergy has made broad use of limited liability laws to structure the company and its subsidiaries in a way that insulates shareholders from liabilities such as storms. The result is a system whereby the company's own customers and taxpayers nationwide foot the bill when something goes wrong.

Entergy has estimated its losses post-Katrina at just over \$1 billion, including lost customers (many residents who fled may not come back), and miles of gas pipeline corroded by the saltwater that poured over the levees. The insurance the company carried covered \$250 million in damages. The rest will likely come from inflated rates for those customers who remain in New Orleans, and from federal funds.

The Federal Energy Regulatory Commission (FERC), which has minimal oversight of Entergy, does not require companies like Entergy to carry insurance to cover losses from catastrophic events such as a hurricane, even though conventional wisdom has long considered a Katrina-sized storm and flood inevitable. The cost of the insurance it does carry may be passed on to ratepayers, according to FERC spokesman Bryan Lee.

Citing a "precedent" set by bailouts of ConEdison and the airline industry after 9/11, Entergy New Orleans is seeking a Community Development Block Grant (CDBG) to make up the difference. Without CDBG aid, Entergy New Orleans estimates that the average ratepayer's share of the losses comes to \$8,943, which would be exacted in the form of a rate increase of at least 140 percent.

No Cost of Doing Business in Hurricane Alley

In the days after the storm, all public comments focused solely on restoration, as if the effort to rebuild New Orleans could be accomplished with nothing more than elbow grease and well-wishing. President George W. Bush cut an iconic pose in New Orleans' Jackson Square on September 15, 2005, with his sleeves rolled up for a prime-time television appearance as he stood in front of a statue of Andrew Jackson and vowed "one of the largest reconstruction efforts the world has ever seen."

Meltdown? Not Our Problem

An Entergy subsidiary, Entergy Nuclear Northeast, operates the Indian Point nuclear power plant in Westchester County, New York. In late March, a huge crowd assembled to meet with Nuclear Regulatory Commission (NRC) and Entergy representatives, who repeatedly claimed that the numerous radioactive leaks recently detected seeping from the plant and toward the Hudson River were nothing to worry about. But the crowd was concerned, largely because they knew Entergy was positioned to protect its assets by filing for bankruptcy in the event of a nuclear disaster. Where, they wondered, was the motivation to maintain safety standards, if not the specter of lost profits?

"Corporations like Entergy have the luxury of walking away from these disasters unscathed, while citizens who lose their homes and jobs will be saddled with the additional burden of having to pay for Entergy's mess," said Lisa Rainwater, Indian Point campaign director for watchdog environmental group Riverkeeper. "The new consumer bankruptcy law is yet another disturbing example of how Washington is more interested in protecting the financial interests of corporate America than the financial security of hard-working Americans. It's appalling."

What has been happening in New York with Entergy Nuclear may provide clues about what's ahead for New Orleans. Activists have been sounding the alarm there for years about the potential for a private company to cut and run with its profits, leaving devastation — and a massive bill — in its wake.

Indeed, the nuclear industry is no stranger to federal assistance. In July 2003, the Bush-Cheney Energy Bill was passed by Congress, and Republican Senator John McCain referred to it as the "no lobbyist left behind" bill. It was considered by many to be a bonanza for the

"Throughout the area hit by the hurricane," Bush pledged, "we will do what it takes, we will stay as long as it takes, to help citizens rebuild their communities and their lives." Two weeks later, on October 4 in the Rose Garden at the White House, Bush had a new philosophy: cut non-security spending to fund the recovery effort — when necessary.

"As the federal government meets its responsibilities, the people of the Gulf Coast must also recognize its limitations," Bush said. "The engine that drives growth and job creation in America is the private sector, and the private sector will be the engine that drives the recovery of the Gulf Coast."

Entergy New Orleans heard the siren call of a bailout.

In November of 2005, according to a Reuters

nuclear industry, including nearly \$6 billion in operating tax credits, over a billion in decommissioning subsidies for aging plants and a 20-year extension of liability caps for accidents at nuclear plants. \$3 billion in research subsidies and a nearly equivalent sum for construction subsidies was included for new plants, an effort that put Entergy out in the front of the pack. Entergy Corp. made bipartisan campaign contributions totaling \$1,205,983 to federal candidates during the 2004 election cycle.

Gary Taylor, CEO of Entergy Nuclear, Inc. said on May 25, 2005 at a meeting of the Nuclear Energy Institute in Washington, DC, that Entergy is enjoying a "full partnership" with the Department of Energy in its quest to pave the way for the next generation of nuclear reactors.

"We're putting in money and they're matching it on a dollar for dollar basis," Taylor is quoted in the July/August 2005 issue of Nuclear Plant Journal. "Clearly, they have a responsibility to ensure that this is going in the right direction." He also said that the "President is trying to say that we [the government] will provide some financial certainty if things fall apart."

On August 7, 2002, Synapse Energy Economics published a report, "Financial Insecurity: The Increasing Use of Limited Liability Companies and Multi-Tiered Holding Companies to Own Nuclear Power Plants," which was commissioned in part by Riverkeeper.

Former Commissioner of the NRC, Peter Bradford, wrote in his foreword that the Synapse report "dissects a troublesome set of developments on the cusp between economic and safety regulation, namely, the arrangement of nuclear plant ownership into the limited liability subsidiaries of a few large companies. Because this arrangement has occurred during a period of lax and dispirited regulation, some important issues have not

report, Entergy unveiled a \$3 billion plan that it said would "ensure liquidity" while it "awaits recovery." During a conference call with analysts at that time, Leonard said the company intended to be "relentless in recovery of storm costs."

"New Orleans is Entergy's home and we are absolutely dedicated to the city's reconstruction and resurrection," said Leonard immediately after the storm. "We are hopeful that we will be able to return home soon. Our ability to do that depends, of course, on a number of factors over which we do not have complete control."

"We are heartsick at the losses our communities and employees have suffered," said Curt L. Hebert, executive vice president, external affairs at Entergy Corp. in a public statement. "Even as we launch the largest power restoration in our country's history, we are equally concerned about reaching out to help our co-workers, families and neighbors restore their lives. Together we can and will rebuild and put this storm behind us."

Hebert is a product of the corporate-political revolving door. He was appointed chairman of FERC in 2001 by Bush, but stepped down months later, in September 2001, to take his position at Entergy Corp. He was in charge of lobbying the federal government for aid money after Katrina. That put him at odds with the chairman of the Gulf Coast Recovery and Rebuilding Council, Allan B. Hubbard, whose job it was to explain to Entergy that the feds would not be underwriting the company's New Orleans reconstruction effort.

In a letter dated November 16, 2005, Hebert noted he was "gravely disappointed," that the people of New Orleans would "suffer significantly" as a result of the Bush Administration's "fundamentally flawed" perspective. This stance, he charged, "repudiates the promise" made by Bush in Jackson Square.

been pursued effectively."

Years of "reckless undermining," he said, have now been exposed in a series of financial collapses, among them a "troubling mix of money, pressure, complexity and ideology."

"Regulating in this way is like driving drunk," Bradford went on. "Taxpayers, utility customers and power plant neighbors who thought themselves protected by firm requirements may one day wear the stunned expressions of Eaton retirement plan holders or WorldCom investors."

According to Synapse, limited liability structure is an "effective mechanism" for transferring profits up the chain while creating a shield for the parent in case an unanticipated cost occurs at one of the plants.

"I also want to state clearly," Hebert wrote, "that [Entergy's shareholders and bondholders] have invested in a regulatory agency with the knowledge that the government regulates and protects their opportunity to earn a return."

With those words, Hebert inadvertently laid out the billion-dollar question: where do the boundaries of corporate welfare start and end?

In a response dated November 18, Hubbard pointed out Entergy's healthy bottom line while musing about the "inappropriate" nature of asking the federal government a handout while clasping a fistful of dollars.

"You told us that the ... board of the parent has a fiduciary duty not to take funds from other subsidiaries and use them to subsidize New Orleans," Hubbard wrote. "We respect

the right of your board to decide how to allocate financial resources, such as last year's \$909 million in earnings among various parts of Entergy Corp. We in turn believe it is inappropriate to transfer taxpayer resources to those investors after the fact for a risk they chose to take."

Prudent investors, he added, consider the risks inherent in any investment they make, including the risks of a natural disaster.

Ten days later, in a seven-page letter that smacked of one-upmanship, Hebert threatened that without "immediate federal assistance, it is unlikely that Entergy New Orleans can continue as a viable commercial entity." The threat was on the table: pay up or we pull up stakes.

Hebert also took exception to Hubbard's analysis, arguing that investment risk in a private company might be one thing, but risk in a publicly regulated utility quite another. He insisted that such public-private companies are by nature "entitled the opportunity to recover ... storm restoration costs."

Hebert says the obvious parallel and precedent was September 11. In the aftermath of that disaster, Congress passed the 2002 Supplemental Appropriation Act for Further Recovery From and Response to Terrorist Attacks on the United States. The \$783 million in resulting CDBG funding included restoration of utility infrastructure for ConEdison, which, like Entergy New Orleans, is a publicly regulated utility and a subsidiary of a vast holding company. The airline industry, also, was offered a \$5 billion bailout after 9/11 and a guarantee of up to \$10 billion.

What Can Be Predicted Can Be Insured Against

But is a terrorist attack really a precedent for a natural disaster?

Not at all, said Howard Kunreuther, Cecilia Yen Koo Professor of Decision Sciences and Public

Policy and Co-Director of the Wharton Risk Management and Decision Processes Center at the University of Pennsylvania's Wharton School. Kunreuther has studied and written about the issue of insurance extensively, including an August 2005 report on "Terrorism Risk Financing in the United States," which outlines the many ways in which terrorism is a unique threat, and a January 2006 University of Pennsylvania Press publication, *Has the Time Come for Comprehensive Natural Disaster Insurance?* This work includes a chapter, "On Risk and Disaster: Lessons Learned from Hurricane Katrina."

"9/11 is not a fair precedent for a natural disaster at all," Kunreuther told CorpWatch. "They're both very different in how they've been treated by the insurance industry. With a terrorist attack, you have less control. With a natural disaster, you can protect yourself to some degree."

Those who claim that Katrina was a completely unpredictable event may not have seen the many articles in publications ranging from National Geographic to a five-part series published pre-Katrina in the New Orleans Times-Picayune detailing the potential ramifications of just such a storm. And then there was Eric Berger's article in the Houston Chronicle on December 1, 2001, months after the Bush Administration's announcement of intent to downsize FEMA, in which it was reported that FEMA had declared the top three likeliest devastating emergencies in the United States to be a terrorist attack in New York City, a hurricane hitting New Orleans and a massive earthquake on the San Andreas fault.

Deregulation Comes Back to Roost

According to a May 2004 report from the United States General Accounting Office (GAO), limited liability companies such as Entergy Corp resulted from the deregulation of the electricity industry in the 1990s. "Like a partnership," the report said, "the profits are passed through and taxable to the owners ... like a corporation, it is a separate and distinct legal entity and the owners are insulated from personal liability for its debts and liabilities."

Such structures are made of loopholes the way some castles are made of sand—both, it turns out, can crumble under the sheer force of water.

"Entergy is a great example of how a company can shift liabilities to maximize profits while limiting liability," said Phillip Musegaas, senior policy analyst for the environmental watchdog group Riverkeeper, which is fighting to shut down the Entergy-owned and operated Indian Point nuclear power plants in Buchanan, New York. "Corporate restructuring is very sophisticated. They know their way out of regulation. They are way ahead of us."

All Profit, No Risk

It isn't "fair," said Entergy spokesman Stewart, to pass the cost of reconstructing Entergy New Orleans, the smallest subsidiary under the Entergy Corp umbrella, along to shareholders when the future fate of the company is still uncertain. Stewart explained that each subsidiary is a "separate business," and that each company is "protected from the burden" of picking up unexpected costs from the others.

"It would be irresponsible," Stewart told us. "It would not be prudent to invest shareholder money into the utility if there's no chance of recouping the money."

The corporation also has a "moral responsibility," he added, not to "risk the retirement funds of

employees when we don't know if customers are returning."

Utility investors rely on a "business model," he said, that allows for the utility to pass the costs of reconstruction and damage from natural events along to ratepayers. With the exception of totally decimated areas of New Orleans, power has been returned to "anyone who can take it." He likened the devastation in the region to that suffered by orange juice producers when frosts nip the growing season short.

"The price of juice goes up," he said, "and that's the models investors have invested in here."

Elizabeth Raley, spokesperson for Entergy New Orleans, acknowledged that customers are "very upset."

"We're faced with many customers who have extremely high bills because the natural gas wells in the Gulf of Mexico were damaged," she said. "The market rate for gas is passed on to our customers. ... We're working with customers to help them find a way to pay their bills. It's challenging to serve our customers, but that's what we're doing."

New Orleanians are wary and suspicious of what Entergy may do next. "Our customers have been through life-altering situations," Raley said. "I wouldn't be surprised if some of them feel hostility simply because they are having a rough time."

It turns out that the hostility dates from long before the storm, evidenced by a series of local and federal lawsuits. In an SEC 10-K filing, Entergy Corp describes its relationship with the state of Louisiana as "particularly litigious." 480 class action lawsuits including 10,000 claims have been filed against Entergy's various Gulf Coast subsidiaries, including Entergy New Orleans, for damages allegedly caused by disposal of hazardous waste and "asbestos-related disease" by contractor employees who worked between the years 1950 and 1980 and claim to have been exposed to hazardous materials during that time. In March 2004, endangered brown pelicans were found dead near Entergy New Orleans' Michoud power plant intake structure and return trough. And then there were the ratepayer lawsuits brought on by the City Council, during which it was alleged in testimony filed over a period of years that customers had been overcharged by upwards of \$100 million. When the matter was settled in April 2003, ratepayers were reimbursed \$11.3 million when it was found that Entergy had been incorrectly calculating the cost of fuel and passing the error along to customers.

This had all been sorted out since, according to Clinton A. Vince, managing partner of Sullivan & Worcester's Washington DC office, which represents the New Orleans City Council, the regulatory agency responsible for oversight of Entergy New Orleans. Vince supports the idea of a CDBG bailout.

"I won't second-guess them on their system. Nobody ever could have anticipated a flood of this magnitude," he said when asked why pipes that were susceptible to corrosion salt water were buried underground in a city that lies below sea-level. "This was not a reasonably foreseeable event."

"Entergy needs a reorganization plan," Vince said. "The content of that plan will change drastically based on CDBG funds. There would be dire consequences if Entergy walked away. We need the utility to stay there and rebuild the system. It's a unique situation—the worst disaster for a utility in the history of the country. People have lost everything, and it would be unrealistic

and unfair to pass those costs along [to ratepayers]. People would have no incentive to return.”

On March 30, 2006, Donald Powell, the Bush administration’s Gulf Coast recovery coordinator, said the revival of the Crescent City could take up to a quarter of a century and also hinges on factors that are “out of our control.” The amount of total funds that will be allotted by the state and federal governments, Powell said, is still up in the air.

Will Entergy choose – or be forced – to cut and run from New Orleans?

“Our plan is to stick it out,” Entergy New Orleans' spokeswoman Raley told Corpwatch. “We’re very hopeful that our funds will come through, and we’ll be able to continue to operate.”

EXHIBIT X

April 25, 2003

MEMORANDUM TO: Chairman Diaz

FROM: Hubert T. Bell
Inspector General /RA/

SUBJECT: NRC ENFORCEMENT OF REGULATORY REQUIREMENTS
AND COMMITMENTS AT INDIAN POINT, UNIT 2
(CASE NO. 01-01S)

Attached is an Office of the Inspector General (OIG), U.S. Nuclear Regulatory Commission (NRC) Event Inquiry that addresses the NRC's oversight of operations at the Indian Point, Unit 2 nuclear power plant in Buchanan, New York.

Please call me if you have any questions regarding this Event Inquiry. This report is furnished for whatever action you deem appropriate. Please notify this office within 90 days of what action, if any, you take based on the results of the Event Inquiry.

Attachment: As stated

cc w/attachment:
Commissioner Dicus
Commissioner McGaffigan
Commissioner Merrifield
W. Travers, EDO

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04/ 25 /03	04/ 24 /03	04/ 25 /03	04/ 25 /03	04/ 25 /03

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**OFFICE OF THE INSPECTOR GENERAL
EVENT INQUIRY**



**NRC ENFORCEMENT OF REGULATORY
REQUIREMENTS AND COMMITMENTS
AT INDIAN POINT, UNIT 2**

Case No. 01-01S

/RA/

Veronica O. Bucci, Special Agent

/RA/

**George A. Mulley, Jr.,
Senior Level Assistant for
Investigative Operations**

/RA/

**Brian C. Dwyer
Assistant Inspector
General for Investigations**

**NRC ENFORCEMENT OF REGULATORY
REQUIREMENTS AND COMMITMENTS
AT INDIAN POINT, UNIT 2**

Case No. 01-01S April 25, 2003

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BASIS AND SCOPE

The Office of the Inspector General (OIG) initiated this inquiry in response to a Congressional request that OIG examine issues concerning U.S. Nuclear Regulatory Commission (NRC) oversight of operations at the Indian Point 2 (IP2) nuclear power facility in Buchanan, New York. The request referred specifically to "internal Con Ed/Indian Point 2 condition reports" made public in a January 2001 petition review board meeting that "may include information which indicates that the plant operator may be in violation of a commitment made back in 1997 regarding design bases requirements."

The Congressional request also focused on issues raised by an engineering consultant hired by the licensee who had recently resigned his position due to a differing professional opinion regarding the plant's Reactor Protection System. The request noted that one of the more lengthy condition reports cited discrepancies between design drawings and the as-built configuration of the Reactor Protection System.

Based on the above concerns, OIG initiated an Event Inquiry to examine:

- I. NRC's oversight of IP2's progress toward fulfilling two design bases commitments made to the NRC in 1997. These commitments were made in response to NRC's 1996 request for information concerning plant programs and processes for controlling and maintaining operations within the facility's design bases.
- II. NRC's response to the specific concerns raised by an IP2 engineering consultant pertaining to discrepancies between design drawings and the as-built configuration of the Reactor Protection System.
- III. NRC's oversight of IP2's corrective action program between 1995 and 2001.
- IV. NRC's utilization of its Senior Management Meeting process to heighten attention to IP2.

BACKGROUND

NRC's Regulation of Power Plants — Overview of Terms Used in This Report

Nuclear power plants are required to adhere to U.S. Nuclear Regulatory Commission (NRC) regulations to ensure their safe operation. These regulations include requirements that power plants operate in accordance with their current license, which includes (1) the plant's technical specifications, (2) license conditions, (3) licensee commitments made in response to NRC Generic Letters and Bulletins, and (4) the Final Safety Analysis Report (FSAR).¹ Design bases information identifies the specific functions to be performed by a power plant's structures, systems, and components as well as associated design parameters.

In addition, plants are required to have a corrective action program (CAP) that enables them to identify, prioritize, and correct problems in a timely manner. Power plants manage their CAP by maintaining a database of action items, or condition reports, which describe particular plant conditions in need of repair or attention. Plants typically prioritize these condition reports based on safety significance and address them accordingly.

NRC provides oversight of nuclear power plants to ensure that plants are operating safely. The agency conducts reactor inspections to determine whether power plants are in compliance with agency requirements. Inspections range from routine, baseline inspections² to inspections beyond the baseline which may focus on areas of declining plant performance. The agency issues sanctions (i.e., enforcement actions) — such as Notices of Violation (NOV),³ fines, or orders to modify, suspend, or revoke licenses — when plants are out of compliance. In 2000, NRC implemented a Reactor Oversight Process (ROP), which was intended to be substantially different from the previous oversight process and to take into account improvements in the performance of the nuclear industry over the past 25 years and improved approaches of inspecting and evaluating the safety performance of NRC-licensed plants. Under this process, inspection findings are evaluated for risk significance using pre-established criteria. Plants that fail to meet certain safety objectives, as determined by performance indicators and inspection findings, are to receive increased inspection activity, focusing on areas of declining performance and may be subject to enforcement action.

¹The FSAR is a licensing document that provides a description and safety analysis of the site, the design, design bases and operational limits, normal and emergency operation, potential accidents, predicted consequences of such accidents, and the means proposed to prevent or mitigate the consequences of such accidents. When the FSAR has been updated, it is referred to as the updated FSAR, or UFSAR.

²Baseline inspections are common to all nuclear power plants; NRC's baseline inspection program is the normal inspection program performed at all nuclear power plants. The program focuses on plant activities that are "risk significant," that is, those activities and systems that have a potential to trigger an accident, can mitigate the effects of an accident, or increase the consequences of a possible accident.

³An NOV formalizes a violation by identifying a requirement and how it was violated.

Between 1986 and 2001, NRC also used its semiannual Senior Managers Meetings (SMM)⁴ as a means to increase attention to plants with persistent operational problems. During these meetings, the agency's senior managers reviewed certain plants experiencing declines in performance. Participants decided whether to increase oversight of subject plants and, if so, by what means. For example, a SMM decision might require a plant to undergo additional inspections, or the staff could issue a "trending letter" to advise a licensee that NRC had taken note of declining plant performance, or designate the plant as in need of heightened NRC attention (e.g., designation as an Agency Focus Plant).

One way in which nuclear power plants fulfill NRC expectations is through regulatory commitments. Regulatory commitments are non-binding statements made by licensees to NRC indicating they will take specific actions, for example, to verify the accuracy of UFSAR information, and they typically reflect the means by which licensees will accomplish the commitment (e.g., in a certain timeframe, following a specific approach).

The Indian Point Nuclear Power Plant, Unit 2 (IP2), is one of two operating pressurized water reactors located in Buchanan, NY, 24 miles north of New York City. IP2 began commercial operations in August 1974. The Consolidated Edison Company of New York, Inc. (ConEd), owned IP2 until September 6, 2001, when the plant was purchased by Entergy Nuclear Operations, Inc. NRC's Region I office⁵ provides oversight for IP2.

⁴The Senior Management Meeting (SMM) program which required semiannual meetings of NRC senior managers was replaced in 2001 by the Agency Action Review Meeting (AARM) program. The AARM is an annual meeting of NRC senior managers under the Reactor Oversight Process. This meeting essentially replaces the SMM under NRC's previous oversight process.

⁵NRC has four regional offices that conduct inspections of nuclear reactors within regional boundaries. NRC's Region I provides regulatory oversight for IP2 and other nuclear facilities within the northeast region of the United States.

DETAILS

I. NRC OVERSIGHT OF IP2'S PROGRESS TOWARD FULFILLING TWO 1997 DESIGN BASES COMMITMENTS

Overview of Design Bases

Nuclear power plants are designed so that internal and external events (e.g., loss of coolant accident, fire, earthquake) will not jeopardize plant safety or threaten the health and safety of the public. A plant's design bases in part describe how the plant will cope with various accidents and emergencies. Plant structures, systems, and components (SSC) must be built in accordance with design requirements that will enable the plant to meet its design bases and, consequently, to withstand such accidents and emergencies. Plant operators are expected to not make plant modifications to safety related systems without having performed NRC required safety analyses, which are needed to prove the modification will not affect the plant's ability to meet its design bases requirements. Furthermore, when modifications are made, they are supposed to be reflected in the plant's design bases documents, which link each plant SSC to its design bases and original design requirements. Design bases documents include such information as industry, regulatory, and manufacturer criteria for plant systems and information generally contained in the UFSAR specifying system functions and requirements, component functions and requirements, interface requirements from supporting and supported systems, applicable accident analysis assumptions related to the systems, and plant design drawings and calculations.

NRC Requests Licensee Feedback on Design Bases Issues

NRC team inspections during 1995 and 1996 identified concerns regarding the ability of NRC licensees to maintain and implement the design bases at certain plants. To learn more about the scope and extent of the problems among operating nuclear power reactors, the staff proposed that all licensees be required to provide information regarding the availability and adequacy of design bases information. To that end, on October 9, 1996, NRC issued a letter to each NRC reactor licensee in accordance with Title 10, Part 50, Section 54(f), Code of Federal Regulations (10 CFR 50.54(f)) requesting that each licensee submit under oath a written response within 120 days describing and discussing the effectiveness of its programs and processes for controlling and maintaining operations within the facility's design bases. The stated purpose of the letter was "to require information that will provide the U.S. Nuclear Regulatory Commission (NRC) added confidence and assurance that [licensee plants] are operated and maintained within the design bases and any deviations are reconciled in a timely manner."

Specifically, NRC found it problematic that some licensees had failed to (1) appropriately maintain or adhere to plant design bases, (2) appropriately maintain or adhere to the plant licensing basis, (3) comply with the terms and conditions of licenses and NRC regulations, and (4) assure that the UFSARs properly reflect the facilities. According to the letter, "The extent of the licensees' failures to maintain control and to identify and correct the failures in a timely manner is of concern because of the potential impact on public health and safety should safety systems not respond to challenges from off-normal and accident conditions."

NRC Reviews Overall Response

Subsequent to NRC's receipt and review of all licensee responses to the October 9, 1996, letter, the staff issued SECY-97-160,⁶ which described a four-phased approach which NRC had undertaken to review the licensee responses to the 10 CFR 50.54(f) request. The SECY described the completion of the first three phases and concluded that all licensees had established programs and procedures to maintain the design bases of their facilities. However, SECY-97-160 also recommended certain plant-specific, final-phase followup activities to address the staff's concerns about either (1) the performance of certain licensees in controlling facility design bases or (2) the need to validate the effectiveness of a particular element of a licensee's design control program.

A manager in the NRC's Office of Nuclear Reactor Regulation (NRR) told OIG that the request began with a high level of agency concern that there were widespread problems pertaining to the accuracy of plant UFSARs and there was a heightened awareness that these problems needed to be resolved as quickly as possible. However, as licensee efforts to address these concerns unfolded, NRC staff recognized that this effort was more resource intensive than had initially been anticipated, and staff allowed licensees to have more time to complete these efforts.

IP2 Responds to NRC Design Bases Request

In response to NRC's October 1996 10 CFR 50.54(f) request to ConEd regarding IP2, the licensee made two specific commitments. In its February 13, 1997, letter that conveyed these commitments to NRC, ConEd stated its intent "to voluntarily initiate and complete" an UFSAR review program. The program was scheduled for completion within 24 months. The UFSAR review program was to include (1) verification of the accuracy of the UFSAR design bases information, (2) assessment to confirm that the UFSAR design bases information was properly reflected in plant operation, maintenance, and test procedures, (3) review of the UFSAR to identify and resolve any internal disagreements or inconsistencies which could impact the design bases, and (4) development of a process to enhance overall the UFSAR accessibility. In its second commitment, ConEd stated it would continue its "Design Basis Document (DBD) Initiative" to review and update existing design bases documents and create new ones if needed. The continuation of the DBD Initiative was to include supplementation of 22 DBDs with a combination of additional DBDs and added information on interfacing systems. This effort was also to be completed in 24 months.

IP2 Extends Completion Date

In a letter dated February 17, 1999 (24 months after the initial commitments were made), ConEd provided an update to NRC concerning the commitments it had made pursuant to NRC's 1996 request. The letter reported that both the UFSAR verification effort and DBD initiative were underway; the UFSAR effort was approximately 65 percent complete and the

⁶SECY 97-160, "Staff Review of Licensee Responses to the 10 CFR 50.54(f) Request Regarding the Adequacy and Availability of Design Bases Information," dated July 24, 1997.

supplementation of 6 of 27 DBDs was in progress. The letter also changed the completion date of both commitments: December 31, 1999, for the former and December 31, 2002, for the latter.

OIG learned that NRC is not expected to formally approve changes in commitment completion dates such as the one described above. According to the NRR manager, commitments are often schedule or process related (e.g., licensee commitment to fix something by a specific time or in a particular manner) and changes in completion dates are not necessarily problematic. For example, the manager said, a rule may say to fix something in a timely manner and the licensee will commit to do so within 2 months. However, if the licensee fails to make the 2-month deadline, the licensee may adjust the timeframe to another date that NRC would consider timely.

The NRR manager and Region I staff told OIG that after IP2 became involved in these efforts, all parties realized that the 2-year timeframe that ConEd initially committed to was unrealistic. A number of plants, including IP2, required additional time to complete their review and NRC staff generally viewed these extensions as reasonable.

OIG also learned that with regard to ConEd's schedule change for the UFSAR commitment, Region I staff felt IP2's progress toward fulfilling the commitment was proceeding in a timely manner and that the schedule change was reasonable.

In June 2000, ConEd provided NRC with a new projected completion date of March 31, 2001, for its commitment to verify the accuracy of the UFSAR, and ConEd reported that it still anticipated completing its DBD initiative by December 31, 2002.

On December 31, 2002, Entergy forwarded correspondence to NRC modifying the completion date for the original commitment that was due on December 31, 2002, to a revised commitment date of December 31, 2003. According to the Region I Administrator and staff, the modification of the completion date was reasonable and acceptable. The Region I Administrator said he considered these deferrals to be appropriate given that numerous, more significant operational and design-related issues emerged over this period requiring extensive licensee management attention and resources.

Region I Oversees IP2 Progress in Fulfilling Design Bases Commitments

According to a Region I Branch Chief, he visited IP2 on April 3, 2001, and verified for himself that the UFSAR update was "essentially done" and that ConEd was "just wrapping up loose ends." The Branch Chief drew this conclusion based on a presentation ConEd gave him describing the methodology for and status of the UFSAR effort. Additionally, he stated that his conclusion was supported by a series of NRC inspections conducted at IP2 since the initial commitment that confirmed progress was being made. OIG reviewed NRC inspection reports from October 1997 through August 2002 and found that some of the NRC inspections specifically looked at the UFSAR and DBD efforts through baseline and special inspections. These reports reflected inspectors' observations that progress continued to be made in these efforts.

The Branch Chief also explained to OIG that when Entergy took over as the licensee for IP2 in September 2001, it assumed ConEd's commitment to complete its DBD Initiative by December 31, 2002, without modifying the completion date. Entergy incorporated the commitment into its "Fundamentals and Improvement Plan" for IP2. With regard to the status of the DBD commitment, the Branch Chief said he visited the plant in May 2002 at which time the plant had completed the review of 22 of the 27 DBDs and planned to complete 3 more by the end of 2002.

According to NRC Inspection Report No. 05-247/2002-010, dated August 28, 2002, which reported results of a supplemental and problem identification and resolution (PI & R) inspection from June 17 through July 19, 2002, Entergy had revised its schedule for completing the DBD effort. According to the inspection report, two remaining DBDs (fire protection and electrical separation) would be completed in 2003, rather than by December 2002. The inspection team concluded that the schedule modification was reasonable.

OIG FINDING

In February 1997, ConEd responded to NRC's 10 CFR 50.54(f) request for information by committing to two separate 24-month efforts at IP2. In the first of these two commitments to NRC, ConEd stated its intent to initiate and complete an UFSAR review program and in its second commitment, ConEd stated it would continue its IP2 DBD Initiative to review and update existing design basis documents and create new ones if needed. Although ConEd initially committed to complete both efforts in 2 years, ConEd revised its projected completion dates two times for the first effort. The UFSAR review program, initially expected to be completed by February 1999, was extended to December 1999, and finally completed by April 2001. The completion date for the second effort was also revised twice, once by ConEd and the second time by Entergy Nuclear Operations, Inc., IP2's current license holder. The DBD Initiative, initially slated for completion by February 1999, was extended to December 2002, and is now expected to be finished by December 31, 2003. OIG found that the NRC staff did not object to the time extensions because it believed each extension was reasonable, given other significant operational problems at the plant, the effort that was required to fulfill the commitments, and the licensee's steady, but slow, progress in addressing them.

II. NRC'S RESPONSE TO REPORTED DISCREPANCIES BETWEEN RPS DESIGN DRAWINGS AND AS-BUILT CONFIGURATION

The Reactor Protection System

The Reactor Protection System (RPS), a system described by NRC staff as "very safety significant" to nuclear power plant operations, is designed to detect a problem in the plant and, if the problem is serious enough, cause the plant to trip (i.e., to automatically shut down in an emergency situation). According to NRC staff, the system can be manually or automatically activated to initiate a plant shutdown. Staff said that to ensure that the reactor will shut down when necessary, the RPS features multiple, independent equipment and components. Any individual RPS component, therefore, could be significant. Furthermore, RPS interfaces with many other safety systems for process monitoring of safety parameters such as reactor coolant pressure, temperature and flow, pressurizer level, steam generator level, and reactor building pressure. As a result, staff said, deficiencies in other systems could have an effect on RPS's ability to operate during an event.

The Region I Administrator told OIG it is a significant problem if the as-built configuration of a system, such as the RPS, is inconsistent with what is needed for the system to be functional. He said it is of lesser significance, but still important, when a system's as-built configuration is inconsistent with design drawings but is still functional. He explained that in either case, inconsistencies between system configurations and design drawings may be indicators that other issues within the system warrant attention.

IP2 Condition Reports Identify Design Bases Discrepancies

OIG learned that in February 2001, a ConEd engineering consultant raised an allegation to Region I pertaining to design bases discrepancies between design drawings and the as-built configuration of the RPS. The allegation referred to 13 IP2 condition reports (CR) that IP2 plant personnel, including the engineering consultant, had written to describe these issues. These CRs were a subset of a larger number (more than 300) of CRs written on RPS between 1998 and 2001.⁷ This subset of CRs identified circumstances in which the system's wiring violated statements in the UFSAR. For example, the CRs identified instances of wires associated with computer and alarm circuits being in close proximity of and sometimes in the same cable tray as the wires associated with the trip and logic circuits. The CR reported that these as-built wiring configurations were in conflict with UFSAR wiring separation criteria.

OIG reviewed summaries of the 13 CRs raised in the allegation. Eight of the 13 (CRs 199803574, 199902835, 199903445, 199904968, 200007597, 200009499, 200009641, 200010125) focused on:

- ◆ Quality assurance requirements for design verifications,
- ◆ Wiring changes resulting from modifications that could not be located, and
- ◆ Wiring configurations not in accordance with UFSAR separation requirements.

⁷As context, both regional staff and the IP2 engineering consultant told OIG that roughly 10,000 CRs were being written per year during this timeframe concerning IP2 conditions perceived by licensee staff as in need of attention.

A ninth condition report (CR 200100327) summarized the eight preceding CRs. The remaining four condition reports (CRs 199900478, 199902274, 200008415, and 200008818) documented additional examples of related RPS wiring discrepancies. (See Appendix A for a listing of the 13 CRs and a description of the issues covered in each.)

The engineering consultant told OIG that while employed at IP2 he wrote CR 200100327 as a summary after becoming aware of the eight earlier CRs. These eight CRs summarized documented deficiencies such as wiring separation issues; wiring configurations not in accordance with design drawings, and cable splices not identified on drawings.

The engineering consultant told OIG that he was concerned that collectively these issues warranted a higher level of attention than ConEd had determined was appropriate and that he had raised the matter with ConEd management. Specifically, he explained, he wanted ConEd to perform another Operability Determination (OD) on the RPS to determine whether the system in its current configuration was operable. He told OIG that prior to his writing of CR 200100327, ConEd performed an OD (OD 00-018) on RPS that addressed a subset of the issues raised in CR 200100327. However, he explained that in his opinion that OD did not go far enough to assess the functional changes that may have resulted from the as-found wiring conditions. Dissatisfied with ConEd's response to the issues he raised, and concerned that ConEd would downgrade CR 200100327 from Significance Level (SL) 2 to an SL3,⁸ the engineering consultant formally raised the matter to Region I as an allegation.

NRC's Response to RPS Design Bases Discrepancies

OIG reviewed documentation of NRC's response to the issues raised by the engineering consultant and learned that NRC:

- (1) inspected several RPS deficiencies prior to the engineering consultant's allegation,
- (2) conducted an inspection focused specifically on the RPS wiring discrepancies described in CR 200100327, and
- (3) responded directly, in writing, to the engineering consultant on the outcome of NRC's review of the concerns he raised in his allegation.

In the following three sections, OIG describes each of these efforts, which OIG learned, collectively addressed each of the 13 CRs mentioned in the engineering consultant's allegation.

(1) NRC Inspects RPS Deficiencies

OIG learned that prior to receipt of the allegation from the ConEd engineering consultant, and during the course of escalated regulatory activities by Region I subsequent to a steam

⁸IP2 CRs were ranked on a scale of 1 through 4, with SL1 assigned the highest level of significance. The engineering consultant explained to OIG that CRs assigned a higher SL would receive a more heightened response from ConEd. For example, CRs assigned as SL2 were required to receive a formal Operability Determination, while this was not a requirement for CRs assigned as SL3.

generator tube rupture that occurred at IP2 in February 2000,⁹ a team of Region I inspectors conducted a 7-week inspection of "engineering, operations and maintenance, radiation protection, security, and weld radiographs associated with the steam generator replacement project." Inspection activities included a review of a sample of RPS open corrective action items relating to the RPS's nonconformance with design drawings and the UFSAR.

OIG reviewed the inspection report findings pertaining to the RPS review. The inspection report (IR 05-247/2000-014), dated January 2001, described the RPS issue as follows:

The issue involved the licensee's observation that wiring within the protection racks did not always conform with the statements contained in the UFSAR and electrical separation criteria contained in drawing A208685. Specifically, the licensee found instances of wires associated with computer and alarm circuits being in close proximity of, and sometimes in the same cable tray as, the wires associated with the trip and logic circuits. The licensee also identified examples of switch contacts originally reserved for logic and trip function being used for computer and alarm functions. All potential interactions involved a single train of protection logic and low energy and low voltage circuits.

According to the NRC inspection report, the inspector reviewed three CRs mentioned in the engineering consultant's allegation (CRs 200007597, 200008818, and 200009499) related to RPS logic rack wiring separation concerns, OD 00-018 (dated November 28, 2000), and OD supporting documentation. Based on this review, the report concluded, "There were no significant findings associated with this issue."

The Region I inspector who conducted the review told OIG that the inspection was focused on ensuring that the discrepant conditions reported in the three CRs did not affect the safe operation of the RPS. Although the inspector acknowledged to OIG that it was better to review all open issues and CRs related to a particular system and to sample closed CRs, the inspector explained that he did not do so because of the limited scope of the review coupled with limited manpower resources and time. The Region I Administrator explained to OIG that this sampling of RPS issues was part of a larger review of deficiencies and corrective actions that needed to be addressed at the plant.

(2) NRC Inspects RPS Wiring Discrepancy Issues Described in CR 200100327

OIG learned that following the engineering consultant's allegation pertaining to the RPS, NRC inspectors revisited the issues that the consultant had collectively recorded in CR 200100327 and documented their findings in a June 2001 inspection report (IR 05-247/2001-005) which described the Region I inspectors' review of:

Corrective actions taken by ConEd to address issues raised in CR 200100327;

⁹On February 15, 2000, IP2 experienced a steam generator tube rupture in one of the plant's four steam generators, which resulted in a minor radiological discharge to the atmosphere.

ConEd's February 12, 2001, OD 01-002, "Ensuring the Functional Capability of a System (RPS) or Component," to determine whether the bases used in the OD were valid and accurate;

Safety Evaluation 99-160-EV to change the UFSAR such that wire separation between safety and non-safety wires was no longer required; and

RPS open condition reports.

These inspection efforts are described below.

Corrective Actions Taken to Address CR 200100327 Issues

OIG reviewed IR 05-247/2001-005, which described Region I's examination of the licensee's corrective actions associated with CR 200100327 and the eight feeder CRs, and corrective actions pertaining to CR 200008415 and one additional CR not referenced in the allegation. The inspection report indicated that as background for the inspection, NRC reviewed CRs 199900478 and 199902274, which had been referenced in the allegation. According to the inspection report, inspectors also:

- ◆ Reviewed a ConEd evaluation titled, "SL-2 Evaluation for CR 200100327 on the Reactor Protection System," dated March 7, 2001, to confirm that this evaluation addressed appropriate root causes, contributing causes, compensatory actions and the proposed corrective actions.
- ◆ Attended a Corrective Action Review Board (CARB) meeting which reviewed and discussed the evaluation.
- ◆ Reviewed the list of ICA (Implementation of Corrective Actions) for CR 200100327 to confirm that the listed corrective actions adequately addressed the root causes and the concerns raised in CR 200100327.
- ◆ Reviewed a sample of corrective actions and issues to determine whether these corrective actions were timely and appropriate to address the issues.
- ◆ Reviewed the rationale provided for delayed corrective actions.
- ◆ Reviewed IP2 documents to confirm that on February 12, 2001, ConEd had generated OD 01-002, "Ensuring the Functional Capability of a System (RPS) or Component," to demonstrate that the RPS can perform its safety function, in spite of the combined wiring and documentation deficiencies.
- ◆ Reviewed IP2 documents to confirm that on March 12, 2001, ConEd completed a safety evaluation to address the wiring separation issue regarding RPS wiring configuration conformance with the UFSAR.

Based on this review, the inspectors found no issues that would render the RPS incapable of performing its intended safety function. Specifically, the inspection report stated that no findings of significance were identified.

ConEd's Operability Determination (OD) 01-002, "Ensuring the Functional Capability of a System (RPS) or Component"

According to IR 50-247/2001-005, ConEd generated OD 01-002 "to demonstrate that the RPS could perform its safety function." OIG learned that Region I inspectors reviewed OD 01-002 to determine whether the bases used in the determination were valid and accurate. The inspectors also reviewed supporting documents used in the OD to verify that the data and bases were accurately translated. Supporting documents reviewed included RPS test procedures and test results, a modification for replacing 88 relays in the RPS, and a sample of CRs associated with RPS wiring issues. CRs reviewed included CR 200008818 and two additional CRs not mentioned by the allegor. Based on their review of this issue, the Region I inspectors again concluded that there were "no findings of significance."

Safety Evaluation 99-160-EV

Inspection report 50-247/2001-005 noted that in March 2001, ConEd generated a safety evaluation (SE 99-160-EV) to change the UFSAR so that wire separation between safety and non-safety wires would no longer be required and "safety and non-safety wires can run together within a panduit inside the RPS cabinet." However, according to the Region I inspectors, the safety evaluation did not provide sufficient rationale to justify the change to the UFSAR. According to the inspection report, this matter was not resolved during the inspection and was referred to NRR for review. OIG learned that the results of NRR's review were documented in IR 50-247/2001-010, dated December 17, 2001. In that inspection report, NRR acknowledged that SE 99-160-EV failed to address certain relevant issues; however, NRR concluded that the wiring separation between safety and non-safety wires inside the RPS cabinets was not a design requirement for IP2 and was in compliance with industry standards. Consequently, the wiring configuration at IP2 met design requirements and the issue was closed.

RPS Open Condition Reports

As part of this inspection effort, inspectors also reviewed the RPS condition report history since 1998 and found that since that time more than 300 CRs had been written on the RPS. As of March 9, 2001, 47 CRs remained open in the database, some for almost 3 years. ConEd's records indicated that of the 47 CRs, 3 were ranked as SL4; 37 were ranked as SL3; and 7 were ranked as SL2. The inspection report stated that in response to the inspectors' concerns about possible combined operability or functional effects from the 47 open CRs, ConEd performed an overall assessment of the 47 open CRs and concluded that no functional problems existed. The inspectors reviewed a sample of four CRs to confirm that there were no combined effects that could challenge the functionality of the RPS. The selected CRs were, based on the inspectors' judgement, most likely to yield inspection findings. Based on this review, the inspectors again identified no findings of significance.

(3) Region I Response to Engineering Consultant's Allegation

In a letter dated July 19, 2001, Region I formally responded to the ConEd engineering consultant who wrote CR 200100327 and who subsequently raised the RPS-related issues to Region I. The letter summarized the consultant's RPS-related concerns as presented in CR 200100327, relayed NRC's inspection findings (from IR 50-247/2001-005) pertaining to these concerns, and described the licensee's actions to address them. In its letter to the engineering consultant, Region I addressed the consultant's concern that "there is a lack of response effort and inadequate corrective actions in response to concerns [the consultant] raised regarding deficiencies in the design record and configuration control of the Reactor Protection System (RPS)." The Region I letter also addressed the consultant's concern that OD 00-018 "adequately addressed RPS wire separation and isolation issues, but not the broader concerns" (i.e., loss of design control due to wiring configurations). The letter explained that in response to these concerns, NRC completed an inspection of RPS wiring issues at IP2 on May 4, 2001, that was documented in IR 50-247/2001-005.

The letter also explained that to address the "broader issue for the RPS wiring," ConEd completed an RPS operability determination (OD 01-002) on February 12, 2001, completed a root cause evaluation for CR 200100327, entitled, "SL-2 Evaluation for CR 200100327 on the Reactor Protection System," on March 7, 2001, and established a corrective action program to address other broader aspects of the RPS wiring deficiencies.

In its conclusion to the consultant's concern about RPS configuration control/design record deficiencies, the letter stated,

... your concern was partially substantiated. There were design control weaknesses at IP-2. However, at the time of our inspection, ConEd had established a corrective action plan to address the broader issue as described above [i.e., loss of design control]. Further, our inspection did not uncover any issues that would render the RPS incapable of performing its intended safety function.

The letter also addressed the consultant's concern that CR 200100327, initially assigned an SL of 2, would be reassigned an SL of 3 and that, as a result, ConEd would not conduct an OD "or otherwise address the broader operability issue raised by the lack of quality control in the changes made to the RPS." The letter explained that (1) the licensee did, in fact, complete an OD for the RPS (OD 01-002), which "addressed some important wiring issues;" (2) NRC's inspection did not identify any issues that would affect the functionality of the RPS; and (3) CR 200100327 remained as an SL2 CR.

The Region I inspectors responsible for reviewing the concerns identified by the engineering consultant told OIG that they did not find anything that would render the RPS inoperable.

OIG FINDING

Beginning as early as 1998, ConEd identified problems associated with the IP2 RPS wiring configurations and generated internal CRs to document the findings. These CRs identified circumstances in which the system's wiring violated statements in the UFSAR. Thirteen CRs identifying (or reiterating) such wiring discrepancies were presented

formally to the NRC as an allegation by an IP2 engineering consultant who was concerned that collectively the RPS wiring discrepancies warranted a higher level of attention than the licensee had determined was appropriate. OIG learned that Region I performed two inspections relative to these issues and the NRC's Office of Nuclear Reactor Regulation documented its review in a third inspection report. In addition, Region I responded directly to the engineering consultant in a letter dated July 19, 2001. OIG determined that the NRC appropriately responded to the allegations presented to Region I by the engineering consultant. OIG's review of the three inspection reports and Region I's response to the engineering consultant determined that while NRC validated some of the issues the consultant had raised, the agency repeatedly concluded there were no "findings of significance" related to the RPS wiring issues and that ConEd had appropriate measures in place to address the conditions.

III. NRC REGULATORY OVERSIGHT OF IP2'S CAP: 1995 – 2001

Overview of IP2 Operational Problems

Between 1995 and 2001, IP2 experienced a series of operational problems, attributed in part to deficiencies in IP2's corrective action program (CAP) (i.e., its program to self-identify and resolve plant problems). For example,

- ◆ In 1995, plant personnel cleaned a turbine using grit. The grit caused significant damage to the internal components of a heater drain tank pump and migrated unchecked throughout the feedwater system, surfacing 2 years later and causing valves to operate erratically.
- ◆ NRC inspections conducted between 1996 and 1997 identified various issues, including weaknesses in corrective actions taken to address problems identified by the plant. As a result, in May 1997, NRC issued an NOV citing IP2 for nine violations of NRC requirements, six of which were attributed to corrective action violations.
- ◆ In the fall of 1997, IP2 voluntarily shut down to address a large backlog of equipment, programmatic, and performance problems. The plant remained out of service until September 1998.
- ◆ In 1998, in NRC Evaluation Team Report 05-247/1998-005, NRC noted that IP2 had identified problems with its CAP in that its corrective action processes were cumbersome and inefficient, many corrective actions were untimely, and completed actions were typically not revisited to determine whether they had achieved their goal.
- ◆ In August 1999, IP2 experienced a significant reactor trip, or shutdown, partly due to weaknesses in its CAP.
- ◆ In February 2000, IP2 experienced a steam generator tube rupture, also partly attributed to weaknesses in the plant's CAP.
- ◆ In May 2000, NRC categorized IP2 as an Agency Focus Plant, a status that denotes a need for increased oversight by NRC.
- ◆ In 2001, NRC found that IP2 continued to experience problems in its CAP, including issues pertaining to its RPS.

Significance of the Corrective Action Program

NRC inspects many aspects of nuclear power plants to ensure their safe operation, including the licensees' ability to identify and correct conditions that may affect plant performance and safety. Title 10 of the Code of Federal Regulations, Chapter 50 (10 CFR 50), Appendix B, directs licensees to have a program to assess problems in plant operations and to ensure that timely and effective corrective actions take place. Therefore, it is the licensee's responsibility to implement a program to identify and resolve problems at its facility. Historically this has been referred to as the nuclear power plant's CAP.

NRC Region I staff told OIG that overall plant performance is greatly determined by the effectiveness of a licensee's CAP. Staff told OIG that they expect licensees to be aggressive in identifying concerns and appropriately correcting problems, but they recognize that every plant has problems that need to be addressed. When a CAP is effective, staff said, a licensee is able to identify, prioritize, and quickly resolve conditions that may have a negative impact on plant operations. Staff said they have found that the better performing plants are very aggressive at correcting deficiencies. These plants are also proactive in conducting preventive maintenance and in monitoring plant equipment and conditions. As a result, staff said, those licensees have more durable solutions to their problems than poorer performing plants.

Several staff members interviewed by OIG observed a direct connection between ineffective CAPs and NRC's identification of a plant as an NRC Watch List¹⁰ Plant. According to one staff member, in every case where a plant had problems or became an NRC Watch List Plant, there was a corresponding weakness in the licensee's ability to identify, evaluate, and correct problems, as well as a weakness in assessing the effectiveness of their corrective actions.

The Region I staff told OIG that if NRC lost confidence in a licensee's CAP, the agency would seriously consider whether the licensee should be permitted to operate.

NRC Identifies Repeated Problems With IP2 CAP

OIG was told by the Region I Administrator and staff that between 1995 and 2001, NRC dedicated significant resources to conduct inspections, document findings, and issue sanctions at IP2, yet problems persisted at the plant. Many of the inspections identified problems with IP2's CAP; however, despite heightened levels of NRC attention to these weaknesses, problems related to corrective actions remained unresolved. [See Appendix B for a chronology detailing the significant inspection activity and other oversight efforts performed at IP2 by NRC during this period.]

According to Region I staff, between April 1995 and February 2001, NRC conducted 20 special team inspections at IP2, logging 5,870 inspection hours dedicated to engineering and problem identification and resolution (PI&R).¹¹ By comparison, the average number of hours devoted to these types of inspections at other single unit¹² Region I nuclear power plants during the same period was 3,854. Furthermore, between 1995 and 2001, IP2 received 13 enforcement actions, 9 of which identified corrective action issues and 8 of which resulted in monetary fines. [See Appendix C for additional information on these 13 enforcement actions.] This expenditure of inspection resources at IP2 was NRC's response to a perceived downward performance trend

¹⁰In 1999, there was a change in NRC terminology; Watch List plants are now referred to as Agency Focus Plants.

¹¹NRC now refers to the CAP as problem identification and resolution (PI&R). This Event Inquiry, which covers a time period during which the term used to describe the process changed, refers to the process as CAP.

¹²According to a Region I Branch Chief, the term "single unit" generally refers to a nuclear power plant site with only one operating reactor inside the protected area fence. Although there are two operating units at the Indian Point site (IP2 and IP3), Region I treats IP2 as a single unit site due to its past regulatory performance problems. This results in the allocation of more inspection resources at IP2 than would be the case if the plant were treated as a dual-unit site.

that was occurring during the 1995–1999 time frame. According to NRC Region I staff, between 1995 and 2000, overall IP2 performance was not considered very good. Staff said that during that time period, IP2 had problems related to the plant's CAP.

Region I staff told OIG that it viewed 1995 as a downward turning point for the plant and recalled the grit intrusion event that occurred that year as an example of this decline. Between October 1996 and April 1997, NRC staff conducted four inspections of IP2, which resulted in the issuance of an NOV in May 1997 based on nine violations of NRC requirements. The inspections included an Integrated Performance Assessment Process (IPAP) and three routine inspections conducted by the NRC resident inspectors. Problems identified during the inspections included weaknesses in IP2's design control which, staff explained, pertained to the availability and completeness of design bases information and problems with the CAP.

The Region I Administrator told OIG that following February 1997 there was a series of events that occurred at IP2, coupled with NRC's inspection findings, that reinforced his concerns about IP2's declining performance. He told OIG that the NRC subsequently sent a message to ConEd management by issuing fairly significant civil penalties and a confirmatory action letter (CAL).¹³ Additionally, he met with ConEd's Chief Executive Officer to address NRC's concerns about IP2's declining performance, the decline in overall effectiveness of management oversight, and a perception that management tolerated problems rather than aggressively identifying and correcting them.

Consequently, ConEd management responded to Region I by documenting actions it planned to take to arrest the performance declines and to improve the quality of these activities. These detailed action plans were included in a program that ConEd identified as the *Strategic Improvement Program*.

Declining Systematic Assessment of Licensee Performance Scores

According to the Region I Administrator and Region I staff, the Region's concerns about IP2's performance in 1996 were documented in NRC's Systematic Assessment of Licensee Performance (SALP) scores and periodic SALP reports for IP2. The SALP was an NRC evaluation of plant performance conducted every 12 to 24 months within the parameters of NRC's inspection program. The report included a numerical rating of the plant in four categories — plant operations, maintenance, engineering, and plant support — as well as a narrative discussion of performance in each area.

In the SALP report covering the period from September 17, 1995, through February 15, 1997, Region I staff noted that overall performance at IP2 declined. Performance in the areas of operations and plant support were rated as generally effective and some elements were very good; however, performance declined in maintenance and substantively declined in engineering. The SALP report noted many equipment problems were due to the poor condition

¹³CALs are letters issued by NRC to licensees or vendors to emphasize and confirm a licensee's or vendor's agreement to take certain actions in response to specific issues.

of a number of systems. Licensee management was involved in many plant activities and made operational decisions, but management oversight was at times ineffective regarding overall efforts to identify, evaluate, and correct problems.

IP2 Shuts Down To Address Backlog of Problems

OIG learned that following repetitive failures of safety-related electrical breakers, IP2 voluntarily shut down to address a large backlog of equipment, programmatic, and performance problems. This outage lasted from October 1997 until September 1998. According to NRC staff, IP2 used this period to try to better identify and correct these deficient conditions at the plant.

Instead of conducting a planned Operational Safety Team Inspection (OSTI)¹⁴ of IP2, NRC permitted ConEd to hire a team of independent experts to conduct an Independent Safety Assessment (ISA) of the power plant in the spring of 1998. NRC assembled a special NRC Evaluation Team (NET) to gauge the validity and effectiveness of the ISA and review the outcome. The NET observed and evaluated the IP2 ISA from March 30 through May 7, 1998, to assess the validity of the ISA conclusions and to determine whether the ISA had fulfilled NRC's intent to obtain an OSTI-type performance assessment. According to the NET report, the ISA achieved noteworthy insights, including the identification of problems with IP2's CAP. Specifically, the ISA found that the CAP was cumbersome and inefficient, many corrective actions were untimely, and completed actions were typically not revisited to see whether they had achieved their intended impact. According to an NRC staff member who participated in the review, IP2's CAP "was not working very well at all."

Subsequent to the ISA findings, ConEd developed plans to improve station performance and, according to the regional staff and inspection reports, IP2's performance began slowly to improve following plant startup in September 1998. According to the NRC staff, inspection reports, and other docketed correspondence between NRC and ConEd, substantial changes were made to IP2's CAP during this period. However, although progress was made, a number of problems remained that required continued licensee management attention.

IP2 Experiences Two Significant Events

In August 1999, IP2 experienced a reactor trip, or shutdown, a risk-significant event that NRC staff characterized as preventable and partly attributable to weaknesses in IP2's CAP. The reactor trip was caused partly by a condition involving repetitive problems with one channel of RPS's over-temperature/delta-temperature circuitry. The condition, which existed since January 1999, had not been promptly identified, the cause of the condition had not been determined, and corrective actions had not been taken. According to the Region I Administrator, while the August 1999 event challenged safe operation, safety margins were maintained at an acceptable level.

¹⁴At the time, OSTIs were conducted to supplement normal inspections for special purposes such as to verify that a plant operator has properly prepared the staff and the plant for resumption of power operations after an extended shutdown. These inspections were performed by either a headquarters or regional team and typically consist of a 2-week onsite inspection conducted by a team of seven inspectors and a team leader.

In February 2000, IP2 experienced yet another significant problem attributed to weaknesses in IP2's CAP: a steam generator tube ruptured in one of its four steam generators, resulting in a leak that allowed pressurized radioactive water, which acts to cool the reactor, to mix with non-radioactive water in the steam generator. The power plant was manually shut down following the event. This resulted in a minor radiological discharge to the atmosphere.

CAP Problems Persist at IP2

In an NRC inspection report (IR 05-247/2001-002) issued in 2001, the Region I inspection team again noted weaknesses in IP2's CAP. According to the report, IP2's progress to effect change continued to be slow. The report "noted problems similar to those that have been previously identified at the IP2 facility, including those in the areas of design control, human and equipment performance, PI&R, and emergency preparedness."

When interviewed by OIG, Region I staff attributed IP2's CAP problems to a large backlog of problems — any one of which might not appear significant. Staff said that IP2 was able to identify problems but was frequently ineffective at prioritizing and correcting them and determining their root cause. Staff attributed this specifically to a cultural problem at IP2 that was not recognized by ConEd management until after the August 1999 event. Staff described this culture as one in which ConEd management did not emphasize or encourage staff efforts to prioritize the correction of problems and identify root causes.

The Region I Administrator and staff acknowledged that the improvements at IP2 were slow, and in some respects limited, but steady. The Region I Administrator told OIG that IP2 met NRC's minimum regulatory requirements and there was never a situation where the margins of safety had been reduced to a point where the plant was unsafe. He added that as a regulator one has to work within the regulatory framework and distinguish between conditions that are unsafe and conditions that involve weaknesses in performance. The Region I Administrator and staff repeatedly emphasized to OIG that the increased inspections and aggressive oversight never identified a situation where IP2 was unsafe.

The Region I Administrator explained to OIG that IP2's rate of improvement above fundamental protection of public health and safety is determined by the plant management. The licensee determines the type and amount of resources that it will apply to facilitate improved performance. The licensee also makes personnel selections at the plant and it is ultimately up to the individuals hired to make these improvements and effect change. The Region I Administrator told OIG that he continually pressed ConEd management to strengthen the margins of safety at IP2 by conducting numerous inspections and special assessments and by communicating the Region's findings to ConEd in a clear and direct manner.

OIG FINDING

Between 1995 and 2001, IP2 experienced a series of operational problems, attributed in large part to deficiencies in IP2's CAP. OIG found that during this period, Region I dedicated significant resources to conduct inspections, document findings, and issue sanctions, yet problems persisted at the plant. Between April 1995 and February 2001, NRC conducted 20 special team inspections at IP2, logging 5,870 inspection hours dedicated to engineering and problem identification and resolution. Furthermore,

between 1995 and 2001, Region I issued 13 enforcement actions to IP2. Many of the inspections identified problems with IP2's CAP. However, despite heightened levels of NRC attention to these weaknesses, problems at IP2 remained unresolved. OIG found that in spite of the intensified regulatory oversight by Region I, IP2 was only able to achieve limited improvement in plant performance.

IV. NRC'S UTILIZATION OF THE SMM PROCESS TO HEIGHTEN ATTENTION AT IP2

Senior Management Meeting Process

Between 1986 and 2001, NRC held Senior Management Meetings (SMM) semiannually to allow NRC senior managers to focus agency attention on those plants of highest concern and to monitor licensee efforts to recognize and resolve performance problems. According to the March 1997 version of NRC Management Directive (MD) 8.14, "Senior Management Meeting (SMM)," the primary goal of an SMM was to identify declining trends in the operational safety of individual plants so that early corrective actions could be implemented. OIG was told by senior NRC managers that the SMM offered a means to communicate NRC's concerns to licensees with poor or adverse performance trends.

During the SMM, the senior NRC managers could opt not to take action regarding a particular plant or they could choose to take one of several actions to heighten oversight. For example, senior managers could choose to issue a Trending Letter to advise a licensee that NRC had taken notice of declining plant performance and that if performance did not improve, the plant might be placed on the NRC's Watch List. Or, the managers could choose to place a plant directly on the Watch List. A plant placed on the Watch List received increased oversight from NRC in the form of additional inspections, letters expressing agency concerns about declining performance, and other types of regulatory attention. According to the NRC staff, designation as a Watch List plant could also bring significant public attention to a licensee and could result in a negative economic impact for the utility. These potential negative consequences would motivate a licensee to improve plant performance.

Senior Management Meetings were chaired by the NRC Executive Director for Operations. Participants typically included the Deputy Executive Director for Regulatory Programs; Deputy Executive Director for Regulatory Effectiveness, Program Oversight, Investigations and Enforcement; Deputy Executive Director for Management Services; Regional Administrators; Directors of the Offices of Nuclear Reactor Regulation, Analysis and Evaluation of Operational Data, Nuclear Material Safety and Safeguards, Nuclear Regulatory Research, Enforcement, Investigation, and State Programs; and senior managers from the Office of the General Counsel.

Region I Administrator Seeks SMM Action on IP2

OIG learned that paralleling NRC's inspection activity at IP2 from 1997 through 2000 was a series of attempts by the Region I Administrator to further heighten NRC oversight at the plant through the agency's SMM process. At the June 1997 SMM, the Region I Administrator presented his concerns regarding the declining performance of IP2 that was the result of significant equipment, human performance, and technical support performance issues that were apparent in late 1996. NRC Regional Administrators and senior managers told OIG that at the June 1997 SMM, the Region I Administrator made "a strong presentation" regarding IP2's performance and his belief that IP2 should be designated as a Watch List plant. However, the senior managers decided not to designate IP2 as a Watch List plant but to continue providing the heightened level of regional oversight underway at the time. According to the senior managers, and based on minutes of the SMM proceedings, the information presented at the SMM did not identify a situation where the plant was unsafe, a safety system was inoperable, or

adverse trends were apparent. Thus, the senior managers determined that IP2 did not warrant agency-level action.

During the SMM held in January 1998, the Region I Administrator again presented IP2 for discussion asserting that there had been little change in performance in most respects over the prior 6 months; that recent inspections raised additional concerns with respect to performance; that NRC inspectors, rather than ConEd, continued to identify many of the performance problems, particularly in operations and engineering; and that equipment and human performance issues continued to be of concern. Additionally, the informality of processes contributed to problems observed in several areas, including technical specification implementation, procedural adherence, problem identification, and timely effective resolution of issues. OIG learned that this time, the consensus of the senior managers was to conduct a diagnostic-type review to obtain additional information on the plant's condition and not to issue a trending letter or put the plant on the Watch List. Again, the senior managers believed that Region I did not identify a situation where the plant was unsafe or a safety system was inoperable; however, they acknowledged that IP2 continued to exhibit performance weaknesses, and they noted that a definitive improvement trend was not apparent.

In July 1998, the Region I Administrator again presented IP2 at the SMM in the belief it should be designated as a Watch List Plant. He asserted that the performance at IP2 was largely unchanged during the preceding 6 months with respect to human performance and the control of plant activities. Additionally, the 1998 Independent Safety Assessment (ISA) conducted by ConEd identified some important deficiencies and weaknesses that existed at IP2 particularly in the areas of management and operations. Despite the Region I Administrator's presentation, the SMM again declined to designate IP2 a Watch List plant. This time, the SMM decided to maintain, rather than increase, the level of attention to allow the licensee a period of time to execute its performance improvement initiatives. The senior managers recognized that IP2 continued to have performance weaknesses, but again they believed that Region I did not identify a situation where the plant was unsafe or a safety system inoperable.

IP2 was not discussed during the April 1999 SMM. The Region I Administrator told OIG that he did not recommend that IP2 be presented for discussion because it had experienced no significant events since the last time he presented the plant for SMM discussion. He felt that in 1999, performance weaknesses still existed but that IP2 was no worse than in preceding years and was, in fact, slowly improving. He said he still would have preferred SMM action; however, he felt he lacked a basis for presenting the plant at the SMM.

SMM Designates IP2 as Agency Focus Plant in May 2000

In May 2000, the Region I Administrator presented IP2 at the SMM after the occurrence of two significant events at the plant, the August 1999 reactor trip and the February 2000 steam generator tube rupture. OIG learned that overall, the events and related findings during this assessment period represented issues that were of substantial significance; therefore, the senior managers categorized IP2 as an Agency Focus Plant under the revised SMM process.¹⁵

¹⁵In April 1999, the Commission approved SECY 99-086, "Recommendations Regarding the Senior Management Meeting Process and Ongoing Improvements to Existing Licensee Performance Assessment Processes." SECY 99-086 eliminated the "Watch List" and proposed that during SMM meetings, participants would

According to the SMM minutes, the senior managers concluded that the broad performance issues that had existed at IP2 for the past several years revealed a number of deficiencies in the plant's CAP and that IP2 improvement initiatives yielded some progress but, overall, were limited in remedying the underlying problems.

According to the Region I Administrator, the August 1999 and February 2000 events revealed the depth of IP2's performance problems and were evidence of the significant issues discussed at previous SMMs. Region I staff echoed this sentiment to the OIG, questioning why — given the inspection history, the identified problems, the NRC man-hours at the plant, and the history of civil penalties — IP2 was not put on the Watch List sooner.

Current Status of IP2

Region I staff has informed OIG that since March 2001, NRC has provided a significant amount of oversight and inspection effort at IP2. The Region I staff performed 12,950 hours of inspection activity at IP2 between March 1, 2001, and March 1, 2003, compared to an average of 8,297 hours at other single unit sites in Region I. (See Appendix B for a chronology of NRC inspection activity at IP2 during this time period.) Of the 12,950 hours of inspection performed at IP2 during this 2-year period, 2,216 hours were focused on engineering and PI&R compared to an average of 1,077 hours devoted to these areas at other single-unit Region I sites. The staff informed OIG that these figures indicate that during this period, IP2 has received about 1.5 times as much inspection as the average for other single-unit sites and about 2 times as much inspection pertaining to engineering and PI&R.

Annual assessments of plant performance¹⁶ performed since the plant was categorized as an Agency Focus Plant in May 2000 indicate that IP2 performance has been improving, albeit slowly, since that time. NRC's annual assessment of plant performance for April 2, 2000, to March 31, 2001, found that while IP2 met all cornerstone objectives, it remained in the Multiple/Repetitive Degraded Cornerstone column of the NRC's ROP Action Matrix. According to the Region I staff, that assessment noted a number of issues in design control, equipment reliability, PI&R, and human performance. While some performance improvements were noted, progress was considered slow and limited in some areas. Region I staff noted that as of December 31, 2001, IP2 remained in the Multiple/Repetitive Degraded Cornerstone column of the Action Matrix.

determine whether a plant warranted Agency Focus (characterized by NRC Executive Director for Operations and Commission involvement, e.g., issuance of an order), Regional Focus (managed by the regional administrator, e.g., issuance of a confirmatory action letter), or routine oversight.

¹⁶Under the ROP, NRC assesses licensee performance in various ways, including quarterly plant performance assessments based on inspection findings and performance indicator data. Regional offices conduct a more comprehensive review after the second quarter of the year (mid-cycle) to assist in planning inspections for the next 6 to 12 months. The regions also conduct an annual (end-of-cycle) review after the fourth quarter of the year to develop an annual performance summary for each plant and to plan inspections for the next 12 months. NRC uses an Action Matrix to assist staff in reaching objective conclusions regarding licensees' safety performance. The matrix allows for plants to be categorized into five possible results categories, or matrix columns, which indicate the plant's level of performance and the agency's required response. Categories (from lowest to highest performance) are (1) Unacceptable Performance, (2) Multiple/Repetitive Degraded Cornerstone, (3) Degraded Cornerstone, (4) Regulatory Response, and (5) Licensee Response.

Significant inspection activity continued during 2002, including an augmented PI&R inspection and supplemental team inspection in June and July 2002. OIG was told that in August 2002, IP2 had made sufficient progress to justify removal of the plant from the Multiple/Repetitive Degraded cornerstone into the Degraded Cornerstone column of the Action Matrix. OIG was told by the Region I Administrator that on February 7, 2003, NRC completed its end-of-cycle plant performance assessment of IP2 covering performance from January 1, 2002, through December 28, 2002. NRC concluded that during that time period, IP2 continued to operate in a manner that preserved public health and safety.

The Region I Administrator and staff told OIG that Region I fully utilized the regulatory tools it had available to deal with IP2. The Region I Administrator said that although the plant was never unsafe, improvement in IP2's performance might have been swifter had the plant been designated a "Watch List" plant by the SMM earlier. This designation would have sent a powerful message to the licensee concerning the need for improved performance.

The Region I Administrator commented that while the agency's senior managers designated the plant as an "Agency Focus Plant" in May 2000, this occurred after the plant had reversed its downward trend and, in fact, the designation had a relatively small impact on recent plant operations because the plant's declining performance had already been arrested as a result of earlier actions taken by the NRC. The Region I Administrator also noted that SMM deliberations were always thorough but that decisions were inherently difficult given the complexity of issues involved.

Additionally, the Region I Administrator commented to OIG that Entergy's purchase of IP2 in September 2001, had a considerable impact on plant performance. According to the Region I Administrator, Entergy conducted its own self-assessment of IP2 and subsequently committed significant resources to the plant. Furthermore, Entergy had experience operating other nuclear power plants, was aware of the need to inject resources to improve plant performance, and had those resources available. Entergy also understood the need to bring top management talent to operate the plant, which it did. According to the Region I Administrator, this shift in ownership facilitated the IP2 improved performance trend.

The Region I Administrator considered IP2's improvement as an NRC "regulatory success story." He stated that NRC's aggressive oversight and intervention arrested the decline in early 1996 and prevented IP2 from ever getting to the point where it was unsafe to operate. He acknowledged that IP2's improvement has been slow at times and often uneven, but that, overall, plant performance has steadily improved. In his view, the conditions that led to IP2's poor performance in the mid-1990s developed over a number of years and, therefore, required time to resolve. He credited NRC oversight efforts performed at IP2 since 1996 with having caused the plant to reverse its downward performance trend and begin its slow progress toward the performance improvement reflected in the NRC's recent assessment letters.

OIG FINDING

On four occasions between 1997 and 2000, the Region I Administrator sought additional NRC oversight for IP2 by seeking to have NRC's senior managers place IP2 on NRC's Watch List via the agency's Senior Management Meeting process. However, it was not until May 2000, after the August 1999 reactor trip and the February 2000 steam

generator tube rupture, that NRC senior managers agreed that this form of heightened attention was appropriate. In May 2000, IP2 was classified as an Agency Focus Plant. Subsequent to being so designated, NRC annual assessments of plant performance indicated that IP2 had improved. OIG concurs with the Region I Administrator and his staff that placing IP2 on the Watch List sooner might have sufficiently motivated the licensee to cause earlier improved performance.

APPENDIX A
Summary of IP2 RPS Condition Reports

CR 199803574 identified a discrepancy between the RPS wiring configuration and a description in section 7.2.2.9 of the UFSAR of isolation between safety signals and annunciator and/or computer signals. Contrary to the UFSAR statement that "The center and front decks of RPS logic relays are used for annunciator and computer signals respectively," 22 RPS logic relays were found to violate this criterion.

CR 199900478 identified discrepancies between design drawings and the as-built configuration with respect to contact state associated with interposing relays for the low autostop oil pressure protection scheme. The corrective action for this condition involved revision of four drawings to reflect the field condition.

CR 199902274 identified "minor" inconsistencies affecting 14 RPS and ESF drawings. Corrective action involved revising the affected drawing based on comments received from an outside contractor who was tasked with the drawing review.

CR 199902835 identified three distinct discrepancies between plant drawings and the as-built condition. These discrepancies involved: RPS logic relays used to block the "Source Range High Influx at Shutdown" annunciator, drawings showing RPS relay contact configuration different from the as-built condition, and incorrect RPS relay nomenclature on plant drawings. The corrective action for this CR was limited to revising the affected drawings to agree with the as-found condition.

CR 199903445 was initiated because the drawing revisions prepared in response to CR 199902835 were in error. This CR also identified an additional drawing error in which the drawing showed the incorrect RPS relay contacts used for the Source Range High Flux at Shutdown annunciator block.

CR 199904968 identified another discrepancy between the design drawings and the as-found configuration of the RPS. This discrepancy involved contacts from RPS relay P10-2 that are used to defeat the Source Range Loss of Detector Voltage annunciator above 10% reactor power which are not shown on plant drawings. The corrective action for this CR involved a field verification of the configuration and revision of the affected drawing to reflect the as-found condition.

CR 200007597 identified a number of potential internal wiring related discrepant conditions in the reactor protection racks. Isolated cases of wire routing and/or terminations were observed to be inconsistent with routing/separation requirements stated in the UFSAR. In response to this CR an Operability Determination (OD) 00-018 was issued to address the wiring routing/separation issues. The OD determined that the RPS was operable.

CR 200008415 identified drawing discrepancies between Westinghouse RPS wire lists and field conditions, however, an operability determination concluded that this did not constitute an operability concern.

CR 200008818 identified a broken contact in a reactor trip relay, unidentified, unterminated switchboard wire with exposed lugs in RPS cabinets, and a mixing of wiring associated with computer/logic/annunciator functions. The broken contact has been repaired. A 200-degree hold was placed on this CR. The "Operability Review Note" by the Watch Engineer stated "200 degree hold for loose wires, etc." The response to the unterminated (loose) wire issue was not addressed. The engineer who responded to the 200H action stated that he considered the unterminated wire a housekeeping issue and therefore, did not address it as part of the 200H response.

CR 200009499 identified additional conditions in which the wiring in the RPS racks violated statements in the UFSAR. The CR stated that "Wires (in RPS Racks 4 and 5) were carelessly strewn through multiple wire ways," and "Had the original design been followed, there would have been no mixing (of circuit functions) and there would have also been half as many new wires to mix." These issues were addressed in Operability Determination 00-018 which was conducted on CR 200007597 which found that the RPS was operable.

CR 200009641 identified six issues related to RPS wiring deficiencies or discrepancies, three of which were similar to or a repeat of issues identified in previous CRs. The new issues included a wire associated with an NIS power range logic relay with a splice that is not represented on plant drawings and single cable containing both 125 VDC logic protection power and 118 VAC instrument bus power. Both of these issues were addressed in Operability Determination 00-018.

CR 200010125 identified discrepancies between design drawings and the as-built configuration of the RPS. This CR also identified other CRs that described similar inconsistencies between design drawings and RPS wiring. A review of the corrective action associated with these CRs revealed that the CR actions were typically closed by revising the plant drawings to reflect the as-found configuration without performing a safety evaluation to determine the impact of the change on the design and licensing basis. In some cases the as-found condition affected the system design as depicted in the UFSAR text and/or figures. This CR also identified errors made in drawings as part of the corrective action for CR 199904968. Furthermore, this CR identified discrepancies between drawings and the as-found RPS wiring that had not been previously identified.

CR 200100327 summarized numerous issues identified in eight previously submitted CRs that documented a lack of configuration control and quality control of changes to the RPS wiring since 1998. The concerns raised in CR 200100327 were categorized as quality assurance requirements for design verifications, wiring changes resulting from modifications that could not be located and wiring separation not in accordance with the UFSAR. The eight CRs summarized in CR 200100327 are CR 200010125, CR 199803574, CR 199904968, CR 199902835, CR 199903445, CR 200007597, CR 200009499 and CR 200009641.

APPENDIX B
Chronology of Significant Inspections and Oversight at IP2, 1995 – 2003¹

March 14, 1995	Inspection Report (IR) 1995-01, special safety inspection of AFW digital controller failure.
April 12, 1995	IR 1994-017 service water self-assessment inspection.
August 28, 1995	IR 1995-080, Operational Safety Team Inspection.
October 26, 1995	SALP report issued.
January 28, 1997	IR 1996-080, Integrated Performance Assessment Process (IPAP).
January 31, 1997	Confirmatory Action Letter (CAL) issued.
February 21, 1997	CAL closed.
March 31, 1997	Final SALP report issued.
May 1, 1997	Plant shutdown for refueling outage.
May 9, 1997	IR 1997-003 integrated inspection.
June 19, 1997	IR 1997-005, special inspection conducted for stuck open MSSV.
June 1997	IP2 discussed at Senior Management Meeting (SMM).
June 1997	Regional Administrator meets with ConEd Chief Executive Officer.
July 8, 1997	Plant startup from refuel outage.
July 26, 1997	Generator load rejection and reactor trip.
July 28, 1997	Reactor trip.
August 6, 1997	Shutdown.
August 8, 1997	IR 1997-008, special inspection of outage issues.
August 23, 1997	Reactor trip due to reactor coolant pump breaker testing logic error.
August 25, 1997	Plant startup.
September 29, 1997	IR 1997-010, special inspection of load reject and reactor trip.

¹Information in this chronology was provided to OIG by Region I.

October 14, 1997	Plant shut down due to repetitive DB50 circuit breaker failures.
December 12, 1997	IR 1997-012, integrated inspection report, resident inspection and specialist review of safety-related breaker problems.
January 1998	IP2 discussed at SMM.
January 1998	Performance letter issued to ConEd - decision made to perform Operational Safety Team Inspection/Independent Safety Assessment.
February 13, 1998	IR 1997-013, special inspection of 480 Vac Breaker failures.
March 26, 1998	CAL 1-98-005 due to issues discovered during shut down not related to circuit breakers.
March 26, 1998	IR 1998-201, design inspection.
April 27, 1998	NRC restart action plan for IP2 issued.
May 1998	Independent Safety Assessment performed by ConEd.
June 3, 1998	IR 1998-005, NRC Evaluation Team (NET).
June 26, 1998	IR 1998-006, special inspection focusing on corrective actions regarding plant restart issues.
June 1998	Emergency preparedness exercise.
July 9, 1998	Revised NRC CAL 1-98-005 issued March 26, 1998.
July 1998	IP2 discussed at SMM.
September 16, 1998	IR 1998-012, followup NRC NET evaluation team inspection.
September 21, 1998	Reactor startup.
October 16, 1998	IR 1998-008, special Inspection of corrective action associated with restart issue.
October 23, 1998	IR 1998-014, NRC integrated inspection.
November 3, 1998	IR 1998-016, NRC special inspection of high efficiency particulate air (HEPA) filter deterioration.
January 29, 1999	IR 1998-018 NRC 40500 Corrective Action Program Inspection.
April 1999	Plant Performance Review.

June 1999	ConEd external assessments of operations, work control, and maintenance departments.
August 19, 1999	IR 1999-004 NRC team inspection report (Core Engineering Team).
August 31, 1999	Reactor trip and loss of offsite power.
September 14, 1999	Management meeting - Augmented Inspection Team (AIT) interim results.
September 23, 1999	Public exit meeting - AIT exit meeting.
September 1999	Emergency preparedness exercise.
October 13, 1999	Reactor startup.
October 19, 1999	IR 1999-008, AIT.
October 1999	IR 1999-013, AIT follow up team inspection commenced.
October 1999	Mid-cycle plant performance review letter issued.
November 23, 1999	Public Meeting - IP2 performance assessment results from September 1999 plant performance review.
December 21, 1999	Results of the follow-up inspection to the AIT (1999-013).
December 1999	IP2 Recovery Plan actions transferred to Business Plan.
January 5, 2000	IR 1999-014. Results of enforcement follow up of AIT for August 31, 1999 trip.
January 7, 2000	Drafted charter for the formation of the Indian Point Unit 2 oversight panel (IPOP).
February 1, 2002	Drafted IP2 oversight strategy.
February 15, 2000	Reactor trip - steam generator tube failure (SGTF).
March 1, 2000	SGTF meeting.
March 14, 2000	SGTF public meeting.
March 2000	Formation of IP2 communications team.
March 2000	Plant performance review letter.
April 28, 2000	NRC AIT SGTF IR 2000-002 issued.

May 23, 2000	IP2 discussed at SMM; letter issued characterizing IP2 as an "Agency Focus" plant.
June 25, 2000	Public meeting.
July 10, 2000	IR 2000-007, AIT SGTF follow-up.
July 27, 2000	IR 2000-010; NRC SGTF special inspection.
August 3-4, 2000	Regional Administrator site visit.
August 31, 2000	IR 2000-010, SGTF special inspection.
September 11, 2000	NRC Agency Focus Meeting. (Regional Administrator and NRR Deputy Director Site Visit)
September 26, 2000	Regulatory conference on SGTF "red" finding.
September 2000	Ongoing regional management briefings on cornerstone deficiencies, and plant performance issues throughout restart.
October 2, 16, 2000	Problem Identification and Resolution (PI&R) inspection.
October 5, 2000	EDO brief to discuss content of "Agency Focus" letter.
October 10, 2000	Assessment follow up (Agency Focus Update) letter.
October 11, 2000	ROP meeting held in Cortland Town Hall.
October 16, 2000	Operator requalification Inspection.
October 25, 2000	NRC - ConEd management meeting.
October 31, 2000	Significant Determination Process repanel (final determination of "red or yellow" finding for SGTF issues).
November 1, 2000	IP2 SGTF Lessons Learned Task Force (LLTF) report issued.
November 6, 2000	NRC on-site restart readiness reviews.
November 8, 2000	Mid Cycle review meeting conducted.
November 14, 2000	RI review of four system readiness reviews.
November 16, 2000	Public meeting.
November 16, 2000	NRC noted that the independent 125 VDC SSFA team performed a high quality review.

November 20, 2000 Issued red finding and Notice of Violation (NOV) for the poor SG inspection program that led to the SGTF.

November 27, 2000 NRC safety system readiness review inspection on the Safety Inspection system.

November 29, 2000 Mid cycle performance review and inspection plan letter issued.

December 1, 2000 Region I senior management site visit to IP2.

December 4, 2000 PI&R inspection report.

December 6, 2000 EDO briefing.

December 11, 2000 Plant heat up above 200 degrees - restart inspection begun.

December 18, 2000 IR 2000-014 design issues inspection.

December 20, 2000 NRC replied to ConEd's request for extension to respond to the red finding and NOV.

December 22, 2000 NRC Region I issues NRC review efforts/status letter.

December 30, 2000 Plant restarted.

January 2, 2001 Turbine trip due to low SG level.

January 5, 2001 Regional Administrator visits Congresswoman Kelly.

February 9, 2001 95003 multiple degraded cornerstone supplemental inspection.

February 26 -
May 4, 2001 IR 2001-005, review reactor protection system (RPS) design issues.

February 27, 2001 Chilling effect letter issues.

March 1-2, 2001 Regional Administrator site visit and public exit meeting for 95003 inspection.

March 9, 2001 Chairman site visit with Regional Administrator and Executive Director for Operations.

April 3, 2001 Division of Reactor Safety (DRS) branch chief visit to IP2 - UFSAR verification project status.

April 10, 2001 IR 2001-002, (95003 Inspection) supplemental inspection report issued.

June 18, 2001	IR 2001-007, emergency preparedness (EP) exercise review and supplemental inspection of licensee actions to address three findings in the EP cornerstone area.
July 23, 2001	IR 2001-007, review of 2001 design engineering business plan and scope and 50.54 (f) commitment status.
July 23, 2001	IR 2001008, review of 2001 Design Engineering Business Plan Scope and 50.54(f) commitment status.
October 22, 2001	IR 2002013, NRC on-site to do initial inspection of the failure of three of six crews on licensed operator (LOR) examinations and to observe facility evaluate seventh crew; crew fails: four of seven = yellow finding.
November 5, 2001	IR 2001-010, review of licensee's safety injection (SI) safety system functional assessment (SSFA) and PI&R inspection.
November 27, 2001	IR 2001-011, NRC observes facility-led evaluation of an operating crew; while onsite, conducts regular-hours control room (CR) observations.
December 7, 2001	IR 2001-011, NRC- led evaluation of another operating crew; while onsite, conducts regular-hours CR observations.
December 16, 2001	IR 2001-011, NRC- led evaluation of 4 staff RO licenses.
January 28, 2002	IR 2001-014, review of licensee's self assessment and Fundamentals Improvement Plan (FIP), including the Design Basis Initiative (DBI).
February 7, 2002	IR 2002-007, NRC observes facility-administered evaluations (High Intensity Training (HIT)).
March 21, 2002	IR 2002-007, NRC observes facility-administered evaluations (HIT).
March 21, 2002	IR 2002-009, supplemental inspection to review causes and corrective actions for yellow finding related to operator requalification.
June 24, 2002	IR 2002-010, augmented PI&R inspection, reviewed performance issues related to the multiple degraded cornerstone designation, progress implementing the FIP, and review of the degraded control room west wall fire barrier.
November 4, 2002	IR 2002-007, review of reactor protection system (RPS) wiring verification.
December 9, 2002	IR 2003-002, PI&R team inspection.
December 2002 - February 2003	IR 2003-003 and IR 2003-005 (both draft), team inspections to review TI 2515/148 and various other security issues.

January 27, 2003

IR 2003-004 (draft), engineering team inspection reviewed design and performance capability of component cooling water and offsite power supplies.

APPENDIX C
Summary of Escalated Enforcement Action from 1995-2000

1996-01, Enforcement Action 96-089, Significance Level (SL) III
10 CFR 50.59 (SL III) and 50.72 (SL IV)

Repair activities on central control room roof left ventilation system in unanalyzed condition for 2 months. Inadequate corrective actions.

1996-04, Enforcement Action 96-272, SL IV
Criterion XVI (SL IV) and Technical Specification (TS) 6.8.1. (SL IV)

- 1) Failure to maintain proper configuration control over containment isolation valve, contrary to procedure requirements.
- 2) Failure to preform required safety evaluation on procedure change.

1996-07, Enforcement Action 97-031, SL III (\$50,000 civil penalty)
Criterion XVI (SL III)

Inadequate measures were taken to assure that the cause of each condition was determined and corrective action taken to preclude repetition.

- 1) Repeated surveillance test failures associated with the TDAFW pump's steam admission valve and discharge flow control valves. Valve damage subsequently identified.
- 2) Preconditioning of TDAFW pump by blowing down steam traps prior to testing. Adequate engineering review was not performed to support pump operability.
- 3) Multiple surveillance test failures associated with alternate safe shutdown system power transfer switches for the 23 and 24 service water pumps.
- 4) Untimely identification of degradation of PAB filter/fire deluge system control panel and associated circuits. System was incapable of performing design function. Poor implementation of an alarm response procedure's required actions.

1996-08, Enforcement Action 97-113, SL III (\$50,000 civil penalty)
Criterion XVI (SL III), TS 6.8.1(SL IV), TS 6.5.1.6.a. (SL IV)

- 1) Failure to take adequate corrective actions following grit intrusion during the 1995 refueling outage. Resulted in inoperability of three of the four safety-related MFRV's and one low-flow bypass MFRV in January 1997.
- 2) Control of SG levels not in accordance with procedure and the failure to make temporary procedure changes to invoke administrative allowances for situation where deviation is necessary.
- 3) Failure to perform a required review of a vendor report that was used as the basis to support DG operability following the 1995 grit intrusion.

1996-80, Enforcement Action 96-509, SL III (\$50,000 civil penalty)
Appendix R (SL III)

Fire protection features not provided to protect one train of systems - two instances.

- 1) Certain normal safe shut down instrumentation and the corresponding alternate safe shutdown instrumentation would be subject to fire damage.
- 2) Potential for hot shorts exists as a result of fire damage to cables associated with both the pressurizer PORV and block valves (a high/low pressure interface).

1997-03, Enforcement Action 97-191, SL III (\$55,000 civil penalty)
Criterion XVI (SL III)

Failure to promptly identify and take corrective actions. Maintenance worker drilled into an electrical junction box, causing fire dampers in two safety-related electrical distribution rooms to actuate. Some dampers did not drop and other became physically restrained and only partially dropped. Condition went unaddressed by plant personnel for two days until questioned by NRC.

1997-08, Enforcement Action 97-367, SL III (\$110,000 civil penalty)
TS 6.8.1 (SL III), Criterion XVI (SL III), TS 3.1.A.4.a (SL III), TS 4.18.c (SL III),
TS 4.2.1.(SL IV) - 5 violations

- 1) operation of the plant for 2.5 days outside technical specifications pressure and temperature curves with the OPS inoperable. Violation of TS 6.8.1.
- 2) Failed to consider ambient temperature condition on the pressurizer code safety valve set point. Violation of TS 4.2.1 Untimely and ineffective corrective actions. Inadequate 50.59 safety evaluation for a plant mod to remove the pressurizer block house roof. Inoperability of the code safety valves as prescribed by the technical specifications. Numerous opportunities existed for the staff to identify this issue.
- 3) Ingestion of hose in 21 recirculation pump. Poor engineering resolution to degraded pump performance that preceded the identification of the hose in the 1997 refueling outage. Indications are 21 recirculation pump inoperable since 1995. Inadequate corrective actions.

1997-13, Enforcement Action 97-576, SL III (\$55,000 civil penalty)
Criterion XVI (SL III)

Failure to take prompt and appropriate corrective actions prior to voluntary shutdown in October 1997 to address the recurring DB-50 breaker failures to close on demand.

1997-15, Enforcement Action 98-028, SL IV
Criterion XVI (SL IV), TS 6.8.1 (SL IV) - 2 violations

- 1) ConEd's failure to address degraded conditions in a timely manner on the post accident containment venting system (PACVS) and the hydrogen recombiner system.
- 2) An inadequate procedure for operation of the PACVS.

Office of Investigations- January 22, 1998, Enforcement Action 98-056, SL III
50.9 (SL III) - 2 Violations

- 1) On August 8, 1997, the emergency battery lights in the PAB were not tested per procedure. However, records were created that indicated the lights were tested. Technicians were not in room for long enough period to adequately test lights.
- 2) On August 8, 1997, surveillance test of EDG auxiliaries require double verification. Double verification of compressor was not performed. Records were created that indicate second verification was performed. Technician was not in the EDG building to be able to perform verification.

1998-02, Enforcement Action 98-192, SL III (\$55,000 civil penalty)
Criterion XI (SL III)

A significant number of technical surveillance testing discrepancies were identified through ConEd and NRC reviews. Failed to assure that all testing required to demonstrate that systems and components will perform satisfactorily in service, as specified in technical specifications, was incorporated into surveillance test procedures.

1999-014, Enforcement Action 99-319, SL II (\$88,000 civil penalty)
Criterion III (2 violations), Criterion V, Criterion XVI (SL II)

- 1) a. Design basis not correctly translated into specifications and procedures for mod to the 480 vital bus degraded voltage relays. Therefore, relays could not perform design basis function and correctly reset. Contributing to August 31, 1999 transfer of 480V bus from offsite power supply to the RDGs.
- b. Requirement for auto operation of the Station Aux Transformer Load Tap Changer were not translated into procedures. As a result from September 9, 1998 to August 31, 1999, the 138kV offsite power system was unable to perform its function. Violated Technical specification 3.7. B.3.
- 2) Procedure did not adequately ensure proper calibration of DB-75 breaker trip units for the EDGs. Result EDG was inoperable from May 27, 1999 through August 31, 1999.
- 3) Condition adverse to quality with channel 4 of the reactor protection system (RPS) OTDT circuitry between January 1999 and August 31, 1999, resulting in a plant trip during maintenance on channel 3.

2001-010, Enforcement Action 00-179, Red Finding
Criterion XVI (Red)

A PWSCC defect was identified, signifying the potential for other similar cracks in low-row tubes. ConEd did not adequately evaluate the susceptibility for low-row tubes to PWSCC and the extent of degradation.

ConEd did not adequately evaluate the potential for hour-glassing based on the indications of the low-row tube denting. The increased stresses caused by the hour-glassing are a prime precursor for PWSCC.

1997 Steam generator inspection program was not adjusted to compensate for the

adverse effects of increased noise in detecting flaws, particularly when condition that increased the susceptibility to PWSCC existed.

These problems contributed to at least four tubes with PWSCC flaws in their small radius U-bends, being left in service following the 1997 inspection, until one tube failed on February 15, 2000.

Exhibit Y



Entergy Nuclear Northeast
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March 28, 2005
BVY-05-033
NL-05-039
JPN-05-005
ENO Ltr. 2.05.023

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

SUBJECT: Entergy Nuclear Operations, Inc.
Indian Point Nuclear Generating Stations 1, 2 and 3
Docket Nos. 50-3, 50-247 and 50-286
Vermont Yankee Nuclear Power Station
Docket No. 50-271
Pilgrim Nuclear Power Station
Docket No. 50-293
James A. FitzPatrick Nuclear Power Plant
Docket No. 50-333
**Status of Decommissioning Funding for
Plants Operated by Entergy Nuclear Operations, Inc.
For Year Ending December 31, 2004 - 10 CFR 50.75(f)(1)**

- References:**
1. NUREG-1307, "Report on Waste Burial Charges," Revision 10, dated October 2002.
 2. NRC Regulatory Issue Summary 2001-07, "10 CFR 50.75(f)(1) Reports on the Status of Decommissioning Funds (Due March 31, 2001)."

Dear Sir:

10 CFR 50.75(f)(1) requires each power reactor licensee to report to the NRC by March 31, 1999, and every two years thereafter, on the status of its decommissioning funding for each reactor, or share of a reactor, that it owns. On behalf of Entergy Nuclear Indian Point 2 LLC, Entergy Nuclear Indian Point 3 LLC, Entergy Nuclear Vermont Yankee LLC, Entergy Nuclear Generation Company (Pilgrim Station), and Entergy Nuclear FitzPatrick LLC, Entergy Nuclear Operations, Inc. hereby submits the information requested for power reactors operated by Entergy Nuclear Operations, Inc.

A001

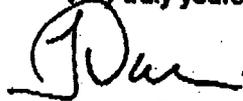
The estimated minimum decommissioning fund values were determined using the NRC's methodology in NUREG-1307 (Reference 1) and does not include activities outside of the scope of decommissioning as defined by 10 CFR 50.2.

Entergy will continue to monitor the status of the funds and will assure that we meet all NRC regulations and implement NRC guidance, as appropriate, to assure adequate funding for the decommissioning when required.

The information provided in Attachment 1 is based on NRC Regulatory Issue Summary 2001-07 (Reference 2).

There are no new commitments made in this letter. If you have any questions, please contact Ms. Charlene Faison at 914-272-3378.

Very truly yours,



Fred R. Dacimo
Acting Senior Vice President and
Chief Operating Officer

Attachment

1. Status of Decommissioning Funding for Plants Operated by Entergy Nuclear Operations, Inc. (Indian Point 1, Indian Point 2, Indian Point 3, Vermont Yankee, Pilgrim, and FitzPatrick) For Year Ending December 31, 2004 - 10 CFR 50.75(f)(1) - (7 sheets)
2. NRC Minimum Funding Calculation (10 CFR 50.75(c)) for Indian Point 1, Indian Point 2, Indian Point 3, Vermont Yankee, Pilgrim, and FitzPatrick - (6 sheets)

cc: Next page.

cc: all w/attachments

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Albany, NY 12223

Attachment 1 to BVY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

Entergy Nuclear Operations, Inc.
Status of Decommissioning Funding
For Year Ending December 31, 2004 – 10 CFR 50.75(f)(1)

Plant Name: Indian Point Nuclear Generating Unit No. 1

- | | | |
|----|---|---|
| 1. | Amount of decommissioning funds estimated to be required pursuant to 10 CFR 50.75 (b) and (c). | \$ 309.59 million ⁽¹⁾⁽³⁾ |
| | Decommissioning cost estimate escalated at 3.0% per year to the midpoint of decommissioning (December 2016). | \$ 441.40 million |
| 2. | Amount accumulated to the end of the calendar year preceding the date of the report (December 31, 2004). | \$ 227.43 million ⁽²⁾ |
| | Fund balance with 5.0% annual growth to the midpoint of decommissioning (December 2016). | \$ 408.43 million |
| 3. | A schedule of the annual amounts remaining to be collected. | None. |
| 4. | Assumptions used in determining rates of escalation in decommissioning costs, rates of earnings on decommissioning funds, and rates of other factors used in funding projections. | Escalation rate: 3.0%
Rate of earnings: 5.0% |
| 5. | Any contracts upon which the licensee is relying pursuant to 10 CFR 50.75(e)(1)(v). | None. |
| 6. | Modifications occurring to a licensee's current method of providing financial assurance since the last submitted report. | None. |
| 7. | Any material changes to trust agreements. | None. |

Attachment 1 to BNY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

Entergy Nuclear Operations, Inc.
Status of Decommissioning Funding
For Year Ending December 31, 2004 – 10 CFR 50.75(f)(1)

Plant Name: Indian Point Nuclear Generating Unit No. 2

- | | | |
|----|---|---|
| 1. | Amount of decommissioning funds estimated to be required pursuant to 10 CFR 50.75 (b) and (c). | \$ 373.79 million ⁽¹⁾ |
| | Decommissioning cost estimate escalated at 3.0% per year to the midpoint of decommissioning (December 2016). | \$ 532.94 million |
| 2. | Amount accumulated to the end of the calendar year preceding the date of the report (December 31, 2004). | \$ 272.04 million ⁽²⁾ |
| | Fund balance with 5.0% annual growth to the midpoint of decommissioning (December 2016). | \$ 488.54 million |
| 3. | A schedule of the annual amounts remaining to be collected. | None. |
| 4. | Assumptions used in determining rates of escalation in decommissioning costs, rates of earnings on decommissioning funds, and rates of other factors used in funding projections. | Escalation rate: 3.0%
Rate of earnings: 5.0% |
| 5. | Any contracts upon which the licensee is relying pursuant to 10 CFR 50.75(e)(1)(v). | None. |
| 6. | Modifications occurring to a licensee's current method of providing financial assurance since the last submitted report. | None. |
| 7. | Any material changes to trust agreements. | None. |

Attachment 1 to BNY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

Entergy Nuclear Operations, Inc.
Status of Decommissioning Funding
For Year Ending December 31, 2004 – 10 CFR 50.75(f)(1)

Plant Name: Indian Point Nuclear Generating Unit No. 3

- | | | |
|----|---|---|
| 1. | Amount of decommissioning funds estimated to be required pursuant to 10 CFR 50.75 (b) and (c). | \$ 369.06 million ⁽¹⁾ |
| | Decommissioning cost estimate escalated at 3.0% per year to the midpoint of decommissioning (December 2018). | \$ 558.24 million |
| 2. | Amount accumulated to the end of the calendar year preceding the date of the report (December 31, 2004). | \$ 393.00 million |
| | Fund balance with 5.0% annual growth to the midpoint of decommissioning (December 2018). | \$ 778.11 million |
| 3. | A schedule of the annual amounts remaining to be collected. | None. |
| 4. | Assumptions used in determining rates of escalation in decommissioning costs, rates of earnings on decommissioning funds, and rates of other factors used in funding projections. | Escalation rate: 3.0%
Rate of earnings: 5.0% |
| 5. | Any contracts upon which the licensee is relying pursuant to 10 CFR 50.75(e)(1)(v). | None. |
| 6. | Modifications occurring to a licensee's current method of providing financial assurance since the last submitted report. | None. |
| 7. | Any material changes to trust agreements. | None. |

Attachment 1 to BVY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

Entergy Nuclear Operations, Inc.
Status of Decommissioning Funding
For Year Ending December 31, 2004 – 10 CFR 50.75(f)(1)

Plant Name: Vermont Yankee Nuclear Power Station

- | | | |
|----|---|---|
| 1. | Amount of decommissioning funds estimated to be required pursuant to 10 CFR 50.75 (b) and (c). | \$ 412.60 million ^{D1} |
| | Decommissioning cost estimate escalated at 3.0% per year to the midpoint of decommissioning (December 2015). | \$ 571.13 million |
| 2. | Amount accumulated to the end of the calendar year preceding the date of the report (December 31, 2004). | \$ 372.80 million |
| | Fund balance with 5.0% annual growth to the midpoint of decommissioning (December 2015). | \$ 637.61 million |
| 3. | A schedule of the annual amounts remaining to be collected. | None. |
| 4. | Assumptions used in determining rates of escalation in decommissioning costs, rates of earnings on decommissioning funds, and rates of other factors used in funding projections. | Escalation rate: 3.0%
Rate of earnings: 5.0% |
| 5. | Any contracts upon which the licensee is relying pursuant to 10 CFR 50.75(e)(1)(v). | None. |
| 6. | Modifications occurring to a licensee's current method of providing financial assurance since the last submitted report. | None. |
| 7. | Any material changes to trust agreements. | None. |

Attachment 1 to BVY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

**Entergy Nuclear Operations, Inc.
Status of Decommissioning Funding
For Year Ending December 31, 2004 - 10 CFR 50.75(f)(1)**

Plant Name: Pilgrim Nuclear Power Station

- | | | |
|----|---|--|
| 1. | Amount of decommissioning funds estimated to be required pursuant to 10 CFR 50.75 (b) and (c). | \$ 426.25 million ⁽¹⁾ |
| | Decommissioning cost estimate escalated at 3.0% per year to the midpoint of decommissioning (December 2015). | \$ 590.03 million |
| 2. | Amount accumulated to the end of the calendar year preceding the date of the report (December 31, 2004). | \$ 528.74 million |
| | Fund balance with 5.0% annual growth to the midpoint of decommissioning (December 2015). | \$ 904.32 million |
| 3. | A schedule of the annual amounts remaining to be collected. | None. |
| 4. | Assumptions used in determining rates of escalation in decommissioning costs, rates of earnings on decommissioning funds, and rates of other factors used in funding projections. | Escalation rate: 3.0%
Rate of earnings: 5.0% |
| 5. | Any contracts upon which the licensee is relying pursuant to 10 CFR 50.75(e)(1)(v). | None. |
| 6. | Modifications occurring to a licensee's current method of providing financial assurance since the last submitted report. | None. [see item 7] |
| 7. | Any material changes to trust agreements. | In March 2003, Mellon Bank, the trustee of the Pilgrim Provisional Decommissioning Trust was given direction to contribute all assets remaining in the Provisional Trust to the non-qualified fund of the Pilgrim Master Trust. Later that month, Mellon Bank transferred approximately \$30 million of assets as directed. The Pilgrim Provisional Trust was then terminated. |

Attachment 1 to BVY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

Entergy Nuclear Operations, Inc.
Status of Decommissioning Funding
For Year Ending December 31, 2004 – 10 CFR 50.75(f)(1)

Plant Name: James A. Fitzpatrick Nuclear Power Plant

- | | | |
|----|---|---|
| 1. | Amount of decommissioning funds estimated to be required pursuant to 10 CFR 50.75 (b) and (c). | \$ 442.19 million ⁽¹⁾ |
| | Decommissioning cost estimate escalated at 3.0% per year to the midpoint of decommissioning (December 2017). | \$ 649.37 million |
| 2. | Amount accumulated to the end of the calendar year preceding the date of the report (December 31, 2004). | \$ 428.80 million |
| | Fund balance with 5.0% annual growth to the midpoint of decommissioning (December 2017). | \$ 808.57 million |
| 3. | A schedule of the annual amounts remaining to be collected. | None. |
| 4. | Assumptions used in determining rates of escalation in decommissioning costs, rates of earnings on decommissioning funds, and rates of other factors used in funding projections. | Escalation rate: 3.0%
Rate of earnings: 5.0% |
| 5. | Any contracts upon which the licensee is relying pursuant to 10 CFR 50.75(e)(1)(v). | None. |
| 6. | Modifications occurring to a licensee's current method of providing financial assurance since the last submitted report. | None. |
| 7. | Any material changes to trust agreements. | None. |

Attachment 1 to BNY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023**Entergy Nuclear Operations, Inc.
Status of Decommissioning Funding
For Year Ending December 31, 2004 - 10 CFR 50.75(f)(1)****Notes:**

- [1] The calculation of the NRC minimum value is provided in Attachment 2.
- [2] The current fund balances for Indian Point 1 and 2 do not include an additional \$25.91 million available in the provisional fund.
- [3] In accordance with 10 CFR 50.75(c)(1)(1) PWR reactors below 1200 MWt are to use this minimum value. Indian Point 1 had a thermal power level of 615 MWt. (Refer to Attachment 3, pg. 15, of June 8, 2001 letter, M. R. Kansler to USNRC regarding "Response to June 5, 2001 Letter, Indian Point Nuclear Generating Unit Nos. 1 and 2, Transfer of Facility Operating License (TAC Nos. MB0743 and MB0744).")

Attachment 2 to BVI-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

**Entergy Nuclear Operations, Inc.
NRC Minimum Funding Calculation (10 CFR 50.75(c))
For Year Ending December 31, 2004**

Plant Name: Indian Point Nuclear Generating Unit No. 1

Inputs:

Plant Characteristics

Plant Type (PWR or BWR)	PWR
Region	NE (Northeast)
Rated (in MWt) ⁽¹⁾	615
Year	2004
Waste Vendor Used (Yes/No)	Yes
Burial Site	South Carolina
Atlantic Compact Member (Yes/No)	No

Producer Price Index

wpu0543 (industrial electric power)	147.9 (December 2004)
wpu0573 (light fuel oils)	133.4

Labor Adjustment Factors

ecu13102i (Northeast)	174.2 (4th Quarter, 2004)
-----------------------	---------------------------

Burial Site Adjustments (South Carolina/non-Atlantic Compact Member)

PWR - direct disposal	18.732 (NUREG-1307, Rev. 10)
PWR - w/waste vendors	9.467

Adjustment Factors

Energy (E)	1.434
Labor (L)	2.076
Burial (B)	9.467

Minimum Amount (millions, \$1986)	\$85.56 (size adjusted for megawatts)
Escalation Factor (L, E, B)	3.618 (65% L, 13% E, 22% B)

NRC Minimum (millions, \$2004)

\$309.59

w/waste vendor

[1] In accordance with 10 CFR 50.75(c)(1)(1) PWR reactors below 1200 MWt are to use this minimum value. Indian Point 1 had a thermal power level of 815 MWt. (Refer to Attachment 3, pg. 15, of June 8, 2001 letter, M. R. Kansler to USNRC regarding "Response to June 5, 2001 Letter, Indian Point Nuclear Generating Unit Nos. 1 and 2, Transfer of Facility Operating License (TAC Nos. MB0743 and MB0744).")

Attachment 2 to BVY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

**Entergy Nuclear Operations, Inc.
NRC Minimum Funding Calculation (10 CFR 50.75(c))
For Year Ending December 31, 2004**

Plant Name: **Indian Point Nuclear Generating Unit No. 2****Inputs:**Plant Characteristics

Plant Type (PWR or BWR)	PWR
Region	NE (Northeast)
Rated (in MWt)	3216
Year	2004
Waste Vendor Used (Yes/No)	Yes
Burial Site	South Carolina
Atlantic Compact Member (Yes/No)	No

Producer Price Index

wpu0543 (industrial electric power)	147.9 (December 2004)
wpu0573 (light fuel oils)	133.4

Labor Adjustment Factors

ecu13102i (Northeast)	174.2 (4th Quarter, 2004)
-----------------------	---------------------------

Burial Site Adjustments (South Carolina/non-Atlantic Compact Member)

PWR - direct disposal	18.732 (NUREG-1307, Rev. 10)
PWR - w/waste vendors	9.467

Adjustment Factors

Energy (E)	1.434
Labor (L)	2.076
Burial (B)	9.467

Minimum Amount (millions, \$1986)	\$103.30 (size adjusted for megawatts)
Escalation Factor (L, E, B)	3.618 (65% L, 13% E, 22% B)

NRC Minimum (millions, \$2004)

\$373.79

w/waste vendor

Attachment 2 to BVY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

**Entergy Nuclear Operations, Inc.
NRC Minimum Funding Calculation (10 CFR 50.75(c))
For Year Ending December 31, 2004**

Plant Name: Indian Point Nuclear Generating Unit No. 3

Inputs:

Plant Characteristics

Plant Type (PWR or BWR)	PWR
Region	NE (Northeast)
Rated (in MWt)	3067.4
Year	2004
Waste Vendor Used (Yes/No)	Yes
Burial Site	South Carolina
Atlantic Compact Member (Yes/No)	No

Producer Price Index

wpu0543 (industrial electric power)	147.9 (December 2004)
wpu0573 (light fuel oils)	133.4

Labor Adjustment Factors

ecu13102i (Northeast)	174.2 (4th Quarter, 2004)
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Burial Site Adjustments (South Carolina/non-Atlantic Compact Member)

PWR - direct disposal	18.732 (NUREG-1307, Rev. 10)
PWR - w/waste vendors	9.467

Adjustment Factors

Energy (E)	1.434
Labor (L)	2.076
Burial (B)	9.467

Minimum Amount (millions, \$1986)	\$101.99 (size adjusted for megawatts)
Escalation Factor (L, E, B)	3.618 (65% L, 13% E, 22% B)

NRC Minimum (millions, \$2004)

\$369.06

w/waste vendor

Attachment 2 to BVY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

**Entergy Nuclear Operations, Inc.
NRC Minimum Funding Calculation (10 CFR 50.75(c))
For Year Ending December 31, 2004**

Plant Name: Vermont Yankee Nuclear Power Station

Inputs:

Plant Characteristics

Plant Type (PWR or BWR)	BWR
Region	NE (Northeast)
Rated (in MWt)	1593
Year	2004
Waste Vendor Used (Yes/No)	Yes
Burial Site	South Carolina
Atlantic Compact Member (Yes/No)	No

Producer Price Index

wpu0543 (industrial electric power)	147.9 (December 2004)
wpu0573 (light fuel oils)	133.4

Labor Adjustment Factors

ecu13102i (Northeast)	174.2 (4th Quarter, 2004)
-----------------------	---------------------------

Burial Site Adjustments (South Carolina/non-Atlantic Compact Member)

BWR - direct disposal	16.705 (NUREG-1307, Rev. 10)
BWR - w/waste vendors	8.860

Adjustment Factors

Energy (E)	1.448
Labor (L)	2.076
Burial (B)	8.860

Minimum Amount (millions, \$1986)	\$118.34 (size adjusted for megawatts)
Escalation Factor (L, E, B)	3.487 (65% L, 13% E, 22% B)

NRC Minimum (millions, \$2004)

\$412.60

w/waste vendor

Attachment 2 to BVY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

**Entergy Nuclear Operations, Inc.
NRC Minimum Funding Calculation (10 CFR 50.75(c))
For Year Ending December 31, 2004**

Plant Name: **Pilgrim Nuclear Power Station**

Inputs:

Plant Characteristics

Plant Type (PWR or BWR)	BWR
Region	NE (Northeast)
Rated (in MWt)	2028
Year	2004
Waste Vendor Used (Yes/No)	Yes
Burial Site	South Carolina
Atlantic Compact Member (Yes/No)	No

Producer Price Index

wpu0543 (industrial electric power)	147.9 (December 2004)
wpu0573 (light fuel oils)	133.4

Labor Adjustment Factors

ecu13102i (Northeast)	174.2 (4th Quarter, 2004)
-----------------------	---------------------------

Burial Site Adjustments (South Carolina/non-Atlantic Compact Member)

BWR - direct disposal	16.705 (NUREG-1307, Rev. 10)
BWR - w/waste vendors	8.860

Adjustment Factors

Energy (E)	1.448
Labor (L)	2.076
Burial (B)	8.860

Minimum Amount (millions, \$1986)	\$122.25 (size adjusted for megawatts)
Escalation Factor (L, E, B)	3.487 (65% L, 13% E, 22% B)

NRC Minimum (millions, \$2004)

\$426.25

w/waste vendor

Attachment 2 to BVY-05-033, NL-05-039, JPN-05-005, ENO Ltr. 2.05.023

**Entergy Nuclear Operations, Inc.
NRC Minimum Funding Calculation (10 CFR 50.75(c))
For Year Ending December 31, 2004**

Plant Name: James A. Fitzpatrick Nuclear Power Plant

Inputs:

Plant Characteristics

Plant Type (PWR or BWR)	BWR
Region	NE (Northeast)
Rated (In MWt)	2538
Year	2004
Waste Vendor Used (Yes/No)	Yes
Burial Site	South Carolina
Atlantic Compact Member (Yes/No)	No

Producer Price Index

wpu0543 (industrial electric power)	147.9 (December 2004)
wpu0573 (light fuel oils)	133.4

Labor Adjustment Factors

ecu13102i (Northeast)	174.2 (4th Quarter, 2004)
-----------------------	---------------------------

Burial Site Adjustments (South Carolina/non-Atlantic Compact Member)

BWR - direct disposal	16.705 (NUREG-1307, Rev. 10)
BWR - w/waste vendors	8.860

Adjustment Factors

Energy (E)	1.448
Labor (L)	2.076
Burial (B)	8.860

Minimum Amount (millions, \$1986)	\$126.82 (size adjusted for megawatts)
Escalation Factor (L, E, B)	3.487 (65% L, 13% E, 22% B)

NRC Minimum (millions, \$2004)

\$442.19

w/waste vendor

EXHIBIT Y

EXHIBIT Z

[Federal Register: August 1, 2007 (Volume 72, Number 147)]
[Notices]
[Page 42134-42135]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr01au07-109]

NUCLEAR REGULATORY COMMISSION

[Docket Nos. 50-247 and 50-286]

Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit Nos. 2 and 3; Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License Nos. DPR-26 and DPR-64 for an Additional 20-Year Period

The U.S. Nuclear Regulatory Commission (NRC or the Commission) is considering an application for the renewal of Operating License Nos. DPR-26 and DPR-64, which authorize Entergy Nuclear Operations, Inc., to operate Indian Point Nuclear Generating Unit Nos. 2 and 3, respectively, at 3216 megawatts thermal (MWT) for each unit. The renewed licenses would authorize the applicant to operate Indian Point Nuclear Generating Unit Nos. 2 and 3 for an additional 20 years beyond the period specified in the current licenses. The current operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3 expire on September 9, 2013, and December 12, 2015, respectively.

Entergy Nuclear Operations, Inc. submitted the application dated April 23, 2007, as supplemented by letters dated May 3, 2007, and June 21, 2007, pursuant to 10 CFR Part 54, to renew Operating License Nos. DPR-26 and DPR-64 for Indian Point Nuclear Generating Unit Nos. 2 and 3, respectively. A Notice of Receipt and Availability of the license renewal application (LRA), "Entergy Nuclear Operations, Inc.; Notice of Receipt and Availability of Application for Renewal of Indian Point Nuclear Generating Unit Nos. 2 and 3; Facility Operating Licenses Nos. DPR-26 and DPR-64 for an Additional 20-Year Period," was published in the Federal Register on May 11, 2007 (72 FR 26850).

The Commission's staff has determined that Entergy Nuclear Operations, Inc. has submitted sufficient information in accordance with 10 CFR Sections 54.19, 54.21, 54.22, 54.23, 51.45, and 51.53(c) to enable the staff to undertake a review of the application, and the application is therefore acceptable for docketing. The current Docket Nos. 50-247 and 50-286 for Operating License Nos. DPR-26 and DPR-64, respectively, will be retained. The determination to accept the license renewal application for docketing does not constitute a determination that a renewed license should be issued, and does not preclude the NRC staff from requesting additional information as the review proceeds.

Before issuance of each requested renewed license, the NRC will have made the findings required by the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations. In accordance with 10 CFR 54.29, the NRC may issue a renewed license on the basis of its review if it finds that actions have been identified and have been or will be taken with respect to: (1) Managing the effects of aging during the period of extended operation on the functionality of structures and components that have been identified as requiring aging management review, and (2) time-limited aging analyses that have been identified as requiring review, such that there is reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the current licensing basis (CLB), and that any changes made to the plant's CLB comply with the Act and the Commission's regulations.

Additionally, in accordance with 10 CFR 51.95(c), the NRC will prepare an environmental impact statement that is a supplement to the Commission's NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants," dated May 1996. In considering the license renewal application, the Commission must find that the applicable requirements of Subpart A of 10 CFR Part 51 have been satisfied. Pursuant to 10 CFR 51.26, and as part of the environmental scoping process, the staff intends to hold a public scoping meeting. Detailed information regarding the environmental scoping meeting will be the subject of a separate Federal Register notice.

Within 60 days after the date of publication of this Federal Register Notice, any person whose interest may be affected by this proceeding and who wishes to participate as a party in the proceeding must file a written request for a hearing or a petition for leave to intervene with respect to the renewal of the license. Requests for a hearing or petitions for leave to intervene must be filed in accordance with the Commission's "Rules of Practice for Domestic Licensing Proceedings" in 10 CFR Part 2. Interested persons should consult a current copy of 10 CFR 2.309, which is available at the Commission's Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland 20852 and is accessible from the NRC's Agencywide Documents Access and Management

System (ADAMS) Public Electronic Reading Room on the Internet at <http://www.nrc.gov/reading-rm/adams.html>.
Persons who do not have access to

ADAMS or who encounter problems in accessing the documents located in ADAMS should contact the NRC's PDR reference staff by telephone at 1-800-397-4209 or 301-415-4737, or by e-mail at pdr@nrc.gov. If a request for a hearing/petition for leave to intervene is filed within the 60-day period, the Commission or a presiding officer designated by the Commission or by the Chief Administrative Judge of the Atomic Safety and Licensing Board Panel will rule on the request and/or petition; and the Secretary or the Chief Administrative Judge of the Atomic Safety and Licensing Board will issue a notice of a hearing or an appropriate order. In the event that no request for a hearing or petition for leave to intervene is filed within the 60-day period, the NRC may, upon completion of its evaluations and upon making the findings required under 10 CFR Parts 51 and 54, renew the license without further notice.

As required by 10 CFR 2.309, a petition for leave to intervene shall set forth with particularity the interest of the petitioner in the proceeding, and how that interest may be affected by the results of the proceeding, taking into consideration the limited scope of matters that may be considered pursuant to 10 CFR Parts 51 and 54. The petition must specifically explain the

[[Page 42135]]

reasons why intervention should be permitted with particular reference to the following factors: (1) The nature of the requestor's/petitioner's right under the Act to be made a party to the proceeding; (2) the nature and extent of the requestor's/petitioner's property, financial, or other interest in the proceeding; and (3) the possible effect of any decision or order which may be entered in the proceeding on the requestor's/petitioner's interest. The petition must also set forth the specific contentions which the petitioner/requestor seeks to have litigated in the proceeding.

Each contention must consist of a specific statement of the issue of law or fact to be raised or controverted. In addition, the requestor/petitioner shall provide a brief explanation of the bases of each contention and a concise statement of the alleged facts or the expert opinion that supports the contention on which the requestor/petitioner intends to rely in proving the contention at the hearing. The requestor/petitioner must also provide references to those specific sources and documents of which the requestor/petitioner is aware and on which the requestor/petitioner intends to rely to establish those facts or expert opinion. The requestor/petitioner must provide sufficient information to show that a genuine dispute exists with the applicant on a material issue of law or fact. \1\ Contentions shall be limited to matters within the scope of the action under consideration. The contention must be one that, if proven, would entitle the requestor/petitioner to relief. A requestor/petitioner who fails to satisfy these requirements with respect to at least one contention will not be permitted to participate as a party.

\1\ To the extent that the application contains attachments and supporting documents that are not publicly available because they are asserted to contain safeguards or proprietary information, petitioners desiring access to this information should contact the applicant or applicant's counsel to discuss the need for a protective order.

The Commission requests that each contention be given a separate numeric or alpha designation within one of the following groups: (1) Technical (primarily related to safety concerns); (2) environmental; or (3) miscellaneous.

As specified in 10 CFR 2.309, if two or more requestors/petitioners seek to co-sponsor a contention or propose substantially the same contention, the requestors/petitioners will be required to jointly designate a representative who shall have the authority to act for the requestors/petitioners with respect to that contention.

Those permitted to intervene become parties to the proceeding, subject to any limitations in the order granting leave to intervene, and have the opportunity to participate fully in the conduct of the hearing. A request for a hearing or a petition for leave to intervene must be filed by: (1) First class mail addressed to the Office of the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, Attention: Rulemaking and Adjudications Staff; (2) courier, express mail, and expedited delivery services to the Office of the Secretary, Sixteenth Floor, One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, Attention: Rulemaking and Adjudications Staff; (3) E-mail addressed to the Office of the Secretary, U.S. Nuclear Regulatory Commission, HEARINGDOCKET@NRC.GOV; or (4) facsimile transmission addressed to the Office of the Secretary, U.S. Nuclear Regulatory Commission, Washington, DC., Attention: Rulemaking and Adjudications Staff at 301-415-1101 (verification number: 301-415-1966). \2\ A copy of the request for hearing or petition for leave to intervene must also be sent to the Office of the General Counsel, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, and it is requested that copies be transmitted either by means of

facsimile transmission to 301-415-3725 or by e-mail to OGCMailCenter@nrc.gov. A copy of the request for hearing or petition

for leave to intervene should also be sent to the Assistant General Counsel, Entergy Nuclear Operations, Inc., 440 Hamilton Avenue, White Plains, NY 10601.

\2\ If the request/petition is filed by e-mail or facsimile, an original and two copies of the document must be mailed within 2 (two) business days thereafter to the Secretary, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; Attention: Rulemaking and Adjudications Staff.

Non-timely requests and/or petitions and contentions will not be entertained absent a determination by the Commission, the presiding officer, or the Atomic Safety and Licensing Board that the petition, request and/or contentions should be granted based on a balancing of the factors specified in 10 CFR 2.309(a)(1)(i)-(viii).

Detailed information about the license renewal process can be found under the Nuclear Reactors icon at <http://www.nrc.gov/reactors/operating/licensing/renewal.html> on the NRC's Web site. Copies of the

application to renew the operating licenses for Indian Point Nuclear Generating Unit Nos. 2 and 3, are available for public inspection at the Commission's PDR, located at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland 20852-2738, and at <http://www.nrc.gov/reactors/operating/licensing/renewal/applications.html>, the

NRC's Web site while the application is under review. The application may be accessed in ADAMS through the NRC's Public Electronic Reading Room on the Internet at <http://www.nrc.gov/reading-rm/adams.html> under

ADAMS Accession Numbers ML071210507, ML071280700, and ML071800318. As stated above, persons who do not have access to ADAMS or who encounter problems in accessing the documents located in ADAMS may contact the NRC Public Document Room (PDR) Reference staff by telephone at 1-800-397-4209 or 301-415-4737, or by e-mail to pdr@nrc.gov.

The NRC staff has verified that a copy of the license renewal application is also available to local residents near Indian Point Nuclear Generating Unit Nos. 2 and 3 at the White Plains Public Library, 100 Martine Avenue, White Plains, NY 10601; the Field Library, 4 Nelson Avenue, Peekskill, NY 10566; and the Hendrick Hudson Free Library, 185 Kings Ferry Road, Montrose, NY 10548.

Dated at Rockville, Maryland, this 25th day of July, 2007.

For The Nuclear Regulatory Commission.

Pao-Tsin Kuo,
Director, Division of License Renewal, Office of Nuclear Reactor Regulation.

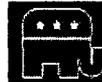
[FR Doc. E7-14864 Filed 7-31-07; 8:45 am]

BILLING CODE 7590-01-P

EXHIBIT AA



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Introduced: Feb 12, 2007

Status: **Introduced**Sponsor:
Rep. John Hall [D-NY][Legislation](#) > 2007-2008 (110th Congress) > [H.R. 994](#)

H.R. 994: To require the Nuclear Regulatory Commission to conduct an Independent Safety Assessment of the...

HR 994 IH

110th CONGRESS

1st Session

H. R. 994

To require the Nuclear Regulatory Commission to conduct an Independent Safety Assessment of the Indian Point Energy Center.

IN THE HOUSE OF REPRESENTATIVES

February 12, 2007

Mr. HALL of New York (for himself, Mr. HINCHEY, Mr. ENGEL, Mrs. LOWEY, and Mr. SHAYS) introduced the following bill; which was referred to the Committee on Energy and Commerce

A BILL

To require the Nuclear Regulatory Commission to conduct an Independent Safety Assessment of the Indian Point Energy Center.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. INDEPENDENT SAFETY ASSESSMENT.

Not later than 6 months after the date of enactment of this Act, the Nuclear Regulatory Commission shall transmit to the Congress a report containing the results of--

(1) a focused, in-depth Independent Safety Assessment of the design, construction, maintenance, and operational safety performance of the systems at the Indian Point Energy Center, Units 2 and 3, located in Westchester County, New York, including the systems described in section 2; and

(2) a comprehensive evaluation of the radiological emergency plan for Indian Point Energy Center, Units 2 and 3, conducted by the Nuclear Regulatory Commission and the Department of Homeland Security, which shall include--

(A) a detailed explanation of the factual basis upon which the Nuclear Regulatory Commission and the Federal Emergency Management Agency relied in--

(i) approving the radiological emergency plan; and

(ii) making subsequent annual findings of reasonable assurance that the plan will adequately protect the public in the event of an emergency, beginning on July 25, 2003 and continuing to the present;

(B) a detailed response to each of the criticisms of the radiological emergency plan contained in the Review of Emergency Preparedness of Areas Adjacent to Indian Point and Millstone, published by James Lee Witt Associates on January 10, 2003; and

(C) a detailed explanation of what criteria the Nuclear Regulatory Commission and Department of Homeland Security use in determining whether or not reasonable assurance can be provided that the radiological emergency plan is adequate to protect public health and safety, including what threshold figures of injuries and fatalities these agencies consider acceptable or tolerable in the event of a nuclear accident.

SEC. 2. SYSTEMS.

The systems referred to in section 1(1) are the following:

- (1) The reactor protection system.
- (2) The control room ventilation system and the containment ventilation system.
- (3) The 4.16 kv electrical system.
- (4) The condensate system.
- (5) The spent fuel storage systems.

SEC. 3. INDEPENDENT SAFETY ASSESSMENT TEAM.

The Independent Safety Assessment conducted at Indian Point Nuclear Power Plant shall be conducted by an Independent Safety Assessment Team with 25 members, comprised of--

- (1) 16 members from the Nuclear Regulatory Commission who are unaffiliated with the Nuclear Regulatory Commission Region 1 office or the Nuclear Regulatory Commission Office of Nuclear Reactor Regulation;
- (2) 6 independent contractors with no history of having worked for or at the Indian Point Energy Center or any other nuclear power plant owned or operated by Entergy Corporation;
- (3) the President of New York State Energy and Research Development Authority or his designee;
- (4) the Director of the Bureau of Hazardous Waste and Radiation Management, in the Division of Solid and Hazardous Materials of the New York State Department of Environmental Conservation, or his designee; and
- (5) a New York State-appointed independent contractor with experience in system engineering and no history of affiliation with any nuclear power plant owned by Entergy Corporation.

SEC. 4. INDEPENDENT SAFETY ASSESSMENT MONITORING.

The Independent Safety Assessment conducted at Indian Point Nuclear Energy Center shall be monitored by--

- (1) an Independent Safety Assessment Observation Group comprised of 4 officials appointed by the State of New York; and
- (2) an Independent Safety Assessment Citizens' Review Team comprised of 5 individuals appointed by the State of New York, with one resident from each Emergency Planning Zone county (Westchester, Rockland, Putnam, and Orange) appointed in consultation with the respective County Executive.

The Independent Safety Assessment Observation Group and Independent Safety Assessment Citizens' Review Team shall frequently provide publicly available updates on the progress and conduct of the Independent Security Assessment to the Governor of New York.

SEC. 5. INDEPENDENT SAFETY ASSESSMENT MODEL.

The Independent Safety Assessment conducted at Indian Point Energy Center shall be equal in scope, depth, and breadth to the Independent Safety Assessment of the Maine Yankee Nuclear Power Plant, located near Bath, Maine, conducted by the Nuclear Regulatory Commission in 1996.

SEC. 6. INCORPORATION INTO RELICENSING PROCESS.

The final decision by the Nuclear Regulatory Commission as to whether to renew the operating licenses for Unit 2 or Unit 3 at the Indian Point Energy Center shall not be made until--

- (1) the Nuclear Regulatory Commission has fully entered the complete report and findings of the Independent Safety Assessment into the administrative record of the license renewal proceeding for Unit 2 and Unit 3 at the Indian Point Energy Center; and
- (2) the applicant has fully accepted and implemented all findings and recommendations of the Independent Safety Assessment, including--
 - (A) undertaking all recommended repairs;
 - (B) replacement of safety-related equipment;
 - (C) changes to monitoring plans; and
 - (D) revision of the radiological emergency preparedness plans as called for in the report.

The applicant shall not be allowed to operate the reactors past the expiration date of its current operating licenses for Unit 2 and Unit 3 through administrative license renewals or any other means prior to meeting the requirements in paragraph (1) and paragraph (2) of this section.

SEC. 7. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated to the Nuclear Regulatory Commission to carry out this Act \$10,000,000 for fiscal year 2008, to remain available until expended.

EXHIBIT BB

August 14, 2007 - 72 FR 45466-45467 - NUCLEAR REGULATORY COMMISSION -
Notice of Availability of the Final License Renewal Interim Staff Guidance LR-ISG-2006-03: Staff Guidance for Preparing Severe Accident Mitigation Alternatives Analyses - NRC is issuing its Final License Renewal Interim Staff Guidance LR-ISG-2006-03 for preparing severe accident mitigation alternatives (SAMA) analyses. This LR-ISG recommends that applicants for license renewal use the Guidance Document Nuclear Energy Institute 05-01, Revision A, (ADAMS Accession No. ML060530203) when preparing their SAMA analyses. The NRC staff issues LR-ISGs to facilitate timely implementation of the license renewal rule and to review activities associated with a license renewal application. The NRC staff will also incorporate the approved LR-ISG into the next revision of Supplement 1 to Regulatory Guide 4.2, "Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses."

EXHIBIT CC

PC

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

May 2, 2003

**NRC REGULATORY ISSUE SUMMARY 2003-09
ENVIRONMENTAL QUALIFICATION OF LOW-VOLTAGE
INSTRUMENTATION AND CONTROL CABLES**

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

INTENT

The U.S. Nuclear Regulatory Commission (NRC) is issuing this regulatory issue summary (RIS) to inform addressees of the results of the technical assessment of GSI-168, "Environmental Qualification of Low-Voltage Instrumentation and Control (I&C) Cables." The scope of GSI-168 is limited to safety-related, low-voltage I&C cables. This RIS requires no action or written response on the part of an addressee.

BACKGROUND

In support of the resolution of GSI-168, the NRC sponsored cable test research at Wyle Laboratories and the Brookhaven National Laboratory. The resulting NRC technical assessment was essentially based on reviews and analyses of the research results of six loss-of-coolant-accident (LOCA) cable tests, condition-monitoring tests on I&C cables, and information provided by the nuclear industry. Technical assessments were coordinated with the nuclear industry and the Institute of Electrical and Electronics Engineers.

Following the completion of the NRC research effort, the staff concluded that typical I&C cable qualification test programs include numerous conservative practices that collectively provide a high level of confidence that the installed I&C cables will perform their intended functions during and following design basis events as required by 10 CFR 50.49, "Environmental Qualification (EQ) of Electric Equipment Important to Safety for Nuclear Power Plants." These conservative practices continue to support the current use of a single prototype during qualification testing and, therefore, a successful test provides a high level of confidence that these cables will be able to perform their safety functions during and following a design basis event. However, cable LOCA test failures that occurred during the NRC-sponsored research program indicate that in certain cases the original margin and conservatism inherent in the qualification process have been reduced. Licensees have stated in a few cases that a reduction in margin can be addressed by monitoring operating service environments (temperature, radiation, and humidity)

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to ensure that operating conditions do not exceed the parameters that were assumed during qualification testing. In this regard, walkdowns to look for any visible signs of anomalies attributable to aging, with particular emphasis on localized adverse environments, coupled with the knowledge of the operating service environments, could be sufficient to ensure that qualification is maintained.

DISCUSSION OF TECHNICAL ASSESSMENT

The technical assessment of GSI-168 is based on reviews and analyses of the research results of six LOCA tests, condition-monitoring tests on I&C cables, and information provided by the nuclear industry. Summaries of significant research findings are presented below. Details of the NRC technical assessment of GSI-168 are available in the NRC Agencywide Documents Access and Management System (ADAMS), Accession No. ML021790551.

Current EQ Process (40 Years)

The current EQ process is adequate for assuring that low-voltage I&C cables will perform their intended functions for 40 years. When I&C cables are qualified in accordance with NRC regulations, the overall EQ process provides reasonable assurance that I&C cables will perform their intended safety-related functions during their qualified life. Specifically, 10 CFR 50.49(e) requires consideration of all significant types of aging degradation that can affect the component's functional capability. Compliance with 10 CFR 50.49 provides reasonable assurance that the cables will perform their intended functions during and following design basis events after exposure to the effects of service condition aging. Further, some licensees have implemented monitoring programs to ensure that service conditions will not exceed those assumed during the original qualification. Inspection, surveillance, condition monitoring, and trending of selected parameters for any installed safety-related cable system could increase the confidence in cable performance.

EQ Process for License Renewal (60 Years)

Licensees that have addressed license renewal recognize that knowledge of the operating service environments is essential to extending the qualified life of I&C cables. Where measured environmental service conditions are less severe than those used in the original qualification and when the cables are not degraded, the licensees assessed the difference between the operating environment and the original qualification environment to extend the qualified life of the cables to 60 years by reanalysis. This approach, based on the Arrhenius methodology, has been found acceptable by the staff during its review of license renewal applications.

Results of Cable LOCA Tests

Detailed information on the six cable LOCA tests conducted at Wyle Laboratories is provided in NUREG/CR-6704, "Assessment of Environmental Qualification Practices and Condition Monitoring Techniques for Low-Voltage Electric Cables." It should be noted that the LOCA conditions selected for the simulated tests were consistent with those used in the original qualification of the cables. All cable specimens in Test Sequences 1, 2, and 3 passed the LOCA test and the voltage withstand test. Samuel Moore cable specimens failed the voltage withstand test during Test Sequence 4, and Okonite bonded-jacket cable specimens failed the

LOCA test and the voltage withstand test in Test Sequence 5. All of the Test Sequence 6 cable specimens, aged to 60 years, exhibited high leakage currents and several cable specimens failed the voltage withstand test. The summary results of the six test sequences are discussed in Attachment 1.

Research Findings on Cable Condition-Monitoring Techniques

NRC research results on I&C cables indicate that meaningful information can be derived from testing samples of polymeric materials under controlled laboratory conditions. With certain limitations (accessibility being the biggest limitation), some of these test results can be applied in the in situ assessment of installed cable systems. The research concluded that a combination of condition-monitoring techniques could be effective since no single technique is currently adequate to detect insulation degradation of I&C cables. Based on the test results, conclusions were drawn regarding the effectiveness of the techniques studied for monitoring cable condition and are presented in the attachment.

Industry Good Practices for Condition-Monitoring

During the NRC review of GSI-168, the industry stated that cable aging evaluations are ongoing throughout plant life. When unexpected localized adverse conditions are identified, the condition of the affected cables is evaluated and appropriate corrective action is taken. Monitoring or inspection of environmental conditions or component parameters was generally conducted to ensure that the component is within the bounds of its qualification basis. The combination of licensee-specific activities and industry-supported activities that were developed for condition-monitoring can support a high level of confidence that installed safety-related cables would remain qualified to perform their safety functions in the event of an accident. In addition, the nuclear industry continues to advance the state-of-the-art in cable condition-monitoring from the simplest techniques to the most sophisticated. The staff has concluded that, although a single reliable condition-monitoring technique does not currently exist, walkdowns to look for any visible signs of anomalies attributable to cable aging, coupled with monitoring of operating environments, have proven to be effective and useful.

Risk Assessment

The state-of-the-art for incorporating cable aging effects into probabilistic risk assessment is still evolving and current assumptions that need to be made on the failure rate and common cause effects are based on sparse data. One of the key assumptions of the risk assessment is that operating environments are less severe than or the same as those assumed during qualification testing. These assumptions can be relied upon provided licensees have ongoing knowledge of environmental operating conditions at the nuclear power plants.

SUMMARY OF ISSUE

The technical assessment of GSI-168 is complete and the research findings are published in NUREG/CR-6704, Vols. 1 and 2 (Accession Nos. ML010460247 and ML010510387). The significant research findings that resulted from this effort are as follows:

- The current equipment qualification process for low-voltage I&C cables is adequate for the duration of the current license term of 40 years.
- Because of the failures of some I&C cables in the NRC LOCA tests, the original margin and conservatism inherent in the qualification process have been reduced. Adequate margin may be ensured through ongoing monitoring of plant operating environments to confirm that service conditions do not exceed those assumed during qualification testing and the cables are within the bounds of their qualification basis.
- Walkdowns, with particular emphasis on the identification of localized adverse environments, to look for any visible signs of anomalies attributable to cable aging, coupled with the monitoring of operating environments, were proven to be effective and useful for ensuring qualification of cables.
- For license renewal, a reanalysis (based on the Arrhenius methodology) to extend the life of the cables by using the available margin based on a knowledge of the actual operating environment compared to the qualification environment, coupled with observations of the condition of the cables during walkdowns, was found to be an acceptable approach.
- A combination of condition-monitoring techniques may be needed since no single technique is currently demonstrated to be adequate to detect and locate degradation of I&C cables. Monitoring I&C cable condition could provide the basis for extending cable life.

BACKFIT DISCUSSION

This RIS requests no action or written response. Consequently, the staff did not perform a backfit analysis.

FEDERAL REGISTER NOTIFICATION

A notice of opportunity for public comment was not published in the *Federal Register* because this RIS is informational.

PAPERWORK REDUCTION ACT STATEMENT

This RIS does not request any information collection.

If there are any questions concerning this RIS, please contact the person noted below.

/RA/

William D. Beckner, Program Director
Operating Reactor Improvements Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Technical Contact: T. Koshy, NRR
301-415-1176
E-mail: txk@nrc.gov

Attachments:

1. Results of Cable LOCA Tests and Findings On Cable Condition-Monitoring Techniques
2. List of Recently Issued NRC Regulatory Issue Summaries

RESULTS OF CABLE LOCA TESTS AND FINDINGS ON CABLE CONDITION-MONITORING TECHNIQUES

CABLE LOCA TESTS

Detailed information on the six cable LOCA tests conducted at Wyle Laboratories is provided in NUREG/CR-6704, "Assessment of Environmental Qualification Practices and Condition Monitoring Techniques for Low-Voltage Electric Cables." It should be noted that the LOCA conditions selected for the simulated tests were consistent with those used in the original qualification of the cables. The summary results of the six test sequences are presented below.

Test Sequence 1: XLPE Insulated Cables Aged to 20 Years

The samples tested in this sequence were #14 and #16 American wire gauge (AWG) XLPE-insulated cables with a Neoprene overall outer jacket manufactured by Rockbestos, with the trade name "Firewall III." The preaging parameters for the four groups of specimens in this test sequence were as follows:

- Group 1: No accelerated aging (control specimens)
- Group 2: Accelerated aging to match naturally aged cable (2.86 hr @ 248 °F + 0.63 Mrad)
- Group 3: Naturally aged cable (10 years old)
- Group 4: Accelerated aging to 20 years (648.5 hr @ 302 °F + 26.1 Mrad)

The LOCA conditions simulated included exposure to 150 Mrad of accident radiation, followed by exposure to steam at high temperature and pressure (346 °F and 113 psig peak conditions, double-peak profile) and chemical spray. The test duration was 7 days. All cable specimens passed the LOCA test sequence, including the post-LOCA voltage withstand test.

Test Sequence 2. EPR-Insulated Cables Aged to 20 Years

The samples used in this sequence were three-conductor (3/C) and four-conductor (4/C) #16 AWG, 600v AIW cables with ethylene propylene (EPR) and unbonded chlorosulfonated polyethylene (CSPE, with the trade name Hypalon), covering the insulation of each conductor and the conductor bundle. The preaging parameters for the four groups of specimens in this test sequence were as follows:

- Group 1: No accelerated aging (control specimens)
- Group 2: Accelerated aging to match naturally aged cable (28.5 hr @ 250 °F + 3.3 Mrad)
- Group 3: Naturally aged cable (24 years old)
- Group 4: Accelerated aging to 20 years (82.2 hr @ 250 °F + 25.7 Mrad)

The LOCA conditions simulated included exposure to 150 Mrad of radiation followed by exposure to steam (340 °F and 60 psig peak conditions, single-peak profile) and chemical spray. The test duration was 7 days. All cable specimens passed the LOCA test sequence, including the post-LOCA voltage withstand test.

RESULTS OF CABLE LOCA TESTS AND FINDINGS ON CABLE CONDITION-MONITORING TECHNIQUES

CABLE LOCA TESTS

Detailed information on the six cable LOCA tests conducted at Wyle Laboratories is provided in NUREG/CR-6704, "Assessment of Environmental Qualification Practices and Condition Monitoring Techniques for Low-Voltage Electric Cables." It should be noted that the LOCA conditions selected for the simulated tests were consistent with those used in the original qualification of the cables. The summary results of the six test sequences are presented below.

Test Sequence 1: XLPE Insulated Cables Aged to 20 Years

The samples tested in this sequence were #14 and #16 American wire gauge (AWG) XLPE-insulated cables with a Neoprene overall outer jacket manufactured by Rockbestos, with the trade name "Firewall III." The preaging parameters for the four groups of specimens in this test sequence were as follows:

- Group 1: No accelerated aging (control specimens)
- Group 2: Accelerated aging to match naturally aged cable (2.86 hr @ 248 °F + 0.63 Mrad)
- Group 3: Naturally aged cable (10 years old)
- Group 4: Accelerated aging to 20 years (648.5 hr @ 302 °F + 26.1 Mrad)

The LOCA conditions simulated included exposure to 150 Mrad of accident radiation, followed by exposure to steam at high temperature and pressure (346 °F and 113 psig peak conditions, double-peak profile) and chemical spray. The test duration was 7 days. All cable specimens passed the LOCA test sequence, including the post-LOCA voltage withstand test.

Test Sequence 2. EPR-Insulated Cables Aged to 20 Years

The samples used in this sequence were three-conductor (3/C) and four-conductor (4/C) #16 AWG, 600v AIW cables with ethylene propylene (EPR) and unbonded chlorosulfonated polyethylene (CSPE, with the trade name Hypalon), covering the insulation of each conductor and the conductor bundle. The preaging parameters for the four groups of specimens in this test sequence were as follows:

- Group 1: No accelerated aging (control specimens)
- Group 2: Accelerated aging to match naturally aged cable (28.5 hr @ 250 °F + 3.3 Mrad)
- Group 3: Naturally aged cable (24 years old)
- Group 4: Accelerated aging to 20 years (82.2 hr @ 250 °F + 25.7 Mrad)

The LOCA conditions simulated included exposure to 150 Mrad of radiation followed by exposure to steam (340 °F and 60 psig peak conditions, single-peak profile) and chemical spray. The test duration was 7 days. All cable specimens passed the LOCA test sequence, including the post-LOCA voltage withstand test.

Test Sequence 3. XLPE-Insulated Cables Aged to 40 Years

The test specimens were cross-linked-polyethylene (XLPE)-insulated cables with a Neoprene overall outer jacket manufactured by Rockbestos, with the trade name "Firewall III." The preaging parameters for the four groups of specimens in this test sequence were as follows:

- Group 1. No accelerated aging (control specimens)
- Group 2. Accelerated aging to simulate the exposure of the naturally aged specimens (9.93 hr @ 248 °F + 2.27 Mrad)
- Group 3. Naturally aged 10-year-old cable
- Group 4. Accelerated aging to simulate 40 years of qualified life (1301.16 hr @ 302 °F + 51.49 Mrad)

The LOCA conditions simulated included exposure to 150 Mrad of accident radiation followed by exposure to steam (using the same LOCA profile as used in Test Sequence 1) and chemical spray.

One of the Group 4 specimens did not hold the full 500 volts used for insulation resistance (IR) testing even after its splices were removed. The cause of this failure was determined to be human error in handling the test specimen. With the exception of the damaged specimen, all cable specimens passed the LOCA test sequence, including the post-LOCA voltage withstand test.

Test Sequence 4. Multiconductor Cables

The objective of this test sequence was to determine whether multiconductor cables have any unique failure mechanisms that are not present in single-conductor cables. The test specimens were #12 AWG, 3/C, 1,000V EPR-insulated cables with individual and outer CSPE jackets manufactured by Anaconda. In addition, this test sequence included #16 AWG, 2/C, 600V Samuel Moore cables with ethylene propylene diene monomer (EPDM) insulation and a CSPE bonded individual jacket with a Dekorad overall outer jacket. The preaging groups in this test sequence were as follows:

- Group 1. Anaconda and Samuel Moore cables with no accelerated aging (control specimens)
- Group 2. Samuel Moore cables with accelerated aging to simulate 20 years of qualified life (84.85 hr @ 250 °F + 25.99 Mrad)
- Group 3. Anaconda cables (169.20 hr @ 302 °F + 53.60 Mrad) and Samuel Moore cables (169.05 hr @ 250 °F + 51.57 Mrad) with accelerated aging to simulate 40 years of qualified life.

The LOCA conditions simulated included exposure to 150 Mrad of accident radiation followed by steam (346 °F and 113 psig peak conditions, as used in Test Sequences 1 and 3) and chemical spray. During the post-LOCA voltage withstand test, all of the Anaconda cables and Samuel Moore cables aged to simulate 20 years performed acceptably. However, two out of three Samuel Moore specimens aged to simulate 40 years could not hold the 2,400V test voltage on one conductor. Inspection of the two specimens revealed a single pinhole in the insulation of each failed conductor. It was concluded that the failures were due to localized degradation of the insulation, which caused the high-potential test to puncture the insulation on

the two failed conductors. There was no general degradation of the insulation along the length of the cable specimens and no unique failure mechanism was observed between the single-conductor and multiconductor cables. Therefore, based on these test results, the issue of a unique failure mechanism for multiconductor vs. single-conductor low-voltage I&C cables was not demonstrated.

Test Sequence 5. Bonded Jacket Cables

The samples used in this sequence were Anaconda 3/C, #12AWG, 1,000V cables with EPR insulation and a CSPE jacket; Samuel Moore 2/C, #16 AWG, 600V cables with EPDM insulation and a CSPE jacket; and Okonite 1/C, #12 AWG, 600V cables with EPR insulation and a CSPE jacket. The preaging groups in this test sequence were as follows:

- Group 1. Specimens with no accelerated aging (control specimens)
- Group 2. Specimens from A, S, and O with accelerated aging to simulate 20 years of qualified life (A: 84 hr @ 302 °F + 25.69 Mrad; S: 84 hr @ 250 °F + 25.99Mrad; and O: 252 hr @ 302 °F + 25.79 Mrad)
- Group 3. Specimens from A, S, and O with accelerated aging to simulate 40 years of qualified life (A: 169 hr @ 302 °F + 51.35 Mrad; S: 169 hr @ 250 °F + 51.57 Mrad; and O: 504 hr @ 302 °F + 51.49 Mrad)

The LOCA conditions simulated included exposures to 150 Mrad of accident radiation, followed by steam (double-peak LOCA profile, as used in Test Sequences 1 and 3 with a test duration of 10 days) and chemical spray. After post-LOCA inspections, a voltage withstand test was conducted on each of the cable specimens. All of the Samuel Moore and Anaconda cables performed acceptably, while one of the two Okonite specimens in Group 2 and all 3 Okonite specimens in Group 3 failed the 2,400V voltage withstand test. It was observed that the insulation on the Okonite cables had split open along their length during the simulated LOCA, exposing the bare conductor underneath. It was concluded that the failures in the Okonite specimens were caused by differential swelling of the bonded CSPE individual jacket and the underlying EPR insulation.

The Okonite Company has subsequently requalified the 1/C, #12 AWG Okonite Okolon composite cable based on an Arrhenius activation energy of 1.24eV. Calculations using this activation energy (225 hr @ 150 °C + 200 Mrad and 300 hr @ 150 °C + 100 Mrad) extrapolate to a 40-year qualified life at 75 °C and 77 °C, respectively. Additional details of the recent Okonite cable requalification program are contained in Regulatory Issue Summary 2002-11 (ADAMS Accession No. ML022190099), issued August 9, 2002.

Test Sequence 6: EPR- and XLPE-Insulated Cables Aged to 60 Years

The test specimens were Rockbestos cables (same as Test Sequences 1 and 3), AIW cables (same as Test Sequence 2), Samuel Moore cables (same as Test Sequences 4 and 5), and Okonite cables (same as Test Sequence 5). The preaging groups in this test sequence were as follows:

- Group 1: No accelerated aging (control specimens)

Group 2: Rockbestos cables (1366 hr @ 302 °F +77 Mrad), Okonite cables (756 hr @ 302 °F + 77 Mrads), AIW cables (252 hr @ 250 °F + 38 Mrad), and Samuel Moore cables (252 hr @ 250 °F + 77 Mrad) with accelerated aging to simulate 60 years of qualified life.

The LOCA conditions simulated included exposure to either 75 Mrad (AIW cables only) or 150 Mrad of accident radiation, followed by exposure to steam (double-peak LOCA profile, as used in Test Sequences 1 and 3, with peak conditions of 346 °F and 113 psig and a duration of 10 days) and chemical spray.

Following the post-LOCA investigation, the test specimens were subjected to a voltage withstand test. In general, *all* of the specimens aged to 60 years exhibited a weakening of the insulation, which was manifested in the form of high leakage currents. Some of the specimens were unable to hold the required 2,400V of the voltage withstand test.

Error in Irradiation Dose

Following the completion of cable LOCA testing at Wyle Laboratories, the Georgia Institute of Technology notified Wyle Laboratories of an error in irradiation dose that affected LOCA tests 2 through 6. All specimens received irradiations from 6% to 10.5% lower than previously reported. Prior to completion of the GSI-168 technical assessment, the reported error in irradiation dose was evaluated by the Brookhaven National Laboratory and the NRC staff to determine if this error would impact the research findings. The staff's review concluded that none of the conclusions of the GSI-168 technical assessment are impacted by this error. The staff recognizes that the radiation dose of 50 Mrad used for qualification is conservative when compared to the 40-year dose seen during normal service in a nuclear power plant.

RESEARCH FINDINGS ON CABLE CONDITION-MONITORING TECHNIQUES

Based on the results of the testing, the following conclusions were drawn regarding the effectiveness of the techniques studied for monitoring cable condition.

Visual Inspection

Visual inspection does not provide quantitative data; however, it does provide useful information on the condition of the cable that is relatively easy and inexpensive to obtain and that can be used to determine whether further investigation of the cable condition is warranted. Visual inspection is demonstrated to be a valuable source of information in any cable condition-monitoring program.

Elongation at Break (EAB)

EAB was found to be a reliable technique for determining the condition of the polymers studied. While EAB provides trendable data that can be readily correlated with material condition, it is a destructive test and cannot be used as an in situ means of monitoring electric cables unless sacrificial cable specimens are available.

Oxidation Induction Time Method (OITM)

OITM was found to be a promising technique for monitoring the condition of electric cables. Results show that aging degradation can be trended with this technique for both XLPE and EPR insulation. However, a small sample of cable material is needed to perform this test.

Oxidation Induction Temperature (OIT)

OIT, which is related to OITM, was found to be less sensitive for detecting aging degradation of the polymers studied. OITM is preferred at this time.

Fourier Transform Infrared (FTIR) Spectroscopy

In terms of ability to trend aging degradation in the polymers studied, FTIR spectroscopy was found to provide inconclusive results. The results tend to show a consistent trend with age. However, the technical basis for the trend remains questionable.

Indenter

The indenter was found to be a reliable device that provides reproducible, trendable data for monitoring the degradation of cables in situ. It is limited to accessible sections of the cable, but it was found to be effective for monitoring the condition of common cable jacket and insulation materials and can be used for monitoring localized and accessible segments of low-voltage electric cables.

Hardness

The results of the hardness test indicate that, over a limited range, hardness can be used to trend cable degradation. However, different probes must be used to accommodate the change in material hardness. Also, puncturing the cable insulating material is a potential concern with this technique and must be taken into consideration.

Insulation Resistance

Degradation of cable insulation can be trended with this technique. As cables degrade, a definite change in insulation resistance can be detected that can be correlated to cable condition. Using 1-minute and 10-minute readings to calculate the polarization index enables the effects of temperature and humidity variations to be accounted for. This technique can be used as an in situ condition-monitoring technique.

Dielectric Loss

This technique was found to provide useful data for trending the degradation of cable insulation. As the cables degrade, a definite change in phase angle between an applied test voltage and the circuit current can be detected at various test frequencies and correlated to cable condition. This technique can be used as an in situ condition monitoring technique. However, it is more effective when a ground plane is an integral element of a cable system.

Functional Performance

This technique alone does not provide sufficient data to determine the condition of a cable. It is a "go—no go" type of test and may not be effective in detecting degraded conditions and impending failures. Further, functional performance testing is not considered an effective method for determining, in situ, the LOCA survivability for a particular cable.

Voltage Withstand

The capability of the insulating materials to withstand the circuit voltage is an indication of its dielectric performance. In order to detect defects in an incipient state, applied voltages may have to be elevated considerably above the rated voltages of the systems; further, the equipment at both ends of a cable system under test must be either disconnected or protected. Voltage withstand tests may result in unanticipated degradation of cables and can result in failures. Therefore, the risk of causing either catastrophic or incipient damage to cable insulation makes this an unsuitable method for assessing the LOCA survivability of low-voltage electric cables in situ.

Exhibit CC

see page 64

This is the accessible text file for GAO report number GAO-04-654 entitled 'Nuclear Regulation: NRC's Liability Insurance Requirements for Nuclear Power Plants Owned by Limited Liability Companies' which was released on June 08, 2004.

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Report to Congressional Requesters:

May 2004:

Nuclear Regulation:

NRC's Liability Insurance Requirements for Nuclear Power Plants Owned by Limited Liability Companies:

[Hyperlink, <http://www.gao.gov/cgi-bin/getrpt?GAO-04-654>]:

GAO Highlights:

Highlights of GAO-04-654, a report to congressional requesters

Why GAO Did This Study:

An accident at one the nation's commercial nuclear power plants could result in human health and environmental damages. To ensure that funds would be available to settle liability claims in such cases, the Price-Anderson Act requires licensees for these plants to have primary insurance—currently \$300 million per site. The act also requires secondary coverage in the form of retrospective premiums to be contributed by all licensees to cover claims that exceed primary insurance. If these premiums are needed, each licensee's payments are limited to \$10 million per year and \$95.8 million in total for each of its plants. In recent years, limited liability companies have increasingly become licensees of nuclear power plants, raising concerns about whether these companies—by shielding their parent corporations' assets—will have the financial resources to pay their retrospective premiums.

GAO was asked to determine (1) the extent to which limited liability companies are the licensees for U.S. commercial nuclear power plants, (2) the Nuclear Regulatory Commission's (NRC) requirements and procedures for ensuring that licensees of nuclear power plants comply with the Price-Anderson Act's liability requirements, and (3) whether and how these procedures differ for licensees that are limited liability companies.

What GAO Found:

Of the 103 operating nuclear power plants, 31 are owned by 11 limited liability companies. Three energy corporations—Exelon, Entergy, and the Constellation Energy Group—are the parent companies for eight of these limited liability companies. These 8 subsidiaries are the licensees or co-licensees for 27 of the 31 plants.

NRC requires all licensees for nuclear power plants to show proof that they have the primary and secondary insurance coverage mandated by the Price-Anderson Act. Licensees obtain their primary insurance through American Nuclear Insurers. Licensees also sign an agreement with NRC to keep the insurance in effect. American Nuclear Insurers also has a contractual agreement with each of the licensees to collect the retrospective premiums if these payments become necessary. A certified copy of this agreement, which is called a bond for payment of retrospective premiums, is provided to NRC as proof of secondary insurance. It obligates the licensee to pay the retrospective premiums to American Nuclear Insurers.

NRC does not treat limited liability companies differently than other licensees with respect to the Price-Anderson Act's insurance requirements. Like other licensees, limited liability companies must show proof of both primary and secondary insurance coverage. American Nuclear Insurers also requires limited liability companies to provide a letter of guarantee from their parent or other affiliated companies with sufficient assets to pay the retrospective premiums. These letters state that the parent or affiliated companies are responsible for paying the retrospective premiums if the limited liability company does not. American Nuclear Insurers informs NRC it has received these letters. In light of the increasing number of plants owned by limited liability companies, NRC is studying its existing regulations and expects to report on its findings by the end of summer 2004.

In commenting on a draft of this report, NRC stated that it accurately reflects the present insurance system for nuclear power plants.

www.gao.gov/cgi-bin/getrpt?GAO-04-654.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Jim Wells at 202-512-3841.

[End of section]

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Table 1: Limited Liability Companies Licensed to Operate Nuclear Power Plants and Their Parent Companies:

Letter May 28, 2004:

Congressional Requesters:

An accident at one of the nation's 103^[Footnote 1] operating commercial nuclear power plants could result in human health and environmental damages. The Price-Anderson Act was enacted in 1957 to ensure that funds would be available for at least a portion of the damages suffered by the public in the event of an incident at a U.S. nuclear power plant. The act requires each licensee of a nuclear plant to have primary insurance coverage equal to the maximum amount of liability insurance available from private sources--currently \$300 million--to settle any such claims against it. In the event of an accident at any plant where liability claims exceed the \$300 million primary insurance coverage, the act also requires licensees for all plants to pay retrospective premiums (also referred to as secondary insurance). Under current U.S. Nuclear Regulatory Commission (NRC) regulations, these payments could amount to a maximum of \$95.8 million for each of a licensee's plants per incident. If claims for an incident exceed this approximately \$10 billion currently available in primary insurance and retrospective premiums, NRC may request additional funds from the Congress. To operate a nuclear power plant, the owner must obtain a license from NRC and meet its regulatory requirements, including those for liability insurance established under the Price-Anderson Act.

A major aspect of the deregulation or restructuring of the U.S. electricity industry in the 1990s was the separation of electricity generation from transmission and distribution. Utilities could create separate entities or subsidiaries to operate their generation facilities, including nuclear power plants, or could sell them off to other companies. Energy holding companies bought some of the generation facilities, sometimes placing them under subsidiaries. The limited liability company also emerged in the 1990s as a new type of company structure in the United States. These companies have characteristics of both a partnership and a corporation. Like a partnership, the profits are passed through and taxable to the owners, known as members; like a corporation, it is a separate and distinct legal entity and its owners are insulated from personal liability for its debts and liabilities.

You asked us to determine (1) the extent to which limited liability companies are the licensees for U.S. commercial nuclear power plants, (2) NRC's requirements and procedures for ensuring that licensees of nuclear power plants comply with the Price-Anderson Act's liability requirements, and (3) whether and how these procedures differ for licensees that are limited liability companies. To respond to your request, we reviewed applicable sections of the Price-Anderson Act and NRC's implementing regulations and written procedures. We also held discussions with and obtained information from responsible NRC officials and representatives of American Nuclear Insurers, which is a joint underwriting association of 50 insurance companies that provides insurance coverage to the nuclear power plants. These are property/casualty insurance companies licensed to do business in at least one of the states or territories of the United States. We performed our work between April 2003 and April 2004 in accordance with generally accepted government auditing standards.

Results in Brief:

Thirty-one of the 103 operating commercial nuclear power plants nationwide are licensed to limited liability companies. Four of the 31 plants are licensed jointly to two limited liability companies. A total of 11 limited liability companies are licensed to own nuclear power plants. One--the Exelon Generation Company, LLC--is the licensee for 12 plants and co-licensee for 4 plants. The 10 other limited liability companies are the licensees or co-licensees for one to five plants. Three energy corporations--Exelon, Entergy, and the Constellation Energy Group--are the parent companies for eight of the limited liability companies. These eight subsidiaries are the licensees or co-licensees for 27 of the 31 plants.

NRC's procedures for ensuring that licensees comply with Price-Anderson Act liability insurance provisions include requirements that licensees provide proof of primary and secondary insurance coverage. NRC requires each licensee to show proof that it has liability insurance that includes the \$300 million of primary insurance coverage per site required by the Price-Anderson Act. NRC and the licensee also sign an indemnity agreement that requires the licensee to maintain an insurance policy in this amount. This agreement is in effect as long as the owner is licensed to operate the plant. NRC relies on American Nuclear Insurers--the joint underwriting association that provides insurance for U.S. nuclear power plants--to send NRC the annual endorsements documenting proof of insurance after the licensees have paid their annual premiums. In addition to the primary insurance coverage, licensees must also show proof of secondary insurance to NRC. This secondary insurance is in the form of retrospective premiums that, in the event of a nuclear incident causing damages exceeding \$300 million, would be collected from each nuclear power plant licensee at a rate of up to \$10 million per year and up to a maximum of \$95.8 million per incident for each nuclear power plant. Typically, each licensee signs a bond for payment of retrospective premiums as proof of the secondary insurance and furnishes NRC with a certified copy. This bond is a contractual agreement between the licensee and American Nuclear Insurers that obligates the licensee to pay American Nuclear Insurers the retrospective premiums. In the event that claims exhaust primary coverage, American Nuclear Insurers would collect the retrospective premiums. If a licensee did not pay its share of these retrospective premiums, American Nuclear Insurers would, under its agreement with the licensees, pay up to \$30 million of the premiums in 1 year and attempt to collect this amount later from the licensees.

NRC does not treat limited liability companies differently than other licensees of nuclear power plants with respect to Price-Anderson Act liability requirements. All licensees follow the same regulations and procedures regardless of whether they are limited liability companies. Like other licensees, limited liability companies are required to show that they are maintaining \$300 million in primary insurance coverage, and they provide NRC a copy of the bond for payment of retrospective premiums. While NRC does not conduct in-depth financial reviews specifically to determine licensees' ability to pay retrospective premiums, when a licensee applies for a license or when the license is transferred, NRC reviews the licensee's financial ability to safely operate the plant and to contribute decommissioning funds for the future retirement of the plant. According to NRC officials, if licensees have the financial resources to cover these two expenses, they are likely to be capable of paying their retrospective premiums. American Nuclear Insurers goes further than NRC and requires limited liability companies to provide a letter of guarantee from their parent or other affiliated companies with sufficient assets to cover the retrospective premiums. These letters state that the parent or an affiliated company is responsible for paying the retrospective premiums if the limited liability company does not. American Nuclear Insurers informs NRC that it has received these letters of guarantee. Recognizing that limited liability companies are becoming more

prevalent as owners of nuclear power plants, NRC is examining whether it needs to revise any of its regulations and procedures for these companies. NRC estimates the study will be completed by the end of summer 2004.

In commenting on a draft of this report, NRC stated that it accurately reflects the present insurance system for nuclear power plants.

Background:

The Atomic Energy Act of 1954 authorized a comprehensive regulatory program to permit private industry to develop and apply atomic energy for peaceful uses, such as generating electricity from privately owned nuclear power plants. Soon thereafter, government and industry experts identified a major impediment to accomplishing the act's objective: the potential for payment of damages resulting from a nuclear accident and the lack of adequate available insurance. Unwilling to risk huge financial liability, private companies viewed even the remote specter of a serious accident as a roadblock to their participating in the development and use of nuclear power.[Footnote 2] In addition, congressional concern developed over ensuring adequate financial protection to the public because the public had no assurance that it would receive compensation for personal injury or property damages from the liable party in event of a serious accident. Faced with these concerns, the Congress enacted the Price-Anderson Act in September 1957. The Price-Anderson Act has two underlying objectives: (1) to establish a mechanism for compensating the public for personal injury or property damage in the event of a nuclear accident and (2) to encourage the development of nuclear power.

To provide financial protection, the Price-Anderson Act requires commercial nuclear reactors to be insured to the maximum level of primary insurance available from private insurers. To implement this provision, NRC periodically revises its regulations to require licensees of nuclear reactors to increase their coverage level as the private insurance market increases the maximum level of primary insurance that it is willing to offer. For example, in January 2003, NRC increased the required coverage from \$200 million to the current \$300 million, when American Nuclear Insurers informed NRC that \$300 million per site in coverage was now available in its insurance pool.

In 1975, the Price-Anderson Act was amended to require licensees to pay a pro-rated share of the damages in excess of the primary insurance amount. Under this amendment, each licensee would pay up to \$5 million in retrospective premiums per facility it owned per incident if a nuclear accident resulted in damages exceeding the amount of primary insurance coverage. In 1988, the act was further amended to increase the maximum retrospective premium to \$63 million per reactor per incident to be adjusted by NRC for inflation. The amendment also limited the maximum annual retrospective premium per reactor to \$10 million. Under the act, NRC is to adjust the maximum amount of retrospective premiums every 5 years using the aggregate change in the Consumer Price Index for urban consumers. In August 2003, NRC set the current maximum retrospective payment at \$95.8 million per reactor per incident. With 103 operating nuclear power plants, this secondary insurance pool would total about \$10 billion.[Footnote 3]

The Price-Anderson Act also provides a process to deal with incidents in which the damages exceed the primary and secondary insurance coverage. Under the act, NRC shall survey the causes and extent of the damage and submit a report on the results to, among others, the Congress and the courts. The courts must determine whether public liability exceeds the liability limits available in the primary insurance and secondary retrospective premiums. Then the President would submit to the Congress an estimate of the financial extent of damages, recommendations for additional sources of funds, and one or more compensation plans for full and prompt compensation for all valid

claims. In addition, NRC can request the Congress to appropriate funds. The most serious incident at a U.S. nuclear power plant took place in 1979 at the Three Mile Island Nuclear Station in Pennsylvania. That incident has resulted in \$70 million in liability claims.

NRC's regulatory activities include licensing nuclear reactors and overseeing their safe operation. Licensees must meet NRC regulations to obtain and retain their license to operate a nuclear facility. NRC carries out reviews of financial qualifications of reactor licensees when they apply for a license or if the license is transferred, including requiring applicants to demonstrate that they possess or have reasonable assurance of obtaining funds necessary to cover estimated operating costs for the period of the license. NRC does not systematically review its licensees' financial qualifications once it has issued the license unless it has reason to believe this is necessary. In addition, NRC performs inspections to verify that a licensee's activities are properly conducted to ensure safe operations in accordance with NRC's regulations. NRC can issue sanctions to licensees who violate its regulations. These sanctions include notices of violation; civil penalties of up to \$100,000 per violation per day; and orders that may modify, suspend, or revoke a license.

Limited Liability Companies Are Licensees for 31 of the 103 Operating Commercial Nuclear Power Plants in the United States:

Thirty-one commercial nuclear power plants nationwide are licensed to limited liability companies. In total, 11 limited liability companies are licensed to own nuclear power plants. Three energy corporations--Exelon, Entergy, and the Constellation Energy Group--are the parent companies for 8 of these limited liability companies. These eight subsidiaries are licensed or co-licensed to operate 27 of the 31 plants. The two subsidiaries of the Exelon Corporation are the licensees for 15 plants and the co-licensees for 4 others. Constellation Energy Group, Inc., and Entergy Corporation are the parent companies of limited liability companies that are licensees for four nuclear power plants each. (See table 1.):

Table 1: Limited Liability Companies Licensed to Operate Nuclear Power Plants and Their Parent Companies:

Limited liability company: Exelon Generation Company, LLC;
Parent company: Exelon Corporation;
Number of plants owned or co-owned: 12.

Limited liability company: AmerGen Energy Company, LLC;
Parent company: Exelon Corporation;
Number of plants owned or co-owned: 3.

Limited liability company: Exelon Generation Company, LLC; PSEG Nuclear, LLC;
Parent company: Exelon Corporation; Public Service Enterprise Group, Incorporated;
Number of plants owned or co-owned: 4.

Limited liability company: PSEG Nuclear, LLC;
Parent company: Public Service Enterprise Group, Incorporated;
Number of plants owned or co-owned: 1.

Limited liability company: Calvert Cliffs Nuclear Power Plant, LLC;
Parent company: Constellation Energy Group, Inc.;
Number of plants owned or co-owned: 2.

Limited liability company: Nine Mile Point Nuclear Station, LLC;
Parent company: Constellation Energy Group, Inc.;
Number of plants owned or co-owned: 2.

Limited liability company: Entergy Nuclear Indian Point 2, LLC;

Parent company: Entergy Corporation;
Number of plants owned or co-owned: 1.

Limited liability company: Entergy Nuclear Indian Point 3, LLC;
Parent company: Entergy Corporation;
Number of plants owned or co-owned: 1.

Limited liability company: Entergy Nuclear FitzPatrick, LLC;
Parent company: Entergy Corporation;
Number of plants owned or co-owned: 1.

Limited liability company: Entergy Nuclear Vermont Yankee, LLC;
Parent company: Entergy Corporation;
Number of plants owned or co-owned: 1.

Limited liability company: FPL Energy Seabrook, LLC;
Parent company: FPL Group, Inc.;
Number of plants owned or co-owned: 1.

Limited liability company: PPL Susquehanna, LLC;
Parent company: Pennsylvania Power and Light Company;
Number of plants owned or co-owned: 2.

Source: GAO survey of NRC project managers.

[End of table]

Of all the limited liability companies, Exelon Generation Company, LLC, has the largest number of plants. It is the licensee for 12 plants and co-licensee with PSEG Nuclear, LLC, for 4 other plants. For these 4 plants, Exelon Generation owns 43 percent of Salem Nuclear Generating Stations 1 and 2 and 50 percent of Peach Bottom Atomic Power Stations 2 and 3. (App. I lists all the licensees and their nuclear power plants.):

NRC Has Specific Requirements and Procedures to Ensure That All Licensees Comply with the Price-Anderson Act's Liability Provisions:

NRC requires licensees of nuclear power plants to comply with the Price-Anderson Act's liability insurance provisions by maintaining the necessary primary and secondary insurance coverage. First, NRC ensures that licensees comply with the primary insurance coverage requirement by requiring them to submit proof of coverage in the amount of \$300 million. Second, NRC ensures compliance with the requirement for secondary coverage by accepting the certified copy of the licensee's bond for payment of retrospective premiums.

All the nuclear power plant licensees purchase their primary insurance from American Nuclear Insurers. American Nuclear Insurers sends NRC annual endorsements documenting proof of primary insurance after the licensees have paid their annual premiums. NRC and each licensee also sign an indemnity agreement, stating that the licensee will maintain an insurance policy in the required amount. This agreement, which is in effect as long as the owner is licensed to operate the plant, guarantees reimbursement of liability claims against the licensee in the event of a nuclear incident through the liability insurance. The agency can suspend or revoke the license if a licensee does not maintain the insurance, but according to an NRC official, no licensee has ever failed to pay its annual primary insurance premium and American Nuclear Insurers would notify NRC if a licensee failed to pay. [Footnote 4]

As proof of their secondary insurance coverage, licensees must provide evidence that they are maintaining a guarantee of payment of retrospective premiums. Under NRC regulations, the licensee must provide NRC with evidence that it maintains one of the following six types of guarantees: (1) surety bond, (2) letter of credit, (3)

revolving credit/term loan arrangement, (4) maintenance of escrow deposits of government securities, (5) annual certified financial statement showing either that a cash flow can be generated and would be available for payment of retrospective premiums within 3 months after submission of the statement or a cash reserve or combination of these, or (6) such other type of guarantee as may be approved by the Commission.

Before the late 1990s, the licensees provided financial statements to NRC as evidence of their ability to pay retrospective premiums. [Footnote 5] According to NRC officials, in the late 1990s, Entergy asked NRC to accept the bond for payment of retrospective premiums that it had with American Nuclear Insurers as complying with the sixth option under NRC's regulations: such other type of guarantee as may be approved by the Commission. After reviewing and agreeing to Entergy's request, NRC decided to accept the bond from all the licensees as meeting NRC's requirements. NRC officials told us that they did not document this decision with Commission papers or incorporate it into the regulations because they did not view this as necessary under the regulations.

The bond for payment of retrospective premiums is a contractual agreement between the licensee and American Nuclear Insurers that obligates the licensee to pay American Nuclear Insurers the retrospective premiums. Each licensee signs this bond and furnishes NRC with a certified copy. In the event that claims exhaust primary coverage, American Nuclear Insurers would collect the retrospective premiums. If a licensee were not to pay its share of these retrospective premiums, American Nuclear Insurers would, under its agreement with the licensees, pay for up to three defaults or up to \$30 million in 1 year of the premiums and attempt to collect this amount later from the defaulting licensees. According to an American Nuclear Insurers official, any additional defaults would reduce the amount available for retrospective payments. An American Nuclear Insurers official told us that his organization believes that the bond for payment of retrospective premiums is legally binding and obligates the licensee to pay the premium. Under NRC regulations, if a licensee fails to pay the assessed deferred premium, NRC reserves the right to pay those premiums on behalf of the licensee and recover the amount of such premiums from the licensee.

NRC Treats Limited Liability Companies the Same as Other Licensees, but the Insurance Industry Has Added Important Requirements for These Companies:

NRC applies the same rules to limited liability companies that it does to other licensees of nuclear power plants with respect to liability requirements under the Price-Anderson Act.

All licensees must meet the same requirements regardless of whether they are limited liability companies. American Nuclear Insurers applies an additional requirement for limited liability companies with respect to secondary insurance coverage in order to ensure that they have sufficient assets to pay retrospective premiums. Given the growing number of nuclear power plants licensed to limited liability companies, NRC is examining the need to revise its procedures and regulations for such companies.

NRC requires all licensees of nuclear power plants to follow the same regulations and procedures. Limited liability companies, like other licensees, are required to show that they are maintaining the \$300 million in primary insurance coverage and provide NRC a copy of the bond for payment of retrospective premiums or other approved evidence of guarantee of retrospective premium payments. According to NRC officials, all its licensees, including those that are limited liability companies, have sufficient assets to cover the retrospective premiums. While NRC does not conduct in-depth financial reviews

specifically to determine licensees' ability to pay retrospective premiums, it reviews the licensees' financial ability to safely operate their plants and to contribute decommissioning funds for the future retirement of the plants. According to NRC officials, if licensees have the financial resources to cover these two larger expenses, they are likely to be capable of paying their retrospective premiums.

American Nuclear Insurers goes further than NRC and requires licensees that are limited liability companies to provide a letter of guarantee from their parent or other affiliated companies with sufficient assets to cover the retrospective premiums. An American Nuclear Insurers official stated that American Nuclear Insurers obtains these letters as a matter of good business practice. These letters state that the parent or an affiliated company is responsible for paying the retrospective premiums if the limited liability company does not. If the parent company or other affiliated company of a limited liability company does not provide a letter of guarantee, American Nuclear Insurers could refuse to issue the bond for payment of retrospective premiums and the company would have to have another means to show NRC proof of secondary insurance. American Nuclear Insurers informs NRC that it has received these letters of guarantee. The official also told us that American Nuclear Insurers believes that the letters from the parent companies or other affiliated companies of the limited liability company licensed by NRC are valid and legally enforceable contracts.

NRC officials told us that they were not aware of any problems caused by limited liability companies owning nuclear power plants and that NRC currently does not regard limited liability companies' ownership of nuclear power plants as a concern. However, because these companies are becoming more prevalent as owners of nuclear power plants, NRC is examining whether it needs to revise any of its regulations or procedures for these licensees. NRC estimates that it will complete its study by the end of summer 2004.

Agency Comments:

We provided a draft of this report to NRC for review and comment. In its written comments (see app. II), NRC stated that it believes the report accurately reflects the present insurance system for nuclear power plants. NRC said that we correctly conclude that the agency does not treat limited liability companies differently than other licensees with respect to Price-Anderson's insurance requirements. NRC also stated that we are correct in noting that it is not aware of any problems caused by limited liability companies owning nuclear power plants and that NRC currently does not regard limited liability companies' ownership of nuclear power plants as a concern. In addition, NRC commented that we agree with the agency's conclusion that all its reactor licensees have sufficient assets that they are likely to be able to pay the retrospective premiums. With respect to this last comment, the report does not take a position on the licensees' ability to pay the retrospective premiums. We did not evaluate the sufficiency of the individual licensees' assets to make these payments. Instead, we reviewed NRC's and the American Nuclear Insurers' requirements and procedures for retrospective premiums.

Scope and Methodology:

We performed our review at NRC headquarters in Washington, D.C. We reviewed statutes, regulations, and appropriate guidance as well as interviewed agency officials to determine the relevant statutory framework of the Price-Anderson Act. To determine the number of nuclear power plant licensees that are limited liability companies, we surveyed, through electronic mail, all the NRC project managers responsible for maintaining nuclear power plant licenses. We asked them to provide data on the licensees, including the licensee's name and whether it was a limited liability company. If it was a limited liability company, we asked when the license was transferred to the

limited liability company and who is the parent company of the limited liability company. We received responses for all 103 nuclear power plants currently licensed to operate. We analyzed the results of the survey responses. We verified the reliability of the data from a random sample of project managers by requesting copies of the power plant licenses and then comparing the power plant licenses to the data provided by the project managers. The data agreed in all cases. We concluded that the data were reliable enough for the purposes of this report.

To determine NRC's requirements for ensuring that licensees of nuclear power plants comply with the Price-Anderson Act's liability requirements, we reviewed relevant statutes and NRC regulations and interviewed NRC officials responsible for ensuring that licensees have primary and secondary insurance coverage. We also spoke with American Nuclear Insurers officials responsible for issuing the insurance coverage to nuclear power plant licensees, and we reviewed relevant documents associated with the insurance. To determine whether and how these procedures differ for licensees that are limited liability companies, we reviewed relevant documents, including NRC regulations, and interviewed NRC officials responsible for ensuring licensee compliance with Price-Anderson Act requirements.

As agreed with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 7 days from the date of this letter. We will then send copies to interested congressional committees; the Commissioners, Nuclear Regulatory Commission; the Director, Office of Management and Budget; and other interested parties. We will make copies available to others on request. In addition, the report will be available at no charge on GAO's Web site, at [Hyperlink, <http://www.gao.gov>].

If you or your staff have any questions about this report, I can be reached at (202) 512-3841. Major contributors to this report include Ray Smith, Ilene Pollack, and Amy Webbink. John Delicath and Judy Pagano also contributed to this report.

Signed by:

Jim Wells,
Director, Natural Resources and Environment:

List of Congressional Requesters:

The Honorable Hillary Rodham Clinton:
The Honorable James M. Jeffords:
The Honorable Harry Reid:
United States Senate:

[End of section]

Appendixes:

Appendix I: Nuclear Power Plant Ownership:

1;
Plant: Arkansas Nuclear One 1;
Licensed to own: Entergy Arkansas, Inc.;
LLC: No.

2;
Plant: Arkansas Nuclear One 2;
Licensed to own: Entergy Arkansas, Inc.;
LLC: No.

3;
Plant: Arnold (Duane) Energy Center;

Licensed to own: Interstate Power and Light;
LLC: No;
Licensed to own: Central Iowa Power Cooperative;
LLC: No;
Licensed to own: Corn Belt Power Cooperative;
LLC: No.

4;
Plant: Beaver Valley Power Station 1;
Licensed to own: Pennsylvania Power Company;
LLC: No.
Licensed to own: Ohio Edison Company;
LLC: No;
Licensed to own: FirstEnergy Nuclear Operating Company;
LLC: No.

5;
Plant: Beaver Valley Power Station 2;
Licensed to own: Pennsylvania Power Company;
LLC: No;
Licensed to own: Ohio Edison Company;
LLC: No;
Licensed to own: Cleveland Electric Illuminating Company;
LLC: No;
Licensed to own: Toledo Edison Company;
LLC: No;
Licensed to own: FirstEnergy Nuclear Operating Company;
LLC: No.

6;
Plant: Braidwood Station 1;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;
LLC parent company: Exelon Corporation.

7;
Plant: Braidwood Station 2;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;
LLC parent company: Exelon Corporation.

8;
Plant: Browns Ferry Nuclear Power Station 1;
Licensed to own: Tennessee Valley Authority;
LLC: No.

9;
Plant: Browns Ferry Nuclear Power Station 2;
Licensed to own: Tennessee Valley Authority;
LLC: No.

10;
Plant: Browns Ferry Nuclear Power Station 3;
Licensed to own: Tennessee Valley Authority;
LLC: No.

11;
Plant: Brunswick Steam Electric Plant 1;
Licensed to own: Carolina Power & Light Co.;
LLC: No;
Licensed to own: North Carolina Eastern Municipal Power Agency;
LLC: No.

12;
Plant: Brunswick Steam Electric Plant 2;

Licensed to own: Carolina Power & Light Co.;
LLC: No;
Licensed to own: North Carolina Eastern Municipal Power Agency;
LLC: No.

13;
Plant: Byron Station 1;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;
LLC parent company: Exelon Corporation.

14;
Plant: Byron Station 2;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;
LLC parent company: Exelon Corporation.

15;
Plant: Callaway Plant;
Licensed to own: Union Electric Company;
LLC: No.

16;
Plant: Calvert Cliffs Nuclear Power Plant 1;
Licensed to own: Calvert Cliffs Nuclear Power Plant, LLC;
LLC: Yes;
License transfer date: 6/19/2001;
LLC parent company: Constellation Energy Group, Inc..

17;
Plant: Calvert Cliffs Nuclear Power Plant 2;
Licensed to own: Calvert Cliffs Nuclear Power Plant, LLC;
LLC: Yes;
License transfer date: 6/19/2001;
LLC parent company: Constellation Energy Group, Inc..

18;
Plant: Catawba Nuclear Station 1;
Licensed to own: North Carolina Electric Membership Corp.;
LLC: No;
Licensed to own: Saluda River Electric Cooperative, Inc.;
LLC: No;
Licensed to own: Duke Energy Corporation;
LLC: No.

19;
Plant: Catawba Nuclear Station 2;
Licensed to own: North Carolina Municipal Power Agency No. 1;
LLC: No;
Licensed to own: Piedmont Municipal Power Agency;
LLC: No.

20;
Plant: Clinton Power Station;
Licensed to own: AmerGen Energy Company, LLC;
LLC: Yes;
License transfer date: 11/24/1999;
LLC parent company: Exelon Corporation.

21;
Plant: Columbia Generation Station;
Licensed to own: Energy Northwest;
LLC: No.

22;

Plant: Comanche Peak Steam Electric Station 1;
Licensed to own: TXU Generation Company LP;
LLC: No.

23;
Plant: Comanche Peak Steam Electric Station 2;
Licensed to own: TXU Generation Company LP;
LLC: No.

24;
Plant: Cook (Donald C.) Nuclear Power Plant 1;
Licensed to own: Indiana Michigan Power Company;
LLC: No.

25;
Plant: Cook (Donald C.) Nuclear Power Plant 2;
Licensed to own: Indiana Michigan Power Company;
LLC: No.

26;
Plant: Cooper Nuclear Station;
Licensed to own: Nebraska Public Power District;
LLC: No.

27;
Plant: Crystal River Nuclear Plant 3;
Licensed to own: Florida Power Corporation;
LLC: No;
Licensed to own: City of Alachua;
LLC: No;
Licensed to own: City of Bushnell;
LLC: No;
Licensed to own: City of Gainesville;
LLC: No;
Licensed to own: City of Kissimmee;
LLC: No;
Licensed to own: City of Leesburg;
LLC: No;
Licensed to own: City of New Smyrna Beach and Utilities Commission;
LLC: No;
Licensed to own: City of Ocala;
LLC: No;
Licensed to own: Orlando Utilities Commission and City of Orlando;
LLC: No;
Licensed to own: Seminole Electric Cooperative, Inc.;
LLC: No.

28;
Plant: Davis-Besse Nuclear Power Station;
Licensed to own: Cleveland Electric Illumination Company;
LLC: No;
Licensed to own: Toledo Edison Company;
LLC: No.

29;
Plant: Diablo Canyon Nuclear Power Plant 1;
Licensed to own: Pacific Gas and Electric Company;
LLC: No.

30;
Plant: Diablo Canyon Nuclear Power Plant 2;
Licensed to own: Pacific Gas and Electric Company;
LLC: No.

31;
Plant: Dresden Nuclear Power Station 2;
Licensed to own: Exelon Generation Company, LLC;

LLC: Yes;
License transfer date: 8/3/2000;
LLC parent company: Exelon Corporation.

32;
Plant: Dresden Nuclear Power Station 3;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 8/3/2000;
LLC parent company: Exelon Corporation.

33;
Plant: Farley (Joseph M.) Nuclear Plant 1;
Licensed to own: Alabama Power Company;
LLC: No.

34;
Plant: Farley (Joseph M.) Nuclear Plant 2;
Licensed to own: Alabama Power Company;
LLC: No.

35;
Plant: Fermi (Enrico) Atomic Power Plant 2;
Licensed to own: Detroit Edison Company;
LLC: No.

36;
Plant: FitzPatrick (James A.) Nuclear Power Plant;
Licensed to own: Entergy Nuclear FitzPatrick, LLC;
LLC: Yes;
License transfer date: 11/ 21/2000;
LLC parent company: Entergy Corporation.

37;
Plant: Fort Calhoun Station;
Licensed to own: Omaha Public Power District;
LLC: No.

38;
Plant: Ginna (Robert E.) Nuclear Station;
Licensed to own: Rochester Gas and Electric Corporation;
LLC: No.

39;
Plant: Grand Gulf Nuclear Station;
Licensed to own: System Energy Resources, Inc.;
LLC: No;
Licensed to own: South Mississippi Electric Power Assoc.;
LLC: No.

40;
Plant: Harris (Shearon) Nuclear Power Plant;
Licensed to own: Carolina Power & Light Co.;
LLC: No;
Licensed to own: North Carolina Eastern Municipal Power Agency;
LLC: No.

41;
Plant: Hatch (Edwin I.) Nuclear Plant 1;
Licensed to own: Georgia Power Company;
LLC: No;
Licensed to own: Municipal Electric Authority of Georgia;
LLC: No;
Licensed to own: Oglethorpe Power Corporation;
LLC: No;
Licensed to own: City of Dalton, Georgia;
LLC: No.

42;

Plant: Hatch (Edwin I.) Nuclear Plant 2;
Licensed to own: Georgia Power Company;
LLC: No;
Licensed to own: Municipal Electric Authority of Georgia;
LLC: No;
Licensed to own: Oglethorpe Power Corporation;
LLC: No;
Licensed to own: City of Dalton, Georgia;
LLC: No.

43;

Plant: Hope Creek Nuclear Power Station;
Licensed to own: PSEG Nuclear, LLC;
LLC: Yes;
License transfer date: 8/21/2000;
10/18/2001;
LLC parent company: Public Service Enterprise Group, Incorporated.

44;

Plant: Indian Point 2;
Licensed to own: Entergy Nuclear Indian Point 2, LLC;
LLC: Yes;
License transfer date: 9/6/2001;
LLC parent company: Entergy Corporation.

45;

Plant: Indian Point 3;
Licensed to own: Entergy Nuclear Indian Point 3, LLC;
LLC: Yes;
License transfer date: 11/21/2000;
LLC parent company: Entergy Corporation.

46;

Plant: Kewaunee Nuclear Power Plant;
Licensed to own: Wisconsin Public Service Corp.;
LLC: No;
Licensed to own: Wisconsin Power & Light Company;
LLC: No.

47;

Plant: LaSalle County Station 1;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;
LLC parent company: Exelon Corporation.

48;

Plant: LaSalle County Station 2;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;
LLC parent company: Exelon Corporation.

49;

Plant: Limerick Generating Station 1;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;
LLC parent company: Exelon Corporation.

50;

Plant: Limerick Generating Station 2;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;

LLC parent company: Exelon Corporation.

51;

Plant: McGuire (William B.) Nuclear Station 1;
Licensed to own: Duke Energy Corporation;
LLC: No.

52;

Plant: McGuire (William B.) Nuclear Station 2;
Licensed to own: Duke Energy Corporation;
LLC: No.

53;

Plant: Millstone Nuclear Power Station 2;
Licensed to own: Dominion Nuclear Connecticut, Inc.;
LLC: No.

54;

Plant: Millstone Nuclear Power Station 3;
Licensed to own: Dominion Nuclear Connecticut, Inc.;
LLC: No;
Licensed to own: Central Vermont Public Service Corporation;
LLC: No;
Licensed to own: Massachusetts Municipal Wholesale Electric Co.;
LLC: No..

55;

Plant: Monticello Nuclear Generating Plant;
Licensed to own: Northern States Power Company;
LLC: No.

56;

Plant: Nine Mile Point Nuclear Station 1;
Licensed to own: Nine Mile Point Nuclear Station, LLC;
LLC: Yes;
License transfer date: 11/7/ 2001;
LLC parent company: Constellation Energy Group.

57;

Plant: Nine Mile Point Nuclear Station 2;
Licensed to own: Nine Mile Point Nuclear Station, LLC;
LLC: Yes;
License transfer date: 11/7/ 2001;
LLC parent company: Constellation Energy Group;
Licensed to own: Long Island Lighting Company;
LLC: No..

58;

Plant: North Anna Power Station 1;
Licensed to own: Virginia Electric and Power Company;
LLC: No;
Licensed to own: Old Dominion Electric Cooperative;
LLC: No.

59;

Plant: North Anna Power Station 2;
Licensed to own: Virginia Electric and Power Company;
LLC: No;
Licensed to own: Old Dominion Electric Cooperative;
LLC: No.

60;

Plant: Oconee Nuclear Station 1;
Licensed to own: Duke Energy Corporation;
LLC: No.

61;

Plant: Oconee Nuclear Station 2;
Licensed to own: Duke Energy Corporation;
LLC: No.

62;
Plant: Oconee Nuclear Station 3;
Licensed to own: Duke Energy Corporation;
LLC: No.

63;
Plant: Oyster Creek Nuclear Power Plant;
Licensed to own: AmerGen Energy Company, LLC;
LLC: Yes;
License transfer date: 8/8/2000;
LLC parent company: Exelon Corporation.

64;
Plant: Palisades Nuclear Plant;
Licensed to own: Consumers Energy Company;
LLC: No.

65;
Plant: Palo Verde Nuclear Generating Station 1;
Licensed to own: Arizona Public Service Company;
LLC: No;
Licensed to own: Salt River Project Agricultural Improvement and Power District;
LLC: No;
Licensed to own: El Paso Electric Company;
LLC: No;
Licensed to own: Southern California Edison Company;
LLC: No;
Licensed to own: Public Service Company of New Mexico;
LLC: No;
Licensed to own: Los Angeles Dept. of Water and Power;
LLC: No;
Licensed to own: Southern California Public Power Authority;
LLC: No.

66;
Plant: Palo Verde Nuclear Generating Station 2;
Licensed to own: Arizona Public Service Company;
LLC: No;
Licensed to own: Salt River Project Agricultural Improvement and Power District;
LLC: No;
Licensed to own: El Paso Electric Company;
LLC: No;
Licensed to own: Southern California Edison Company;
LLC: No;
Licensed to own: Public Service Company of New Mexico;
LLC: No;
Licensed to own: Los Angeles Dept. of Water and Power;
LLC: No;
Licensed to own: Southern California Public Power Authority;
LLC: No.

67;
Plant: Palo Verde Nuclear Generating Station 3;
Licensed to own: Arizona Public Service Company;
LLC: No;
Licensed to own: Salt River Project Agricultural Improvement and Power District;
LLC: No;
Licensed to own: El Paso Electric Company;
LLC: No;
Licensed to own: Southern California Edison Company;

LLC: No;
Licensed to own: Public Service Company of New Mexico;
LLC: No;
Licensed to own: Los Angeles Dept. of Water and Power;
LLC: No;
Licensed to own: Southern California Public Power Authority;
LLC: No.

68;
Plant: Peach Bottom Atomic Power Station 2;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;
LLC parent company: Exelon Corporation;
Licensed to own: PSEG Nuclear, LLC;
LLC: Yes.

LLC parent company: Public Service Enterprise Group, Incorporated.

69;
Plant: Peach Bottom Atomic Power Station 3;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;
LLC parent company: Exelon Corporation;
Licensed to own: PSEG Nuclear, LLC;
LLC: Yes.

LLC parent company: Public Service Enterprise Group, Incorporated.

70;
Plant: Perry Nuclear Power Plant;
Licensed to own: Ohio Edison Company;
LLC: No;
Licensed to own: Cleveland Electric Company;
LLC: No;
Licensed to own: Toledo Edison Company;
LLC: No.

71;
Plant: Pilgrim Station;
Licensed to own: Entergy Nuclear Generation Co.;
LLC: No.

72;
Plant: Point Beach Nuclear Plant 1;
Licensed to own: Wisconsin Electric Power Company;
LLC: No.

73;
Plant: Point Beach Nuclear Plant 2;
Licensed to own: Wisconsin Electric Power Company;
LLC: No.

74;
Plant: Prairie Island Nuclear Plant 1;
Licensed to own: Northern States Power Company;
LLC: No.

75;
Plant: Prairie Island Nuclear Plant 2;
Licensed to own: Northern States Power Company;
LLC: No.

76;
Plant: Quad Cities Station 1;
Licensed to own: Exelon Generation Company, LLC;

LLC: Yes;
License transfer date: 8/3/2000;
LLC parent company: Exelon Corporation;
Licensed to own: 77: MidAmerican Energy Company;
LLC: 77: No;
License transfer date: 77: [Empty];
LLC parent company: 77: [Empty].

77;
Plant: Quad Cities Station 2;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 8/3/2000;
LLC parent company: Exelon Corporation;
Licensed to own: MidAmerican Energy Company;
LLC: No.

78;
Plant: River Bend Station;
Licensed to own: Entergy Gulf States, Inc.;
LLC: No.

79;
Plant: Robinson (H. B.) Plant 2;
Licensed to own: Carolina Power & Light Co.;
LLC: No.

80;
Plant: Salem Nuclear Generating Station 1;
Licensed to own: PSEG Nuclear, LLC;
LLC: Yes;
License transfer date: 8/21/2000;
LLC parent company: Public Service Enterprise Group, Incorporated;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;
LLC parent company: Exelon Corporation.

81;
Plant: Salem Nuclear Generating Station 2;
Licensed to own: PSEG Nuclear, LLC;
LLC: Yes;
License transfer date: 8/21/2000;
LLC parent company: Public Service Enterprise Group, Incorporated;
Licensed to own: Exelon Generation Company, LLC;
LLC: Yes;
License transfer date: 1/12/2001;
LLC parent company: Exelon Corporation.

82;
Plant: San Onofre Nuclear Generating Station 2;
Licensed to own: Southern California Edison Company;
LLC: No.

83;
Plant: San Onofre Nuclear Generating Station 3;
Licensed to own: Southern California Edison Company;
LLC: No.

84;
Plant: Seabrook Nuclear Power Station;
Licensed to own: FPL Energy Seabrook, LLC;
LLC: Yes;
License transfer date: 11/1/2002;
LLC parent company: FPL Group, Inc.;
Licensed to own: Massachusetts Municipal Wholesale Electric Co.;
LLC: No;

Licensed to own: Tauton Municipal Lighting Plant;
LLC: No;
Licensed to own: Hudson Light & Power Department;
LLC: No.

85;
Plant: Sequoia Nuclear Plant 1;
Licensed to own: Tennessee Valley Authority;
LLC: No.

86;
Plant: Sequoia Nuclear Plant 2;
Licensed to own: Tennessee Valley Authority;
LLC: No.

87;
Plant: South Texas Project 1;
Licensed to own: Texas Genco, LP;
LLC: No;
Licensed to own: City Public Service Board of San Antonio;
LLC: No;
Licensed to own: Central Power & Light Company;
LLC: No;
Licensed to own: City of Austin, Texas;
LLC: No.

88;
Plant: South Texas Project 2;
Licensed to own: Texas Genco, LP;
LLC: No;
Licensed to own: City Public Service Board of San Antonio;
LLC: No;
Licensed to own: Central Power & Light Company;
LLC: No;
Licensed to own: City of Austin, Texas;
LLC: No.

89;
Plant: St. Lucie Plant 1;
Licensed to own: Florida Power and Light Company;
LLC: No.

90;
Plant: St. Lucie Plant 2;
Licensed to own: Florida Power and Light Company;
LLC: No;
Licensed to own: Florida Municipal Power Agency;
LLC: No;
Licensed to own: Orlando Utilities Commission;
LLC: No.

91;
Plant: Summer (Virgil C.) Nuclear Station;
Licensed to own: South Carolina Electric & Gas Company;
LLC: No;
Licensed to own: South Carolina Public Service Authority;
LLC: No.

92;
Plant: Surry Power Station 1;
Licensed to own: Virginia Electric and Power Company;
LLC: No.

93;
Plant: Surry Power Station 2;
Licensed to own: Virginia Electric and Power Company;
LLC: No.

94;

Plant: Susquehanna Steam Electric Station 1;
Licensed to own: PPL Susquehanna, LLC;
LLC: Yes;
License transfer date: 6/1/2000;
LLC parent company: Pennsylvania Power and Light Company.

95;

Plant: Susquehanna Steam Electric Station 2;
Licensed to own: PPL Susquehanna, LLC;
LLC: Yes;
License transfer date: 6/1/2000;
LLC parent company: Pennsylvania Power and Light Company.

96;

Plant: Three Mile Island Nuclear Station 1;
Licensed to own: AmerGen Energy Company, LLC;
LLC: Yes;
License transfer date: 12/20/ 1999;
LLC parent company: Exelon Corporation.

97;

Plant: Turkey Point Station 3;
Licensed to own: Florida Power and Light Company;
LLC: No.

98;

Plant: Turkey Point Station 4;
Licensed to own: Florida Power and Light Company;
LLC: No.

99;

Plant: Vermont Yankee Nuclear Power Station;
Licensed to own: Entergy Nuclear Vermont Yankee, LLC;
LLC: Yes;
License transfer date: 7/1/2002;
LLC parent company: Entergy Corporation;
Licensed to own: Entergy Nuclear Operations, Inc.;
LLC: No.

100;

Plant: Vogtle (Alvin W.) Nuclear Plant 1;
Licensed to own: Georgia Power Company;
LLC: No;
Licensed to own: Municipal Electric Authority of Georgia;
LLC: No;
Licensed to own: Oglethorpe Power Corporation;
LLC: No;
Licensed to own: City of Dalton, Georgia;
LLC: No.

101;

Plant: Vogtle (Alvin W.) Nuclear Plant 2;
Licensed to own: Georgia Power Company;
LLC: No;
Licensed to own: Municipal Electric Authority of Georgia;
LLC: No;
Licensed to own: Oglethorpe Power Corporation;
LLC: No;
Licensed to own: City of Dalton, Georgia;
LLC: No.

102;

Plant: Waterford Generating Station 3;
Licensed to own: Entergy Operations, Inc.;
LLC: No.

103;
Plant: Watts Bar Nuclear Plant 1;
Licensed to own: Tennessee Valley Authority;
LLC: No.

104;
Plant: Wolf Creek Generating Station;
Licensed to own: Kansas Gas & Electric Company;
LLC: No;
Licensed to own: Kansas City Power & Light Company;
LLC: No;
Licensed to own: Kansas Electric Power Cooperative, Inc.;
LLC: No.

Source: GAO survey of NRC Project Managers.

[End of table]

[End of section]

Appendix II: Comments from the Nuclear Regulatory Commission:

UNITED STATES NUCLEAR REGULATORY COMMISSION:
WASHINGTON, D.C. 20555-0001:

April 29, 2004:

Mr. James E. Wells:

Director, Natural Resources and Environment:
United States General Accounting Office:
441 G Street, N.W.
Washington, DC 20548:

Dear Mr. Wells:

I would like to thank you for the opportunity to review and submit comments on the May 2004 draft of the General Accounting Office's (GAO) report entitled "Nuclear Regulation-NBC's Liability Insurance Requirements for Nuclear Power Plants Owned by Limited Liability Companies." The U.S. Nuclear Regulatory Commission (NRC) appreciates the time and effort that you and your staff have taken to review this topic.

GAO correctly concludes that NRC does not treat limited liability companies differently than other licensees with respect to the Price-Anderson's insurance requirements. Like other licensees, limited liability companies must show proof of both primary and secondary financial protection. GAO also is correct in noting that NRC is not aware of any problems caused by limited liability companies owning nuclear power plants and that NRC currently does not regard limited liability companies' ownership of nuclear power plants as a concern. Finally, GAO agrees with NBC's conclusion that all its reactor licensees have sufficient assets that they are likely to be able to pay the retrospective premiums. These assets are assured by a number of different methods that are approved by NRC as GAO discusses in its report.

The NRC believes that the GAO report accurately reflects the present insurance system for nuclear power plants. Therefore, we do not have any comments to provide regarding the draft report.

Sincerely,

Signed by:

William D. Travers:
Executive Director for Operations:

cc: Ilene Pollack, GAO:

(360330):

FOOTNOTES

[1] Although 104 commercial nuclear power plants are licensed to operate in the United States, 1 plant, Browns Ferry Unit 1, was shut down in 1985 and remains idle.

[2] NRC's regulations define a nuclear incident as any occurrence that causes bodily injury, sickness, disease, or death or loss of or damage to property or for loss of the use of property arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of the source, special nuclear or byproduct material.

[3] NRC regulations also require licensees to maintain \$1 billion in on-site property damage insurance to provide funds to deal with cleanup of the reactor site after an accident.

[4] The average annual premium for a single nuclear power plant at a site is about \$400,000. The premium for a second or third plant at the same site is discounted because the maximum amount of primary insurance for a multi-plant site is \$300 million.

[5] Fifteen licensees continue to provide financial statements to NRC.

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EXHIBIT DD



Department of Energy

Idaho Operations Office
1955 Fremont Avenue
Idaho Falls, ID 83415

June 29, 2007

Sherwood Martinelli
351 Dyckman Street
Peekskill, New York 10566

SUBJECT: Freedom of Information Act Request 07-044 Martinelli (OM-PA-07-060)

Dear Mr. Martinelli:

This letter is in partial response to your Freedom of Information Act (FOIA) request in which you asked the Department of Energy (DOE) for documents that relate to or are created to assist the nuclear industry to identify long-term aging issues and problems of nuclear power plants.

Your request was modified in a letter dated May 29, 2007 in which you specifically asked for the following information:

1. Correspondence from NEPO that relates to research and /or effort to address licensing/re-licensing issues of nuclear facilities from 1999 to 2006, specifically reactors, and research conducted into ageing, degradation, and security issues at nuclear facilities; and
2. Correspondence between the DOE, NRC, and NEI and/or owners of nuclear facilities from 1999 to 2006 that relates to research and/or efforts to address licensing/re-licensing issues of nuclear facilities, specifically reactors, and research conducted into ageing, degradation, and security issues at nuclear facilities.

Per a letter to you dated May 30, 2007 from Abel Lopez, Director of the FOIA/ Privacy Act Office at DOE Headquarters, your request was transferred to the DOE Office of Nuclear Energy (DOE-NE) to conduct a search of its files for any documents responsive to your request. Your request to receive a waiver of fees for processing the request was also granted at that time.

The DOE-NE has conducted a thorough search of its files located both at the DOE Headquarters Office as well as the Idaho Operations Office and has found documents responsive to your request.

Enclosed, please find 18 reports that are considered responsive to Item 1 of your request. These reports have been reviewed and determined to be fully releasable to you under the provisions of the FOIA. A complete document index is also enclosed for your convenience.

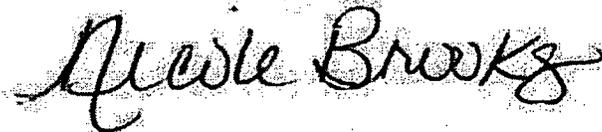
Further, several additional documents were located that may be responsive to Items 1 and 2 of your request. Due to the volume of these documents and the need to coordinate with other DOE Offices, additional time is needed to conduct a review and release determination in accordance

with the FOIA. It is estimated that a final response will be provided to you on or before October 27, 2007 regarding these additional documents.

As the Authorizing and Denying Official, it is my duty to inform you of your right to appeal this decision to the Office of Hearings and Appeals. All of the information you need to file an appeal is enclosed.

If you have any questions regarding this letter or the enclosures, please feel free to contact me at (208) 526-0709.

Sincerely,



Nicole Brooks
Freedom of Information Officer, DOE-ID

Enclosures

EXHIBIT FF

FE

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

May 2, 2003

**NRC REGULATORY ISSUE SUMMARY 2003-09
ENVIRONMENTAL QUALIFICATION OF LOW-VOLTAGE
INSTRUMENTATION AND CONTROL CABLES**

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

INTENT

The U.S. Nuclear Regulatory Commission (NRC) is issuing this regulatory issue summary (RIS) to inform addressees of the results of the technical assessment of GSI-168, "Environmental Qualification of Low-Voltage Instrumentation and Control (I&C) Cables." The scope of GSI-168 is limited to safety-related, low-voltage I&C cables. This RIS requires no action or written response on the part of an addressee.

BACKGROUND

In support of the resolution of GSI-168, the NRC sponsored cable test research at Wyle Laboratories and the Brookhaven National Laboratory. The resulting NRC technical assessment was essentially based on reviews and analyses of the research results of six loss-of-coolant-accident (LOCA) cable tests, condition-monitoring tests on I&C cables, and information provided by the nuclear industry. Technical assessments were coordinated with the nuclear industry and the Institute of Electrical and Electronics Engineers.

Following the completion of the NRC research effort, the staff concluded that typical I&C cable qualification test programs include numerous conservative practices that collectively provide a high level of confidence that the installed I&C cables will perform their intended functions during and following design basis events as required by 10 CFR 50.49, "Environmental Qualification (EQ) of Electric Equipment Important to Safety for Nuclear Power Plants." These conservative practices continue to support the current use of a single prototype during qualification testing and, therefore, a successful test provides a high level of confidence that these cables will be able to perform their safety functions during and following a design basis event. However, cable LOCA test failures that occurred during the NRC-sponsored research program indicate that in certain cases the original margin and conservatism inherent in the qualification process have been reduced. Licensees have stated in a few cases that a reduction in margin can be addressed by monitoring operating service environments (temperature, radiation, and humidity)

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to ensure that operating conditions do not exceed the parameters that were assumed during qualification testing. In this regard, walkdowns to look for any visible signs of anomalies attributable to aging, with particular emphasis on localized adverse environments, coupled with the knowledge of the operating service environments, could be sufficient to ensure that qualification is maintained.

DISCUSSION OF TECHNICAL ASSESSMENT

The technical assessment of GSI-168 is based on reviews and analyses of the research results of six LOCA tests, condition-monitoring tests on I&C cables, and information provided by the nuclear industry. Summaries of significant research findings are presented below. Details of the NRC technical assessment of GSI-168 are available in the NRC Agencywide Documents Access and Management System (ADAMS), Accession No. ML021790551.

Current EQ Process (40 Years)

The current EQ process is adequate for assuring that low-voltage I&C cables will perform their intended functions for 40 years. When I&C cables are qualified in accordance with NRC regulations, the overall EQ process provides reasonable assurance that I&C cables will perform their intended safety-related functions during their qualified life. Specifically, 10 CFR 50.49(e) requires consideration of all significant types of aging degradation that can affect the component's functional capability. Compliance with 10 CFR 50.49 provides reasonable assurance that the cables will perform their intended functions during and following design basis events after exposure to the effects of service condition aging. Further, some licensees have implemented monitoring programs to ensure that service conditions will not exceed those assumed during the original qualification. Inspection, surveillance, condition monitoring, and trending of selected parameters for any installed safety-related cable system could increase the confidence in cable performance.

EQ Process for License Renewal (60 Years)

Licensees that have addressed license renewal recognize that knowledge of the operating service environments is essential to extending the qualified life of I&C cables. Where measured environmental service conditions are less severe than those used in the original qualification and when the cables are not degraded, the licensees assessed the difference between the operating environment and the original qualification environment to extend the qualified life of the cables to 60 years by reanalysis. This approach, based on the Arrhenius methodology, has been found acceptable by the staff during its review of license renewal applications.

Results of Cable LOCA Tests

Detailed information on the six cable LOCA tests conducted at Wyle Laboratories is provided in NUREG/CR-6704, "Assessment of Environmental Qualification Practices and Condition Monitoring Techniques for Low-Voltage Electric Cables." It should be noted that the LOCA conditions selected for the simulated tests were consistent with those used in the original qualification of the cables. All cable specimens in Test Sequences 1, 2, and 3 passed the LOCA test and the voltage withstand test. Samuel Moore cable specimens failed the voltage withstand test during Test Sequence 4, and Okonite bonded-jacket cable specimens failed the

LOCA test and the voltage withstand test in Test Sequence 5. All of the Test Sequence 6 cable specimens, aged to 60 years, exhibited high leakage currents and several cable specimens failed the voltage withstand test. The summary results of the six test sequences are discussed in Attachment 1.

Research Findings on Cable Condition-Monitoring Techniques

NRC research results on I&C cables indicate that meaningful information can be derived from testing samples of polymeric materials under controlled laboratory conditions. With certain limitations (accessibility being the biggest limitation), some of these test results can be applied in the in situ assessment of installed cable systems. The research concluded that a combination of condition-monitoring techniques could be effective since no single technique is currently adequate to detect insulation degradation of I&C cables. Based on the test results, conclusions were drawn regarding the effectiveness of the techniques studied for monitoring cable condition and are presented in the attachment.

Industry Good Practices for Condition-Monitoring

During the NRC review of GSI-168, the industry stated that cable aging evaluations are ongoing throughout plant life. When unexpected localized adverse conditions are identified, the condition of the affected cables is evaluated and appropriate corrective action is taken. Monitoring or inspection of environmental conditions or component parameters was generally conducted to ensure that the component is within the bounds of its qualification basis. The combination of licensee-specific activities and industry-supported activities that were developed for condition-monitoring can support a high level of confidence that installed safety-related cables would remain qualified to perform their safety functions in the event of an accident. In addition, the nuclear industry continues to advance the state-of-the-art in cable condition-monitoring from the simplest techniques to the most sophisticated. The staff has concluded that, although a single reliable condition-monitoring technique does not currently exist, walkdowns to look for any visible signs of anomalies attributable to cable aging, coupled with monitoring of operating environments, have proven to be effective and useful.

Risk Assessment

The state-of-the-art for incorporating cable aging effects into probabilistic risk assessment is still evolving and current assumptions that need to be made on the failure rate and common cause effects are based on sparse data. One of the key assumptions of the risk assessment is that operating environments are less severe than or the same as those assumed during qualification testing. These assumptions can be relied upon provided licensees have ongoing knowledge of environmental operating conditions at the nuclear power plants.

SUMMARY OF ISSUE

The technical assessment of GSI-168 is complete and the research findings are published in NUREG/CR-6704, Vols. 1 and 2 (Accession Nos. ML010460247 and ML010510387). The significant research findings that resulted from this effort are as follows:

- The current equipment qualification process for low-voltage I&C cables is adequate for the duration of the current license term of 40 years.
- Because of the failures of some I&C cables in the NRC LOCA tests, the original margin and conservatism inherent in the qualification process have been reduced. Adequate margin may be ensured through ongoing monitoring of plant operating environments to confirm that service conditions do not exceed those assumed during qualification testing and the cables are within the bounds of their qualification basis.
- Walkdowns, with particular emphasis on the identification of localized adverse environments, to look for any visible signs of anomalies attributable to cable aging, coupled with the monitoring of operating environments, were proven to be effective and useful for ensuring qualification of cables.
- For license renewal, a reanalysis (based on the Arrhenius methodology) to extend the life of the cables by using the available margin based on a knowledge of the actual operating environment compared to the qualification environment, coupled with observations of the condition of the cables during walkdowns, was found to be an acceptable approach.
- A combination of condition-monitoring techniques may be needed since no single technique is currently demonstrated to be adequate to detect and locate degradation of I&C cables. Monitoring I&C cable condition could provide the basis for extending cable life.

BACKFIT DISCUSSION

This RIS requests no action or written response. Consequently, the staff did not perform a backfit analysis.

FEDERAL REGISTER NOTIFICATION

A notice of opportunity for public comment was not published in the *Federal Register* because this RIS is informational.

PAPERWORK REDUCTION ACT STATEMENT

This RIS does not request any information collection.

If there are any questions concerning this RIS, please contact the person noted below.

/RA/

William D. Beckner, Program Director
Operating Reactor Improvements Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Technical Contact: T. Koshy, NRR
301-415-1176
E-mail: txk@nrc.gov

Attachments:

1. Results of Cable LOCA Tests and Findings On Cable Condition-Monitoring Techniques
2. List of Recently Issued NRC Regulatory Issue Summaries.

Test Sequence 3. XLPE-Insulated Cables Aged to 40 Years

The test specimens were cross-linked-polyethylene (XLPE)-insulated cables with a Neoprene overall outer jacket manufactured by Rockbestos, with the trade name "Firewall III." The preaging parameters for the four groups of specimens in this test sequence were as follows:

- Group 1. No accelerated aging (control specimens)
- Group 2. Accelerated aging to simulate the exposure of the naturally aged specimens (9.93 hr @ 248 °F + 2.27 Mrad)
- Group 3. Naturally aged 10-year-old cable
- Group 4. Accelerated aging to simulate 40 years of qualified life (1301.16 hr @ 302 °F + 51.49 Mrad)

The LOCA conditions simulated included exposure to 150 Mrad of accident radiation followed by exposure to steam (using the same LOCA profile as used in Test Sequence 1) and chemical spray.

One of the Group 4 specimens did not hold the full 500 volts used for insulation resistance (IR) testing even after its splices were removed. The cause of this failure was determined to be human error in handling the test specimen. With the exception of the damaged specimen, all cable specimens passed the LOCA test sequence, including the post-LOCA voltage withstand test.

Test Sequence 4. Multiconductor Cables

The objective of this test sequence was to determine whether multiconductor cables have any unique failure mechanisms that are not present in single-conductor cables. The test specimens were #12 AWG, 3/C, 1,000V EPR-insulated cables with individual and outer CSPE jackets manufactured by Anaconda. In addition, this test sequence included #16 AWG, 2/C, 600V Samuel Moore cables with ethylene propylene diene monomer (EPDM) insulation and a CSPE bonded individual jacket with a Dekorad overall outer jacket. The preaging groups in this test sequence were as follows:

- Group 1. Anaconda and Samuel Moore cables with no accelerated aging (control specimens)
- Group 2. Samuel Moore cables with accelerated aging to simulate 20 years of qualified life (84.85 hr @ 250 °F + 25.99 Mrad)
- Group 3. Anaconda cables (169.20 hr @ 302 °F + 53.60 Mrad) and Samuel Moore cables (169.05 hr @ 250 °F + 51.57 Mrad) with accelerated aging to simulate 40 years of qualified life.

The LOCA conditions simulated included exposure to 150 Mrad of accident radiation followed by steam (346 °F and 113 psig peak conditions, as used in Test Sequences 1 and 3) and chemical spray. During the post-LOCA voltage withstand test, all of the Anaconda cables and Samuel Moore cables aged to simulate 20 years performed acceptably. However, two out of three Samuel Moore specimens aged to simulate 40 years could not hold the 2,400V test voltage on one conductor. Inspection of the two specimens revealed a single pinhole in the insulation of each failed conductor. It was concluded that the failures were due to localized degradation of the insulation, which caused the high-potential test to puncture the insulation on

the two failed conductors. There was no general degradation of the insulation along the length of the cable specimens and no unique failure mechanism was observed between the single-conductor and multiconductor cables. Therefore, based on these test results, the issue of a unique failure mechanism for multiconductor vs. single-conductor low-voltage I&C cables was not demonstrated.

Test Sequence 5. Bonded Jacket Cables

The samples used in this sequence were Anaconda 3/C, #12AWG, 1,000V cables with EPR insulation and a CSPE jacket; Samuel Moore 2/C, #16 AWG, 600V cables with EPDM insulation and a CSPE jacket; and Okonite 1/C, #12 AWG, 600V cables with EPR insulation and a CSPE jacket. The preaging groups in this test sequence were as follows:

- Group 1. Specimens with no accelerated aging (control specimens)
- Group 2. Specimens from A, S, and O with accelerated aging to simulate 20 years of qualified life (A: 84 hr @ 302 °F + 25.69 Mrad; S: 84 hr @ 250 °F + 25.99Mrad; and O: 252 hr @ 302 °F + 25.79 Mrad)
- Group 3. Specimens from A, S, and O with accelerated aging to simulate 40 years of qualified life (A: 169 hr @ 302 °F + 51.35 Mrad; S: 169 hr @ 250 °F + 51.57 Mrad; and O: 504 hr @ 302 °F + 51.49 Mrad)

The LOCA conditions simulated included exposures to 150 Mrad of accident radiation, followed by steam (double-peak LOCA profile, as used in Test Sequences 1 and 3 with a test duration of 10 days) and chemical spray. After post-LOCA inspections, a voltage withstand test was conducted on each of the cable specimens. All of the Samuel Moore and Anaconda cables performed acceptably, while one of the two Okonite specimens in Group 2 and all 3 Okonite specimens in Group 3 failed the 2,400V voltage withstand test. It was observed that the insulation on the Okonite cables had split open along their length during the simulated LOCA, exposing the bare conductor underneath. It was concluded that the failures in the Okonite specimens were caused by differential swelling of the bonded CSPE individual jacket and the underlying EPR insulation.

The Okonite Company has subsequently requalified the 1/C, #12 AWG Okonite Okolon composite cable based on an Arrhenius activation energy of 1.24eV. Calculations using this activation energy (225 hr @ 150 °C + 200 Mrad and 300 hr @ 150 °C + 100 Mrad) extrapolate to a 40-year qualified life at 75 °C and 77 °C, respectively. Additional details of the recent Okonite cable requalification program are contained in Regulatory Issue Summary 2002-11 (ADAMS Accession No. ML022190099), issued August 9, 2002.

Test Sequence 6: EPR- and XLPE-Insulated Cables Aged to 60 Years

The test specimens were Rockbestos cables (same as Test Sequences 1 and 3), AIW cables (same as Test Sequence 2), Samuel Moore cables (same as Test Sequences 4 and 5), and Okonite cables (same as Test Sequence 5). The preaging groups in this test sequence were as follows:

- Group 1: No accelerated aging (control specimens)

Group 2: Rockbestos cables (1366 hr @ 302 °F +77 Mrad), Okonite cables (756 hr @ 302 °F + 77 Mrads), AIW cables (252 hr @ 250 °F + 38 Mrad), and Samuel Moore cables (252 hr @ 250 °F + 77 Mrad) with accelerated aging to simulate 60 years of qualified life.

The LOCA conditions simulated included exposure to either 75 Mrad (AIW cables only) or 150 Mrad of accident radiation, followed by exposure to steam (double-peak LOCA profile, as used in Test Sequences 1 and 3, with peak conditions of 346 °F and 113 psig and a duration of 10 days) and chemical spray.

Following the post-LOCA investigation, the test specimens were subjected to a voltage withstand test. In general, *all* of the specimens aged to 60 years exhibited a weakening of the insulation, which was manifested in the form of high leakage currents. Some of the specimens were unable to hold the required 2,400V of the voltage withstand test.

Error in Irradiation Dose

Following the completion of cable LOCA testing at Wyle Laboratories, the Georgia Institute of Technology notified Wyle Laboratories of an error in irradiation dose that affected LOCA tests 2 through 6. All specimens received irradiations from 6% to 10.5% lower than previously reported. Prior to completion of the GSI-168 technical assessment, the reported error in irradiation dose was evaluated by the Brookhaven National Laboratory and the NRC staff to determine if this error would impact the research findings. The staff's review concluded that none of the conclusions of the GSI-168 technical assessment are impacted by this error. The staff recognizes that the radiation dose of 50 Mrad used for qualification is conservative when compared to the 40-year dose seen during normal service in a nuclear power plant.

RESEARCH FINDINGS ON CABLE CONDITION-MONITORING TECHNIQUES

Based on the results of the testing, the following conclusions were drawn regarding the effectiveness of the techniques studied for monitoring cable condition.

Visual Inspection

Visual inspection does not provide quantitative data; however, it does provide useful information on the condition of the cable that is relatively easy and inexpensive to obtain and that can be used to determine whether further investigation of the cable condition is warranted. Visual inspection is demonstrated to be a valuable source of information in any cable condition-monitoring program.

Elongation at Break (EAB)

EAB was found to be a reliable technique for determining the condition of the polymers studied. While EAB provides trendable data that can be readily correlated with material condition, it is a destructive test and cannot be used as an in situ means of monitoring electric cables unless sacrificial cable specimens are available.

Oxidation Induction Time Method (OITM)

OITM was found to be a promising technique for monitoring the condition of electric cables. Results show that aging degradation can be trended with this technique for both XLPE and EPR insulation. However, a small sample of cable material is needed to perform this test.

Oxidation Induction Temperature (OIT)

OIT, which is related to OITM, was found to be less sensitive for detecting aging degradation of the polymers studied. OITM is preferred at this time.

Fourier Transform Infrared (FTIR) Spectroscopy

In terms of ability to trend aging degradation in the polymers studied, FTIR spectroscopy was found to provide inconclusive results. The results tend to show a consistent trend with age. However, the technical basis for the trend remains questionable.

Indenter

The indenter was found to be a reliable device that provides reproducible, trendable data for monitoring the degradation of cables in situ. It is limited to accessible sections of the cable, but it was found to be effective for monitoring the condition of common cable jacket and insulation materials and can be used for monitoring localized and accessible segments of low-voltage electric cables.

Hardness

The results of the hardness test indicate that, over a limited range, hardness can be used to trend cable degradation. However, different probes must be used to accommodate the change in material hardness. Also, puncturing the cable insulating material is a potential concern with this technique and must be taken into consideration.

Insulation Resistance

Degradation of cable insulation can be trended with this technique. As cables degrade, a definite change in insulation resistance can be detected that can be correlated to cable condition. Using 1-minute and 10-minute readings to calculate the polarization index enables the effects of temperature and humidity variations to be accounted for. This technique can be used as an in situ condition-monitoring technique.

Dielectric Loss

This technique was found to provide useful data for trending the degradation of cable insulation. As the cables degrade, a definite change in phase angle between an applied test voltage and the circuit current can be detected at various test frequencies and correlated to cable condition. This technique can be used as an in situ condition monitoring technique. However, it is more effective when a ground plane is an integral element of a cable system.

Functional Performance

This technique alone does not provide sufficient data to determine the condition of a cable. It is a "go—no go" type of test and may not be effective in detecting degraded conditions and impending failures. Further, functional performance testing is not considered an effective method for determining, in situ, the LOCA survivability for a particular cable.

Voltage Withstand

The capability of the insulating materials to withstand the circuit voltage is an indication of its dielectric performance. In order to detect defects in an incipient state, applied voltages may have to be elevated considerably above the rated voltages of the systems; further, the equipment at both ends of a cable system under test must be either disconnected or protected. Voltage withstand tests may result in unanticipated degradation of cables and can result in failures. Therefore, the risk of causing either catastrophic or incipient damage to cable insulation makes this an unsuitable method for assessing the LOCA survivability of low-voltage electric cables in situ.

UNITED STATES
NUCLEAR REGULATORY COMMISSION

In the Matter of)
ENTERGY NUCLEAR INDIAN POINT 2, L.L.C.) Docket No. 50-247
and ENTERGY NUCLEAR OPERATIONS, INC.) License No. DPR 26
Indian Point Entergy Center Unit 2)
License Renewal Application)

SECOND DECLARATION OF ULRICH WITTE
Review of Contention 17

1. My name is Ulrich Witte. "Friends United for Sustainable Energy" (FUSE) have retained me as a consultant with respect to the above-captioned proceeding. I am a mechanical engineer with over twenty-six years of professional experience in engineering, licensing, and regulatory compliance of commercial nuclear facilities. I have considerable experience and expertise in the areas of configuration management, engineering design change controls, and licensing basis reconstitution. I have authored or contributed to two EPRI documents in the areas of finite element analysis, and engineering design control optimization programs. I have led industry guidelines endorsed by the American National Standards Institute regarding configuration management programs for domestic nuclear power plants. My 26 years of experience has generally focused on assisting nuclear plant owners in reestablishing fidelity of the licensing and design bases with the current plant design configuration, and with actual plant operations. In short, my expertise is in assisting problematic plants where the regulator found reason to require the owner to reestablish competence in safely operating the facility in accordance with regulatory

requirements. My curriculum vitae is attached hereto as Attachment A to my first declaration.

2. I submit the following comments in support of Contentions 17, Safety/Aging Management: Applicant's LRA for Indian Point 2 is insufficient in managing the environmental qualification required by federal rules mandated after Three Mile Island that are required to mitigate numerous design basis accidents to avoid a reactor core melt and to protect the health and safety of the public.

With the wealth of in situ data available to validate the Equipment Qualification methodology since 10CFR50.49 was first promulgated, the controversial methodology surrounding accelerated aging remains. In particular the validity of the Arrhenius aging methodology. I personally provided equipment qualification analysis during the early 1980s for a number of licensees. The definition of passive versus active components is ambiguous. Uncertainty and unreliability is shown by the numerous citations made in the contention, and are specific to Unit 2. Even within the ACRS this issue appears to be unresolved.

Extrapolating from a few days of accelerated testing to 40 years is subject to substantial uncertainty. Ignoring years of in situ data appears to be bypass opportunities to validate or correct what appears to the industry as tenuous at best. Cost estimates for replacement of cables to qualified cables were estimated for example by Monticello of 40 million dollars. Extrapolating to 60 years needs validation—however, insufficient analysis is being performed given that the consequences of negative outcome is high.

Sufficient years of equipment qualification scope service is available. Materials and components that have been in service in operating reactors should be acquired specifically from Indian Point Unit 2, to be used for comparison with laboratory aged materials, to validate models for aging effects, and to validate nondestructive examination methods. Obtaining 60-year equivalent aging data to support plant licensing in laboratory

testing requires accelerating the aging process, e.g., using artificially high temperatures or radiation dose rates and extrapolating short duration test data. These results need to be "benchmarked" against components and materials that have aged under prototypical operating conditions. In some cases, electrical cables, the components of interest may become available because they have been replaced. In others they can be obtained from plants which have been retired from service. Opportunities to obtain this information in the past have been lost due to 1) the unavailability of resources, 2) the lack of a systematic evaluation of the needs for component retrieval and assessment, and 3) the relatively short "window of opportunity" to obtain such components before they are sent for disposal at a waste storage site or otherwise rendered inaccessible.

The Environmental Qualification program is a well established program to ensure that electrical components, such as cables, that may be subject to a harsh environment are properly constructed to perform their intended function even when subject to that harsh environment. This new program called for requires periodic visual inspections of accessible, i.e. able to be approached and viewed easily, non-EQ cables which are in the scope of license renewal. The inspections will look for cable and connection jacket surface anomalies such as embrittlement, discoloration, cracking, or surface contamination. Such jacket surface anomalies are precursors of insulation aging degradation and may indicate adverse localized equipment environments caused by heat or radiation which can accelerate aging of electrical cables. These visual inspections are to be performed at least once every ten years. The initial inspections are to be performed following the issuance of the renewed operating licenses and prior to the end of the current operating license for Unit 2. The Applicant does not include plans or procedures for this AMP.

Second, inaccessible Medium Voltage Cables Aging Management Program and testing of on inaccessible, e.g. in conduit or direct buried, non-EQ medium voltage cables that are exposed to significant moisture simultaneously with significant voltage needs to be addressed. Significant moisture is defined as exposure to long term, such as a few years, continuous standing water. Significant voltage is defined as being energized for more than twenty-five percent of the time. The cables require periodically testing to provide an indication of the condition of the conductor insulation and the ability of the cable to perform its intended function. The actual type of test has yet to be determined. The initial tests are to be performed following the issuance of the renewed operating licenses and prior to the end of the current operating license for unit 2. The tests will be repeated with a 10 year frequency. The Applicant has shown no evidence of inspection procedures for this AMP.

In addition, chapter 7 of the FSAR provides:

Category 1 – Instrumentation

Except for sump level channels LT-938, 939, 940, and 941, the supplier completed preliminary qualification tests on pressure and differential pressure transmitters. These are reported in WCAP-7354-L,² which has been superceded by WCAP-7410-L.³

Additional instrumentation tests were performed by Westinghouse on equipment obtained from the Indian Point Unit 2 plant equipment supplier. The results of these tests confirmed that the equipment would provide the required signals in the post-LOCA environment.

The test conditions of the Westinghouse test were as follows:

steam environment, a 5-sec period rise to 286°F and 60-psig pressure and the maintenance of these conditions for 2 hr. All equipment, listed below, continued to operate throughout the test and are typical of transmitter ranges used in the containment.

<u>Static Pressure</u>	<u>Differential Pressure</u>
<u>Transmitters</u>	<u>Transmitters</u>
0-2500 psig	0-240-in. of water
1700-2500 psig	0-300 psid

Containment sump and recirculation sump level channels consist of hermetically sealed magnetic switches in a stainless steel housing. The instrumentation was designed for submerged service in borated water at 295°F at a pressure of 69 psig. Since instruments of this design have seen considerable actual service in applications more severe than the post-LOCA design conditions, environmental testing for these instruments was not required.

The question remains as to how these 40-60 year old instruments can be shown to still meet this acceptance criteria. No where does the applicant discuss surveillance, or planned replacement of these components. No where does the licensee provide confidence that a fifty year old instrument will survive submerged service at almost 300 deg F, and 69 psig.

This is only one example of the incomplete program as described by the Applicant in the LRA.



Ulrich Witte

EXHIBIT II

**UNITED STATES
NUCLEAR REGULATORY COMMISSION**

<i>In the Matter of</i>)	
ENERGY NUCLEAR INDIAN POINT 2, L.L.C.	)	Docket No. 50-247
and ENERGY NUCLEAR OPERATIONS, INC.	)	License No. DPR 26
Indian Point Entergy Center Unit 2)	
License Renewal Application)	

**THIRD DECLARATION OF ULRICH WITTE
Review of Contention 20**

1. My name is Ulrich Witte. "Friends United for Sustainable Energy" (FUSE) have retained me as a consultant with respect to the above-captioned proceeding. I am a mechanical engineer with over twenty-six years of professional experience in engineering, licensing, and regulatory compliance of commercial nuclear facilities. I have considerable experience and expertise in the areas of configuration management, engineering design change controls, and licensing basis reconstitution. I have authored or contributed to two EPRI documents in the areas of finite element analysis, and engineering design control optimization programs. I have led industry guidelines endorsed by the American National Standards Institute regarding configuration management programs for domestic nuclear power plants. My 26 years of experience has generally focused on assisting nuclear plant owners in reestablishing fidelity of the licensing and design bases with the current plant design configuration, and with actual plant operations. In short, my expertise is in assisting problematic plants where the regulator found reason to require the owner to reestablish competence in safely operating the facility in accordance with regulatory

requirements. My curriculum vitae is attached hereto as Attachment A to my first declaration.

2. Contention 20: Leak-Before-Break analysis is unreliable for welds associated with high energy line piping containing certain alloys at Indian Point Unit 2.

Certain locations of piping systems that are susceptible to stress corrosion cracking do not qualify for Leak-Before-Break (LBB) relief. Previously, butt welds associated with 82/182 alloys for example were considered to be free of SCC problems since PWRs operate in low oxygen environments. However, more recent events with these welds have made use of Leak-Before-Break (LBB) questionable for these weld alloys. These include VC Summers, and other PWR plants.

Industry guidance as well as emerging regulatory funded studies memorialized in a NUREG "Conference on Vessel Penetration Inspection, Crack Growth and Repair" have specifically warned against traditional reliance of Leak-Before-Break (LBB) credited in Section 4.7.2 of IP2 Section 4 LRA, partly because of the nickel-based alloy weld. [page 4.7-2 of the LRA].

Indian Point 2's LRA does not address this potential safety threat, and relies wholly on previous studies such as WCAP-10977m and WCAP-10931. These studies are out of date. See for example, NUREG/CR-6936. "Probabilities of Failure and Uncertainty Estimate Information for Passive Components – A Literature Review."

In addition, the NRC announced on March 13, 2007, the licensees of 40 pressurized water reactors will raise levels of vigilance concerning reactor coolant system (RCS) welds. The US Nuclear Regulatory Commission (NRC) has issued Confirmatory Action Letters (CALs) confirming the licensees' commitment to put in place "more timely inspection and [weld] flaw prevention measures, more aggressive

monitoring of RCS leakage, and more conservative leak rate thresholds for a plant to shut down to investigate a possible [coolant water] leak.” The measures should be put in place and welds inspected during an outage before the end of 2007. If no outage is scheduled this year, they must justify an extended schedule to the NRC.

The concerns are centered on welds containing Alloy 82 and Alloy 182, used to weld together alloys like Inconel 600 and 601 as well as dissimilar metals such as carbon steel and stainless steel. The steps were taken after the discovery of certain flaws in the welds of the pressurizer at the Wolf Creek plant, which “were repaired and did not affect the safe operation of the plant.” The CALs are an interim measure while the American Society of Mechanical Engineers updates its Boiler and Pressure Vessel Code, which will subsequently be reviewed and incorporated into NRC requirements. See Declaration Number of Ulrich Witte contained in exhibit II.

I cannot therefore agree with the Applicant’s LRA for Indian Point 2 because it does not contain a reliable and adequate Aging Management Plan with regard to piping and welds, specifically Leak-before-Break (LBB), and without addressing and without remediating this issue specific to Unit 2, the licensee puts at risk public health and safety during the 20 year new superseding license.



Ulrich Witte

EXHIBIT JJ



Entergy Nuclear Northeast
Indian Point Energy Center
295 Broadway, Suite 1
P.O. Box 249
Buchanan, NY 10511-0249

James Comiotes
Director, Nuclear Safety Assurance
Tel 914 271-7130

July 31, 2006

Re: Indian Point Units 1, 2 and 3
Docket Nos. 50-003, 50-247 and 50-286
NL-06-079

Document Control Desk
U.S. Nuclear Regulatory Commission
Mail Stop O-P1-17
Washington, DC 20555-0001

Subject: Ground Water Protection Baseline Information
Indian Point Energy Center – Units 1, 2 and 3

Dear Sir or Madam:

The nuclear industry, in conjunction with the Nuclear Energy Institute (NEI), developed a questionnaire to facilitate compilation of baseline information regarding the current status of site programs for monitoring and protecting ground water. All participating nuclear sites agreed to provide the requested information to both NEI and the Nuclear Regulatory Commission.

Attachment 1 to this letter contains the questionnaire response for Indian Point Energy Center (IPEC). Please contact Mr. Patric W. Conroy at (914) 734-6668 if you have any questions or comments regarding this submittal.

There are no new commitments contained in this submittal.

Sincerely,

Patric W. Conroy for
James Comiotes
Director, Nuclear Safety Assurance
Indian Point Energy Center

Attachment 1 (Ground Water Protection Questionnaire Response)

cc: see next page

IE25

cc: Mr. John P. Boska
U.S. Nuclear Regulatory Commission

Mr. Samuel J. Collins
U.S. Nuclear Regulatory Commission

Resident Inspector's Office
Indian Point Unit 2 Nuclear Power Plant
U.S. Nuclear Regulatory Commission

Mr. Paul Eddy
New York State Dept. of Public Service

Mr. Ralph Anderson
Nuclear Energy Institute

ATTACHMENT 1 TO NL-06-079

GROUND WATER PROTECTION QUESTIONNAIRE RESPONSE

INDIAN POINT UNITS 1, 2 and 3

**ENTERGY NUCLEAR OPERATIONS, INC.
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 1, 2 AND 3
DOCKET NOS. 50-003, 50-247, AND 50-286**

Ground Water Protection Questionnaire Response
Indian Point Energy Center (IPEC)

1. Briefly describe the program and/or methods used for detection of leakage or spills from plant systems, structures, and components that have a potential for an inadvertent release of radioactivity from plant operations into ground water.

Response: IPEC has identified radioactive contamination in its on-site ground water. This contamination is currently being characterized to determine the sources of this contamination, as well as the nature and extent of the resulting ground water contamination plumes. As such, IPEC's ground water monitoring program is primarily focused on identifying the source of and characterizing after the fact release conditions. However, the program does include provisions for detecting leakage from potential future inadvertent releases to ground water. They include

- Operator plant rounds include inspection for leaks and spills,
- Radiation Protection surveys include inspection for leaks and spills,
- Leaks/spills documented in corrective action program,
- Inspection of systems, structures and components to identify potential leak points,
- Radioactive Effluent Monitoring Program (REMP) Sampling,
- Storm drain periodic sampling program, and
- Corrective action program reporting/trending.

2. Briefly describe the program and/or methods for monitoring onsite ground water for the presence of radioactivity released from plant operations.

Response: IPEC is in the process of investigating known Tritium and Sr-90 ground water contamination, resulting from leaks from the Unit 1 and 2 spent fuel pools (SFP). Other potential sources of leakage are also within the scope of this investigation. To accomplish this objective, a program for characterizing the nature and extent of the resulting ground water contamination and the site's hydro-geological characteristics is being conducted. As a part of this program, more than 30 monitoring wells have been installed throughout the site for the purpose of sampling ground water and obtaining hydro-geological data. These monitoring wells are sampled on a periodic basis, with the samples analyzed for Tritium, Sr-90 and gamma emitters. Upon conclusion of this investigation and any warranted remediation, these investigation monitoring wells will be transitioned into a long-term ground water monitoring program.

3. If applicable, briefly summarize any occurrences of inadvertent releases of radioactive liquids that have been documented in accordance with 10 CFR 50.75(g).

Response: The most significant sources for potential releases to ground water include leakage from the Unit 1 and 2 SFPs, storm drains with contaminated sediment resulting from past spills, and an impoundment containing contaminated soil from a Unit 1 septic leach field that was excavated for construction of Unit 3. Other smaller inadvertent releases and spills have also occurred.

Handwritten signature or scribble consisting of several overlapping, curved lines.

EXHIBIT KK

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Indian Point 2 2Q/2007 Plant Inspection Findings

Initiating Events

Significance: [REDACTED] Mar 31, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

FAILURE TO INCORPORATE DESIGN BASIS INFORMATION INTO PROCEDURES TO ASSURE ADEQUATE COOLING WATER FLOW TO THE RCP THERMAL BARRIERS

The inspectors identified a Green, non-cited violation (NCV) of 10 CFR 50, Appendix B, Criterion III, "Design Control," in that, Entergy did not appropriately incorporate design requirements into an operating procedure used to establish adequate component cooling water (CCW) flow to the reactor coolant pump (RCP) thermal barriers. Specifically, the flow specification in the CCW operating procedure did not incorporate the calculated design flow requirements to bound allowable CCW temperature limits. Entergy entered this issue into their corrective action program and will be evaluating the flow requirements specified in procedure 2-SOP-4.1.2, "Component Cooling Water System Operation," to ensure that they bound the allowed plant operating limits.

The inspectors determined that this finding was more than minor because it was associated with the Equipment Performance attribute of the Initiating Events cornerstone; and, it affected the cornerstone objective of limiting the likelihood of those events that upset plant stability and challenge critical safety functions during shutdown as well as power operations. Specifically, Entergy did not incorporate design flow requirements necessary to assure adequate cooling water flow to the RCP thermal barriers into the plant operating procedures which establish the required flow. On a loss of seal injection, the procedure did not ensure that the heat removal capability was adequate to prevent a rise in seal temperature which would require the RCP to be stopped with a subsequent reactor trip. The inspectors evaluated the significance of this finding using Phase 1 of IMC 0609, Appendix A, "Significance Determination of Reactor Inspection Findings for At-Power Situations." This finding was determined to be of very low safety significance because it would not result in exceeding the Technical Specification limit for identified reactor coolant system leakage and would not have likely affected other mitigating systems resulting in a loss of their safety function. The inspectors found that the procedurally established nominal flow band would have assured adequate cooling of the RCP thermal barriers for the highest CCW supply temperature recorded over the previous year.

The inspectors determined that this finding had a cross-cutting aspect in the area of human performance because the operating procedure used to set the flow rate of cooling water to the RCP thermal barriers was not adequate to make certain that sufficient cooling water was available to assure the components could perform their design function. (Section 1R15)

Inspection Report# : 2007002 ([pdf](#))

Significance: [REDACTED] Mar 31, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

FAILURE TO ESTABLISH TESTING TO ASSURE ADEQUATE COOLING WATER FLOW TO THE RCP THERMAL BARRIERS

The inspectors identified a Green, NCV of 10 CFR 50 Appendix B, Criterion XI, "Test Control," in that, Entergy did not establish appropriate testing to assure adequate component cooling water (CCW) flow to the reactor coolant pump thermal barriers. Specifically no preventive maintenance activities or functional checks were conducted for the individual flow meters. It was determined that the rotameters on 21 and 23 RCP were not indicating correctly and that actual CCW flow to the thermal barrier heat exchangers was less than the design requirements for CCW temperature. Entergy entered this issue into their corrective action program (CR-IP2-2007-00783 and 00955), adjusted individual cooling water flow within the

nominal band using ultrasonic flow meters, wrote work orders to replace the faulty flow meters, and is conducting an evaluation to determine the appropriate test requirements for the flow indicators.

This inspectors determined that this finding was more than minor because it was associated with the Equipment Performance attribute of the Initiating Events cornerstone; and, it affected the cornerstone objective of limiting the likelihood of those events that upset plant stability and challenge critical safety functions during shutdown as well as power operations. Specifically, Entergy's test program did not assure that all testing required to demonstrate that the RCP thermal barriers will perform satisfactorily in service because no testing was performed to ensure the accuracy of the individual flow meters used to establish the required cooling water flow. Consequently, it was identified that two individual flow indicators did not read correctly and the CCW flow to two RCP's was not sufficient to assure adequate cooling in the event that seal water was lost based on the flow requirements established in design calculations. On a loss of seal injection, the cooling water flow would not ensure that the heat removal capability was adequate to prevent a rise in seal temperature which would require the RCP to be stopped with a subsequent reactor trip. The inspectors evaluated the significance of this finding using Phase 1 of IMC 0609, Appendix A, "Significance Determination of Reactor Inspection Findings for At-Power Situations." This finding was determined to be of very low safety significance because it would not result in exceeding the Technical Specification limit for identified reactor coolant system leakage and would not have likely affected other mitigating systems resulting in a loss of their safety function. (Section 1R15)

Inspection Report# : 2007002 (*pdf*)

Significance: [REDACTED] Dec 31, 2006

Identified By: NRC

Item Type: NCV NonCited Violation

INADEQUATE RISK ASSESSMENT FOR 21 MBFP STEAM INLET VALVE

The inspectors identified a Green non-cited violation (NCV) of Title 10 of the Code of Federal Regulations (CFR), Part 50.65(a)(4), because Entergy did not adequately assess and manage the risk of on-line maintenance activities while operating with a degraded steam inlet valve on one of Entergy's two main boiler feed pumps (MBFP). Specifically, from November 16 through 21, 2006, the degraded condition of the 21 MBFP increased the likelihood of a reactor trip, but was not assessed or included in the plant's on-line risk model. Entergy entered this issue into their corrective action program and properly assessed 21 MBFP risk on November 21, 2006.

The inspectors determined that this finding was more than minor because Entergy failed to consider risk significant structures, systems, components, and support systems that were unavailable during the performance of on-line maintenance. Specifically, Entergy failed to assess the increase in online risk from the increased likelihood of a reactor trip due to the 21 MBFP degraded condition. The inspectors evaluated this finding using IMC 0609, Appendix K, "Maintenance Risk Assessment and Risk Management Significance Determination Process," and determined that this finding was of very low safety significance because the finding resulted in an increase in the incremental core damage probability of less than 1×10^{-6} (actual increase was approximately 2×10^{-8}).

The inspectors determined that this finding had a cross-cutting aspect in the area of human performance because Entergy did not provide complete and accurate procedures, in that, the online risk assessment procedure did not require degraded equipment that impacted risk to be assessed or managed.

Inspection Report# : 2006005 (*pdf*)

Significance: [REDACTED] Sep 30, 2006

Identified By: Self-Revealing

Item Type: FIN Finding

INADEQUATE OPERATING PROCEDURES FOR LOSS OF BOTH HEATER DRAIN TANK PUMPS

A Green self-revealing finding was identified because Entergy failed to develop adequate procedures for governing the response to a loss of both heater drain tank pumps and to an approaching rod insertion limit (RIL) alarm condition. Specifically, the procedure governing operator actions during a loss of heater drain tank pumps did not specify for the operators to reset the steam dumps following the rapid downpower. The alarm response procedure for the approaching rod insertion limit condition directed the operators to place the rod control system in manual to stop further automatic inward rod motion. This impacted operators ability to add negative reactivity and control the transient. Entergy entered these procedural deficiencies into their corrective action program and is evaluating the appropriate steps to correct the procedural deficiencies.

The inspectors determined that this finding is greater than minor because it is associated with the Procedure Quality attribute of the Initiating Events cornerstone; and, it impacted the cornerstone objective of limiting the likelihood of those events that upset plant stability and challenge critical safety functions. Specifically, the procedural inadequacies complicated operator actions to a rapid downpower, resulted in a manual reactor trip when the operators determined that they did not have sufficient control of the transient, and could impact other accident sequences requiring negative reactivity addition. The inspectors evaluated this finding using Phase I of IMC 0609, Appendix A, "Significance Determination of Reactor Inspection Findings for At-Power Situations," and determined it to be of very low safety significance because it did not

contribute to the likelihood of both a reactor trip and the likelihood that mitigation equipment or functions would be unavailable. The inspectors determined that this finding had a cross-cutting aspect in the area of human performance because Entergy did not ensure that plant operating procedures were adequate to ensure operators could appropriately respond to a rapid downpower transient.

Inspection Report# : 2006004 ([pdf](#))

Significance: [REDACTED] Sep 30, 2006

Identified By: Self-Revealing

Item Type: FIN Finding

INADEQUATE PROCEDURE FOR CALIBRATING THE STEAM DUMP LOSS OF LOAD CONTROLLER

A Green self-revealing finding was identified because Entergy failed to develop an accurate procedure for calibration of the steam dump loss of load controller. This resulted in the steam dumps failing to operate properly during a plant transient, complicating operator response, and leading to a manual reactor trip. Following identification of the issue, Entergy entered the issue into the corrective action program, corrected the procedural deficiency, and re-calibrated the controller.

The inspectors determined that this finding is greater than minor because it is associated with the Procedural Quality attribute of the Initiating events cornerstone; and, it impacted the cornerstone objective of limiting the likelihood of those events that upset plant stability and challenge critical safety functions. Specifically, the inadequacy in Entergy's calibration procedure caused the steam dumps to operate improperly during a plant transient and contributed to a reactor trip. The inspectors evaluated this finding using Phase I of IMC 0609, Appendix A, "Significance Determination of Reactor Inspection Findings for At-Power Situations," and determined it to be of very low safety significance because it did not contribute to the likelihood of both a reactor trip and the likelihood that mitigation equipment or functions would be available. The inspectors determined that this finding had a cross-cutting aspect in the area of human performance because Entergy did not ensure that the procedure for calibration of the steam dump loss of load controller was accurate, in that, it specified incorrect settings for the controller.

Inspection Report# : 2006004 ([pdf](#))

Mitigating Systems

Significance: [REDACTED] Feb 16, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

INADEQUATE DESIGN CONTROL ASSOCIATED WITH VORTEXING AND NET POSITIVE SUCTION HEAD CALCULATIONS

The team identified a finding of very low significance involving a non-cited violation of 10 CFR 50, Appendix B, Criterion III, "Design Control," in that, Entergy did not ensure adequate suction submergence for the three safety injection (SI) pumps by not properly translating vortex and net positive suction head (NPSH) design parameters into calculations relative to reactor water storage tank (RWST) level. Specifically, Entergy used a non-conservative method to calculate the level required to prevent pump vortexing, and used a non-conservative RWST level value for determining available NPSH for the SI pumps. Entergy entered the issue into their corrective action program and revised the affected calculations.

The finding is more than minor because the calculation deficiencies represented reasonable doubt on the operability of the SI pumps, even though the pumps were ultimately shown to be operable. The finding is associated with the design control attribute of the Mitigating Systems cornerstone and affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. The finding has very low safety significance, based on Phase 1 of the significance determination process (SDP), documented in NRC Inspection Manual Chapter 0609, Appendix A, "Significance Determination of Reactor Inspection Findings for At-Power Situations," because it was a design deficiency that did not result in a loss of SI system operability, based upon the team's verification of Entergy's revised calculations.

Inspection Report# : 2007007 ([pdf](#))

Significance: [REDACTED] Feb 16, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

INADEQUATE DIFFERENTIAL PRESSURE VALUE USED FOR MOV 746 AND MOV 747 TONENSURE VALVE CAPABILITY

The team identified a finding of very low significance involving a non-cited violation of 10 CFR 50, Appendix B, Criterion III, "Design Control," in that, Entergy did not accurately incorporate design parameters into valve thrust calculations for motor operated valve (MOV) 746 and MOV 747. Specifically, Entergy used an incorrect and non-conservative differential pressure in the calculations for MOV 746 and MOV 747, which were developed to verify that the valves could develop sufficient thrust to open under postulated design basis conditions. Additionally, an incorrect equation was used in determining the reduction

in motor torque due to degraded voltage conditions. Entergy entered the issue into their corrective action program and revised the affected calculations using the correct information.

The finding is more than minor because the calculation deficiencies represented reasonable doubt on the operability of MOV 746 and MOV 747. The finding is associated with the design control attribute of the Mitigating Systems cornerstone and affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. The finding has very low safety significance, based on Phase 1 of the SDP, because it was a design deficiency that did not result in a loss of MOV 746 and MOV 747 operability, based upon the team's verification of Entergy's revised calculations.

Inspection Report# : 2007007 (pdf)

Significance: [REDACTED] Feb 16, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

INADEQUATE DESIGN CONTROL FOR ENVIRONMENTAL EFFECTS TO ENSURE THE AVAILABILITY OF THE TURBINE DRIVEN AUXILIARY FEEDWATER PUMP OPERATION

The team identified a finding of very low safety significance involving a non-cited violation of 10 CFR 50, Appendix B, Criterion III, "Design Control," in that, Entergy did not establish adequate design control measures to ensure the availability of the turbine driven auxiliary feedwater pump (TDAFWP) during a postulated loss-of-offsite power (LOOP) event. Under certain LOOP situations, the team determined that the TDAFWP steam supply could be inadvertently isolated because of inadequate calculations and procedures for limiting the AFWP room temperature rise. Specifically, a calculation to determine the auxiliary feedwater pump (AFWP) room temperature rise during a LOOP did not include heat input from the TDAFWP. Further, actions that could limit the rise in AFWP room temperature and prevent the inadvertent isolation of the TDAFWP pump (opening an AFWP room roll-up door or promptly restoring forced ventilation) were not included in procedures. Entergy entered this issue into their corrective action program, implemented immediate compensatory actions, and revised AFWP room temperature rise calculations.

The finding is more than minor because it is associated with the design control attribute of the Mitigating Systems cornerstone and affected the cornerstone objective of ensuring the availability, reliability and capability of systems that respond to initiating events to prevent undesirable consequences. The finding has very low safety significance, based on Phase 1 of the SDP, because it did not represent the loss of safety function of the TDAFWP (single train) for greater than its 72 hour technical specification allowed outage time, based on the team's review and assessment of site ambient temperature data over the last year.

Inspection Report# : 2007007 (pdf)

Significance: [REDACTED] Feb 16, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

FAILURE TO ADEQUATELY MONITOR GAS TURBINE SYSTEM PERFORMANCE AS REQUIRED BY THE MAINTENANCE RULE

The team identified a finding of very low safety significance (Green) involving a non-cited violation of 10 CFR 50.65(a)(1), the Maintenance Rule, in that, Entergy failed to monitor the gas turbine (GT) system in a manner that provided reasonable assurance that the system could perform its intended safety function. Specifically, Entergy did not establish appropriate GT reliability goals, and therefore did not take corrective actions, when GT-1 had exceeded these goals for maintenance preventable functions failures (MPFF). In addition, Entergy did not properly classify repeat MPFFs, which resulted in a similar failure to take corrective actions as required. This resulted in additional GT-1 out of service time that would not have happened if appropriate actions had been taken. Entergy entered this issue into their corrective action program and lowered the allowable goal for MPFFs, and revised the GT-1 (a)(1) action plan to improve reliability.

The finding is more than minor because appropriate GT reliability goals were not established commensurate with safety and appropriate corrective actions were not taken when goals were not met. This finding is associated with the equipment performance attribute of the Mitigating Systems cornerstone and affected the cornerstone objective of ensuring the availability, reliability and capability of systems that respond to initiating events to prevent undesirable consequences. The finding has very low safety significance, based on Phase 1 and Phase 2 of the SDP, which considered that the additional GT-1 out of service time due to this issue could be as much as three days. The finding has a cross-cutting aspect in the area of human performance because Entergy did not adequately ensure procedures were complete, accurate, and up-to-date. Specifically, procedure ENN-DC-171, "Maintenance Rule Monitoring," did not provide steps to discriminate between the classification of an initial design deficiency and further failures due to the same condition, resulting in mis-classifying several GT functional failures.

Inspection Report# : 2007007 (pdf)

Significance: [REDACTED] Feb 16, 2007

Identified By: NRC

Item Type: FIN Finding

FAILURE TO CORRECT DEGRADED GAS TURBINE 1 RELIABILITY

The team identified a finding of very low safety significance involving Entergy procedure, EN-LI-102, "Corrective Action Process," in that, Entergy failed to take corrective actions to address degraded GT-1 reliability. This resulted in a two and one half day time period in January 2007 when GT-1 and GT-3 were simultaneously inoperable because, after GT-3 was made inoperable for planned maintenance activities, GT-1 was subsequently found to be inoperable. Specifically, the reliability of GT-1 declined from an average of 75% for 2005 and the first 10 months of 2006, to 50% for the three months from November 2006 to January 2007; however, Entergy did not take actions to correct this degraded reliability. Entergy entered this issue into their corrective action program and developed an action plan to address GT reliability issues.

The issue is more than minor because it is associated with the equipment reliability attribute of the Mitigating Systems cornerstone and affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. The finding has very low safety significance, based on Phase 1 and Phase 2 of the SDP, assuming that both GT-1 and GT-3 were unavailable for the two and one half days, due to this issue. The finding has a cross-cutting aspect in the area of problem identification and resolution because Entergy did not correct degraded reliability of GT-1, resulting in having GT-1 and GT-3 simultaneously inoperable.

Inspection Report# : 2007007 ([pdf](#))

Significance: [REDACTED] Feb 16, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

INADEQUATE STATION BATTERY CAPACITY TESTING FOR DEGRADATION MONITORING

The team identified a finding of very low safety significance (Green) involving a non-cited violation of Technical Specification 3.8.6.6, in that, Entergy did not perform station battery capacity testing in accordance with IEEE Standard 450-1995 (related to battery maintenance and testing). Specifically, Entergy procedurally terminated battery capacity testing at the rated discharge time (four hours), before reaching the minimum voltage, as specified by IEEE Standard 450-1995. This prevented accurate quantitative measurement of capacity degradation and identification of the need to conduct potential accelerated battery testing, as specified by both IEEE Standard 450-1995 and the technical specifications, if battery capacity drops by more than 10% relative to the previous test. Entergy entered the issue into their corrective action program and performed calculations using past test data, which demonstrated that the capacities of station batteries had not degraded more than 10%.

This issue is more than minor because it is associated with the procedure quality attribute of the Mitigating Systems cornerstone and affected the cornerstone objective to ensure the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. The finding has very low safety significance, based on Phase 1 of the SDP, because it did not represent the loss of station battery safety function, based upon the team's verification of Entergy's calculations.

Inspection Report# : 2007007 ([pdf](#))

Significance: [REDACTED] Feb 16, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

INEFFECTIVE CORRECTIVE ACTION FOR HIGH INTER-TIER BATTERY RESISTANCES

The team identified a finding of very low safety significance involving a non-cited violation of 10 CFR 50, Appendix B, Criterion XVI, "Corrective Action," in that, Entergy did not take effective corrective actions for a condition adverse to quality concerning out-of-tolerance inter-tier resistances on the No. 21 station battery. Specifically, after repeated failures of the No. 21 station battery inter-tier resistance testing, vendor and IEEE Standard 450-1995 recommended corrective actions were not taken to correct the adverse out-of-tolerance resistance trend. Entergy entered the issue into their corrective action program and performed calculations, which demonstrated that the voltage drop due to the as-found resistance of the inter-tier connections was small and did not impact No. 21 battery operability.

This issue is more than minor because if it was left uncorrected, it would have become a more significant safety concern. Specifically, high resistance connections in a battery that is loaded during accident conditions can cause localized heating and can cause permanent damage to the battery. The finding has very low safety significance, based on Phase 1 of the SDP, because it did not represent the loss of No. 21 station battery safety function, based upon the team's verification of Entergy's revised calculations. The finding has a cross-cutting aspect in the area of problem identification and resolution because Entergy did not take effective corrective actions to address the adverse trend of out-of-tolerance inter-tier resistances.

Inspection Report# : 2007007 ([pdf](#))

Significance: [REDACTED] Feb 16, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

UNTIMELY CORRECTIVE ACTIONS FOR DECREASE IN BATTERY MARGIN

The team identified a finding of very low safety significance involving a non-cited violation of 10 CFR 50, Appendix B, Criterion XVI, "Corrective Action," in that, Entergy did not promptly identify and correct a condition adverse to quality, with respect to known errors in the No. 23 station battery design calculations. Specifically, Entergy did not recognize at the appropriate time the need to write a condition report, perform an operability determination, or place controls on the use of the No. 23 battery design calculations when errors were discovered in the No. 23 battery design calculations that significantly lowered the battery capacity margin. Entergy entered the issue into their corrective action program and performed calculations, which demonstrated No. 23 station battery operability through the next refueling outage, based on the calculated margin and conservatism available.

This issue is more than minor because it is associated with the design control attribute of the Mitigating Systems cornerstone and affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. The finding has very low safety significance, based on Phase 1 of the SDP, because it did not represent the loss of No. 23 station battery safety function, based upon the team's verification of Entergy's revised calculations.

The finding has a cross-cutting aspect in the area of problem identification and resolution because Entergy failed to promptly identify the decrease in margin found in the No. 23 battery design calculations of record.
Inspection Report# : 2007007 (*pdf*)

Significance: [REDACTED] Dec 31, 2006

Identified By: NRC

Item Type: FIN Finding

FAILURE TO IMPLEMENT CORRECTIVE ACTIONS TO CORRECT A DEGRADED CONDITION WHICH IMPACTED GAS TURBINE #1 RELIABILITY AND AVAILABILITY

The inspectors identified a Green finding, in that, Entergy's corrective actions were inadequate to resolve a deficiency associated with the gas turbine 1 (GT-1) starting diesel. This deficiency was identified following a failure of GT-1 to start on February 7, 2005, and resulted in three subsequent failures. A corrective action was written to correct the deficient condition following the initial failure and was closed on June 22, 2005, with no actions taken based on a senior management decision to cancel preventive maintenance activities on the gas turbines due to pending system retirement. Entergy entered this issue into their corrective action program and installed a modification to the coolant system to prevent further trips due to this condition.

The inspectors determined that this finding was more than minor because it was associated with the equipment performance attribute of the Mitigating Systems cornerstone objective of ensuring the availability, reliability and capability of systems that respond to initiating events to prevent undesirable consequences. Specifically, it impacted GT-1 reliability, in that, the deficiency resulted in multiple failures to start on demand after the condition was identified and the action to correct the condition was closed without being implemented. The inspectors evaluated the significance of this finding using Phase 1 of Inspection Manual Chapter (IMC) 0609, Appendix A, "Significance Determination of Reactor Inspection Findings for At-Power Situations," and determined that a Phase 2 evaluation was required because the finding represented an actual loss of safety function of a non-Technical Specification required train of equipment designated as risk significant per 10 CFR 50.65 for greater than 24 hours. The inspectors used the Risk-Informed Inspection Notebook for Indian Point Nuclear Generating Unit 2, to conduct the Phase 2 evaluation. The inspectors determined that 65 hours of unavailability were caused by the additional failures of GT-1 due to the starting diesel coolant system deficiency. The inspectors conservatively equated this cumulative unavailability time to the total exposure time and used an initiating events likelihood of less than three days. The Phase 2 approximation yielded a result of very low safety significance (Green).

The inspectors determined this finding had a cross-cutting aspect in the area of human performance because Entergy did not ensure that equipment and resources were available and adequate to assure reliable operation of GT-1. Specifically, Entergy did not minimize long-standing equipment issues and maintenance deferrals associated with the gas turbine system.

Inspection Report# : 2006005 (*pdf*)

Significance: [REDACTED] Dec 05, 2006

Identified By: NRC

Item Type: NCV NonCited Violation

FAILURE TO IDENTIFY A DEGRADED CONDITION OF AN AUXILIARY FEED WATER CHECK VALVE IN THE CORRECTIVE ACTION PROGRAM

The inspectors identified a non-cited violation (NCV) of 10 CFR 50, Appendix B, Criterion XVI, "Corrective Action," in that, Entergy failed to identify a condition adverse to quality associated with improper internal clearances on BFD-68, an auxiliary feedwater check valve, in the corrective action program. Specifically, upon inspection in September 2006, the gasket between the valve's body to bonnet seal was found over-crushed causing the gasket to partially unwind, potentially impacting valve operation. Gasket damage was noted in work orders during internal valve inspections of BFD-68 performed in 1997 and 2002; however, the deficiencies were not identified in the corrective action program. Consequently, the

problem was not evaluated and corrected prior to reassembly of the valve. Entergy entered this issue into the corrective action program, evaluated the condition, and conducted repairs to the valve to ensure the proper gasket crush was obtained.

The inspectors determined that this finding was more than minor because it was associated with the Equipment Performance attribute of the Mitigating Systems cornerstone; and, it affected the cornerstone objective of ensuring the availability, reliability and capability of systems that respond to initiating events to prevent undesirable consequences. The inspectors evaluated the significance of this finding using Phase 1 of IMC 0609, Appendix A, "Significance Determination of Reactor Inspection Findings for At-Power Situations," and determined that the finding was of very low safety significance because it was not a design or qualification deficiency; it did not result in the loss of a system safety function or a train safety function for greater than the Technical Specification Allowed Outage Time; and it did not screen as potentially risk significant due to external events.

Inspection Report# : 2006006 (pdf)

Significance: [REDACTED] Dec 05, 2006

Identified By: Self-Revealing

Item Type: NCV NonCited Violation

INADEQUATE EVALUATION OF LEAKING 22 STEAM GENERATOR LOW FLOW BYPASS VALVE FCV-427L

A self-revealing, non-cited violation of 10 CFR 50, Appendix B, Criterion XVI, "Corrective Action," was identified, in that, Entergy failed to adequately evaluate leakage into the 22 steam generator. During the Indian Point Unit 2 reactor trip on August 23, 2006, main feedwater low flow bypass valve FCV-427L leaked excessively and resulted in an uncontrolled rise in 22 steam generator level; operator response to isolate feedwater to the steam generator in accordance with emergency operating procedures; and automatic actuation of the feedwater isolation system. The excessive leakage condition into the 22 steam generator was identified on April 4, 2006, prior to Indian Point Unit 2 refueling outage 2R17, but was not fully evaluated or corrected prior to the reactor trip on August 23, 2006. This issue was entered into the corrective action program, and FCV-427L was repaired and retested satisfactorily.

The inspectors determined that this finding was more than minor because it was associated with the Equipment Performance attribute of the Mitigating Systems cornerstone; and, it affected the cornerstone objective of ensuring the availability, reliability and capability of systems that respond to initiating events to prevent undesirable consequences. The inspectors evaluated the significance of the finding using Phase 1 of IMC 0609, Appendix A, "Significance Determination of Reactor Inspection Findings for At-Power Situations," and determined that the finding was of very low safety significance because it was not a design or qualification deficiency; it did not result in the loss of a system safety function or a train safety function for greater than the Technical Specification Allowed Outage Time; and it did not screen as potentially risk significant due to external events.

The inspectors determined that the finding had a cross-cutting aspect in the area of problem identification and resolution because Entergy did not thoroughly evaluate the cause of excessive leakage into the 22 steam generator such that the resolutions addressed the causes and extent of condition of the problem.

Inspection Report# : 2006006 (pdf)

Barrier Integrity

Significance: [REDACTED] Mar 31, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

FAILURE TO MOVE CONTAINMENT HYDROGEN ANALYZERS TO 10 CFR 50.65 (A)(1) STATUS

The inspectors identified a Green, NCV of 10 CFR 50.65(a)(2) because Entergy did not demonstrate that the performance or condition of the containment hydrogen monitoring system was being effectively controlled through the performance of appropriate preventive maintenance such that the system remained capable of performing its intended function. The inspectors identified that both channels of the containment hydrogen/oxygen (H₂/O₂) analyzers had been out of service since September 7, 2006, due to compressor seal leakage. The inspectors determined that the H₂/O₂ analyzers are within the scope of Entergy's Maintenance Rule program since they are used in the emergency operating procedures. The inspectors noted that, based on the significant unavailability time of both trains, the system should have been in 10 CFR 50.65(a)(1) status with an action plan to improve system performance back to an (a)(2) status. Entergy entered this issue into their corrective action program and changed the priority of the work orders to perform repairs on the H₂/O₂ analyzers.

This inspectors determined that this finding affected the Barrier Integrity cornerstone and was more than minor since it was similar to Example 7.b in IMC 0612, Appendix E, "Examples of Minor Issues." Specifically, Entergy failed to demonstrate effective control of the performance of the H₂/O₂ analyzers and did not place the system in (a)(1) status. The inspectors evaluated the significance of this finding using Phase 1 of IMC 0609, Appendix A, "Significance Determination of Reactor Inspection Findings for At-Power Situations." The finding required further evaluation through IMC 0609, Appendix H,

"Containment Integrity Significance Determination Process," because it resulted in an actual reduction in the defense-in-depth for the hydrogen control function of the reactor containment. The inspectors determined that this finding was of very low safety significance because it did not affect core damage frequency and the H2/O2 analyzers are not important to large early release frequency.

The inspectors determined this finding had a cross-cutting aspect in the area of human performance because Entergy did not ensure that equipment and resources were available to assure reliable operation of the H2/O2 analyzers. Specifically, Entergy did not minimize long-standing equipment issues and maintenance deferrals associated with the containment hydrogen monitoring system. (Section 40A2)

Inspection Report# : 2007002 (*pdf*)

Significance: SL-IV Dec 31, 2006

Identified By: NRC

Item Type: NCV NonCited Violation

INADEQUATE CONTAINMENT CLOSURE EQUIPMENT

The inspectors identified a Severity Level IV NCV of 10 CFR 50.59, "Changes, Tests and Experiments," for failure to obtain a license amendment pursuant to 10 CFR 50.90 prior implementing a change to alter the requirements of a shutdown fission product barrier. The inspectors reviewed Safety Evaluation 04-0732-MD-00-RE R1, "Installation of a Temporary Roll-up Door on the Containment Equipment Hatch," to determine if the conclusion that a licensee amendment was not required was correct. Entergy concluded that the roll-up door was equivalent to the closure plate and, therefore, adequate to close containment as required by the action statement. The inspectors found that the door was not designed to be air-tight; therefore, any radioactive release inside containment would bypass the roll-up door. The inspectors concluded that the roll-up door did not meet the design or licensing basis of the closure plate as described in the Updated Final Safety Analysis Report (UFSAR) and previously approved license amendments. Consequently, Entergy incorrectly concluded that a license amendment pursuant to 50.90 was not required prior to implementing the change. Entergy entered the issue into their corrective action program to evaluate and correct.

The inspectors determined that Entergy changed the requirements for the shutdown fission product barrier (containment) prior to receiving NRC approval. As a result, traditional enforcement was used to evaluate the issue because the deficiency affected the NRC's ability to perform its regulatory function. The severity level of the violation was determined to be Severity Level IV in accordance with example D.5 of Supplement 1 of the NRC Enforcement Policy. Additionally, the issue was determined to be of very low safety significance (Green) based on the low decay heat levels at the time the roll-up door was credited in accordance with the significance determination process described in Inspection Manual Chapter (IMC) 0609 Appendix H, "Containment Integrity."

Inspection Report# : 2006005 (*pdf*)

Emergency Preparedness

Significance: [REDACTED] Mar 31, 2007

Identified By: NRC

Item Type: FIN Finding

INADEQUATE CORRECTIVE ACTIONS FOR FAILURE TO APPROPRIATELY MONITOR SERVICE WATER INTAKE BAY LEVEL

The inspectors identified a Green finding because Entergy failed to take adequate corrective actions for an issue associated with monitoring of service water intake bay level. This deficiency could have prevented identification of entry conditions for an emergency action level. Entergy entered this issue into the corrective action program as CR IP3-2007-00453, and initiated several corrective actions, including plans for enhanced monitoring of service water bay levels, backwashing of trash racks, procedural upgrades, correction of service water bay level instrumentation modification installation, development of modifications for enhanced service water level monitoring equipment, and enhanced inspection and cleaning of intake structure trash racks.

The inspectors determined that this finding was more than minor because it was associated with the Emergency Preparedness cornerstone attribute of facilities and equipment; and, it affected the cornerstone objective of ensuring that a licensee is capable of implementing adequate measures to protect the health and safety of the public in the event of a radiological emergency. Specifically, inadequate monitoring of service water intake bay level could have resulted in failure to declare a notification of unusual event (UE). The inspectors reviewed the EAL entry criteria and determined that this performance deficiency did not affect Entergy's ability to declare any event higher than a UE. The inspectors evaluated this finding using IMC 0609, Appendix B, "Emergency Preparedness Significance Determination Process," Sheet 1, "Failure to Comply," and determined that it was of very low safety significance because the declaration of a UE based on low service water bay level could have been missed or delayed, consistent with the example provided in the appendix.

The inspectors determined that this finding had a cross-cutting aspect in the area of problem identification and resolution because Entergy did not implement effective corrective actions for a previously identified issue associated with inadequate

monitoring of service water intake bay level. (Section 1R17)

Inspection Report# : 2007002 (*pdf*)

Occupational Radiation Safety

Significance: [REDACTED] Dec 31, 2006

Identified By: Self-Revealing

Item Type: NCV NonCited Violation

FAILURE TO SURVEY AND PROVIDE ACCESS TO AN UNPOSTED HIGH RADIATION AREA

A Green, self-revealing NCV of 10 CFR 20.1501 with respect to 10 CFR 20.1902(b) was identified, in that, Entergy failed to survey radiological condition changes after a plant manipulation that was likely to cause a change in radiological conditions, and this led to the failure to post a plant area as a high radiation area. As a result, two workers were allowed access to an unsurveyed and unposted high radiation area.

The finding is more than minor because it is associated with the Occupational Radiation Safety cornerstone attribute of exposure control and affected the cornerstone objective, because not establishing radiological conditions and commensurate controls after changing plant radiological conditions prior to allowing access to the affected areas can cause increased personnel exposure. The inspectors evaluated this finding using IMC 0609, Appendix C, "Occupational Radiation Safety Significance Determination Process," and determined that it was of very low safety significance (Green) because it did not involve ALARA planning and controls, an overexposure, a substantial potential for overexposure, or an impaired ability to assess dose. This issue was entered into Entergy's corrective action program and training was provided to the radiation protection staff.

The inspectors determined that this finding had a cross-cutting aspect in the area of human performance because Entergy did not use a conservative assumption in the decision-making process, in that, the watch radiation protection technician did not question the radiological conditions of the pipe chase area after a change of plant conditions had occurred and did not require a survey of the pipe chase area before authorizing access to personnel.

Inspection Report# : 2006005 (*pdf*)

Significance: [REDACTED] Dec 31, 2006

Identified By: Self-Revealing

Item Type: FIN Finding

UNIT 2 CONTAINMENT SUMP STRAINER MODIFICATION COLLECTIVE EXPOSURE OVERRUNS DUE TO INADEQUATE MOD PREPARATION

A self-revealing finding was identified that involved inadequate modification planning and construction preparations relative to a Unit 2 containment sump strainer modification that resulted in significant unplanned collective exposure (93.7 person-rem compared to a work activity estimate of 10.9 person-rem). Specifically, the actual job site conditions for installation of the containment sump modification were not adequately evaluated with respect to the radiological impact of increased occupancy in high dose rate work areas. This unplanned additional in-field high radiation work resulted in significant unintended exposure that could have been avoided. This issue was entered into Entergy's corrective action program so that lessons learned could be incorporated into the Unit 3 containment sump modification.

The inspectors determined that this finding was more than minor because it was similar to examples 6.a and 6.b of IMC 0612, Appendix E, "Examples of Minor Issues," in that, the issue involved actual collective exposure greater than 5 person-rem and was greater than 50 percent above the estimated or intended exposure; and the majority of the dose overrun was due to activities within Entergy's control. The inspectors evaluated this finding using IMC 0609, Appendix C, "Occupational Radiation Safety Significance Determination Process," and determined that the finding was of very low safety significance (Green) because it involved an ALARA planning issue, and the 3-year rolling average collective dose for Unit 2 was less than 135 person-rem (73 person-rem average annual exposure for 2003 through 2005).

The inspectors determined that this finding had a cross-cutting aspect in the area of human performance because Entergy did not adequately incorporate job site conditions in the work control planning process.

Inspection Report# : 2006005 (*pdf*)

Public Radiation Safety

Physical Protection

Although the NRC is actively overseeing the Security cornerstone, the Commission has decided that certain findings

pertaining to security cornerstone will not be publicly available to ensure that potentially useful information is not provided to a possible adversary. Therefore, the cover letters to security inspection reports may be viewed.

Miscellaneous

Significance:  Dec 05, 2006

Identified By: NRC

Item Type: FIN Finding

FAILURE TO ENTER SAFETY CULTURE ASSESSMENT RESULTS INTO CORRECTIVE ACTION PROGRAM

The NRC inspectors identified a finding when Entergy failed to initiate condition reports in accordance with EN-LI-102, "Corrective Action Process," for the adverse conditions identified in the 2006 Safety Culture Assessment. Consequently, the adverse conditions were not evaluated and appropriate corrective actions were not identified in a timely manner. The contractor who performed the independent safety culture assessment presented the site specific results to Entergy management in June 2006. The negative responses and declining trends identified in the assessment constituted adverse conditions that should have been entered into the corrective action program. At the time of the inspection, Entergy had not initiated condition reports for the assessment results. Consequently, the results had not been fully evaluated to understand the causes and identify appropriate actions to address the identified issues. Additionally, organizations identified by the contractor as needing management attention had not developed departmental action plans at the time of the inspection. Entergy entered this issue into the corrective action program and initiated a learning organization condition report to track development and implementation of action plans to address the assessment results.

The inspectors determined that the finding was more than minor because if left uncorrected it would become a more significant safety concern. Without appropriate action, the weaknesses in the safety culture onsite would continue, increasing the potential that safety issues would not receive the attention warranted by their significance. The finding was not suitable for SDP evaluation, but has been reviewed by NRC management and has been determined to be a finding of very low safety significance. The finding was not greater than very low safety significance because the inspectors did not identify any issues that were not raised which had an actual impact on plant safety or were of more than minor safety significance.

The inspectors determined that this finding had a cross-cutting aspect in the area of problem identification and resolution because Entergy did not identify issues with the potential to impact nuclear safety in the corrective action process for evaluation and resolution in a timely manner.

Inspection Report# : 2006006 (*pdf*)

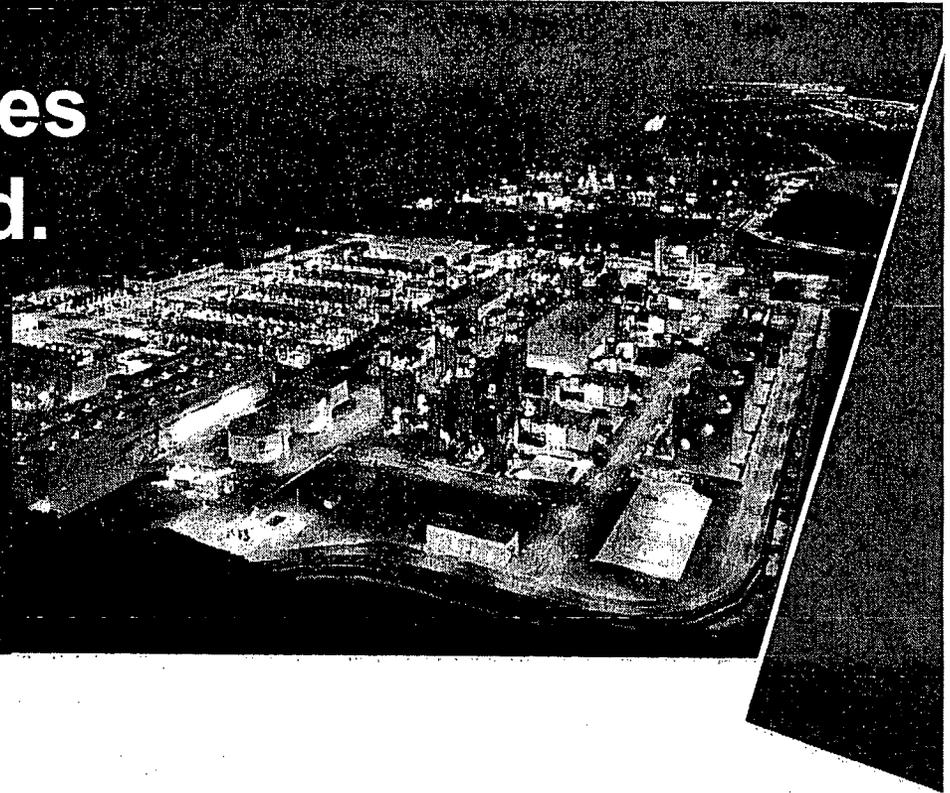
Last modified : August 24, 2007

EXHIBIT LL



Doosan Heavy Industries & Construction

**Doosan Heavy Industries
& Construction Co., Ltd.**
www.doosanheavy.com



Presented at the
Burns & Roe 17th Annual Seminar
Powering the Future
March 21, 2007

On-going Projects (I)

◆ Entergy Replacement Reactor Vessel Head

- Customer : Entergy
- Primary Contractor : Westinghouse
- Projects : ANO #2 (Site Delivery: January, 2008)
Waterford #3 (Site Delivery: February, 2008)
Indian Point #2 (Site Delivery: October, 2011)
Indian Point #3 (Site Delivery: October, 2012)
- Scope : Four (4) RRVHs
Two (2) sets of CRDM (for Indian Point #2 & 3 only)
- Manufacturer : DOOSAN (EMD supplies CRDM as the subsupplier)

◆ Qinshan Phase II #3 Reactor Vessel

- Customer : NPQJVC (Nuclear Power Qinshan Joint Venture Co.)
- Contractors : DOOSAN (#3), CFHI (#4)
- DOOSAN's Scope : One(1) Reactor Vessel & Technical Assistance
- Expected shipping : June, 2008



March 27, 2007

Re: NRC Proposed Rule: Power Reactor Security Requirements (RIN 3150-AG63)

Annette Vietti-Cook, Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attn: Rulemakings and Adjudications Staff
Submitted via e-mail to SECY@nrc.gov

**COUNCIL ON INTELLIGENT ENERGY & CONSERVATION POLICY (CIECP)
COMMENTS TO PROPOSED RULE 10 CFR PARTS 50, 72 AND 73 REGARDING
POWER REACTOR SECURITY REQUIREMENTS AT LICENSED NUCLEAR
FACILITIES**

Nearly six years after September 11, 2001, the 103 civilian nuclear reactors in the United States are still not in a position to repel attacks by adversaries with capabilities commensurate with those of either the 9/11 terrorists or with enemies of the United States currently operative on the world stage. The present Power Reactor Security Requirements (PRSR) thus fall far short of the actual threat level faced by the U.S. today, much less the escalated level the nation will face as nations such as Russia, China and Iran improve and export nuclear engineering expertise. Indeed, as numerous security experts have pointed out, a terrorist group with access to sympathetic nuclear scientists and engineers would have sufficient sophistication to target the critical systems and weak links of nuclear reactors. The assistance that Pakistani nuclear scientists reportedly offered to Al Qaeda illustrates this threat.

Recent National Intelligence Estimates and National Intelligence Council Reports describe the terrorist threat to the U.S. as real and as having no sign of abatement for many years to come. These reports further warn of a new class of "professionalized" terrorists—in part created by the Iraq war—who must be expected to have strong technical skills and English language proficiency. Such individuals should, in the future, be expected to become major players in international terrorism.

Al Qaeda and other terrorist groups have shown extraordinary tactical ingenuity and a complete lack of reverence for human life. Further there is ample evidence that U.S. nuclear power plants, particularly those sited near metropolitan areas, are viewed as attractive terrorist targets. Notably, the 9/11 Commission learned that the original plan for a terrorist spectacular was for a larger strike, using more planes, and including an attack on nuclear power plants. In an Al-Jazeera broadcast in 2002, one of the planners of 9/11 said that a nuclear plant was the initial target considered. We also know from the 9/11 Commission's investigation that, even after the plot was scaled down, when Mohammed Atta was conducting his surveillance flights he spotted a nuclear power plant (unidentified by name, but obviously the Indian Point nuclear power plant) and came close to redirecting the strike. National Research Council analyses and post-9/11 intelligence has also indicated that the U.S. nuclear infrastructure is viewed as an alluring target for a future terrorist spectacular. As the Chairman of the National Intelligence Council stated in 2004, nuclear power plants "are high on Al Qaeda's

targeting list,” adding that the methods of Al Qaeda and other terrorist group may be “evolving.”

There is, thus, every reason to believe that a sizable, well-planned and orchestrated military operation against a U.S. nuclear facility is well within both present and near-future terrorist intent and capability. In view of these realities, the current proposed PRSR is utterly inadequate.

Consequently, the COUNCIL ON INTELLIGENT ENERGY & CONSERVATION POLICY (CIECP) urges the NRC to address the following realities in its PRSR:

ACTIVE INSIDERS

The voluminous number of security breaches which have occurred at critical infrastructure, including nuclear weapons and power facilities after 9/11 (such as the 16 foreign-born construction workers who were able to gain access to the Y-12 nuclear weapons plant with falsified documentation) demonstrates that nuclear “insiders” must be deemed potential active participants in an attack.

This threat is significantly augmented by nuclear power plant operators’ increasing outsourcing of on-site work in order to cut costs.

Contractor oversight failures have been documented by the NRC. For example a December 22, 2003 NRC Special Inspection Report on the Indian Point Nuclear Generating Station in Buchanan, New York (Indian Point) operated by Entergy Nuclear Northeast (Entergy) notes “the common theme of a lack of direct contractor oversight and quality control measures, along with the absence of Entergy subject matter experts to independently assess contracted work activities....” Critically, the risk of sabotage is elevated at all power plants during periods of refueling and major construction work when hundreds of outside contract workers have site access.

The active participation of insiders, including contract workers, in a terrorist offensive need not take place during the time of attack. It may occur days or even many months prior to an attack. In addition to actions such as surveillance of plant schematics, security features and protocols, pre-attack participation may involve the sabotage of critical instrumentation, computers, piping, electronic systems or any number of other components, where such sabotage would likely not be discovered prior to an emergency event.

COMPUTER SYSTEM COMPROMISE

Nuclear power plant computer systems, like those of other critical infrastructure, are subject to a range of vulnerabilities, including power outages, attacks by malicious hackers, viruses and worms. Compromise of integrity may also occur at the level of software development via backdoors written into code or the implantation of logic bombs programmed to shut down a safety system at a particular time.

Many terrorist networks have the resources and technical savvy to wreak havoc. For example, the alleged terrorist, Muhammad Naeem Noor Khan, picked up in Pakistan in 2004, and believed to have links with Al Qaeda, is a computer engineer.

The fact that U.S. nuclear reactors are not impregnable was demonstrated by the penetration of the Slammer worm into the Davis-Besse nuclear facility. That intrusion disabled a safety monitoring system for nearly 5 hours. In addition, computer hackers have broken into U.S. Department of Energy computers. Some of such intrusions were root-level compromises, indicating that hackers had enough access to install viruses.

Computers at nuclear power stations are also vulnerable to acts of sabotage against off-site power transmission, as was evidenced at Indian Point during the 2003 blackout which struck the Northeast. At Indian Point, various computer systems had to be removed from service, including the Critical Function Monitoring System, the Local Area Network, the Safety Assessment System/Emergency Data Display System, the Digital Radiation Monitoring System and the Safety Assessment System.

It is, accordingly, a matter of pressing importance that the NRC engage independent experts to develop a comprehensive computer vulnerability and cyber-attack threat assessment. Such an assessment must evaluate the vulnerability of the full range of nuclear power plant computer systems and the potential consequences of such vulnerabilities. The PRSR must incorporate such findings and include a protocol for quickly detecting such an attack and recovering key computer functions in the event of an attack.

CHEMICAL WEAPONS

The PRSR must fully address the potential consequences of the use of toxic chemicals as part of an attack scenario. There are numerous agents that can be deployed with almost instantaneous effect and can immobilize targets via paralysis, convulsions, blinding, suffocation or death. Such agents could be employed as part of the initialization strategy. For, example, a truck or even large SUV filled with chlorine, boron trifluoride, hydrofluoric acid, liquid ammonia, or any number of other agents could be crashed into a perimeter barrier, with the resulting fumes killing or disabling plant personnel guarding the outdoor area of the facility.

Chemical agents could also be introduced surreptitiously into building ventilation systems. They may also be used strategically to neutralize workers endeavoring to maintain control of the situation.

Many such agents are easy to make and do not require sophisticated delivery systems. Some can be carried in coffee mugs or in vials within body cavities. Phenarsazine chloride, an arsenic derivative, can be transported in minute quantities, even as a powder that can be dusted on paper. It is lethal if burned and even a spoonful can cause immediate extreme irritation of the eyes and breathing passages. A chemical like chloroform acetone methanol can be transported on filter paper, then combined with a heat source to create an explosion.

CONVENTIONAL WEAPONRY

Intelligence and military analysts have repeatedly warned that extremists in Iraq; the tribal areas of Pakistan and elsewhere are currently developing a high level of military skill and experience. This reality underscores the need for nuclear plants to be able to defend against attackers utilizing the full range of potential weaponry that terrorists are known to be capable of using, including heavy caliber automatic weapons; sniper rifles; shoulder-fired rockets; mortars; platter charges; anti-tank weaponry; bunker busters; shaped charges; rocket-propelled grenades; and high-power explosives.

Numerous weapons systems posing a threat to even the best trained and equipped civilian guard force, as well as to on-site installations, are readily available and easy to transport. To wit:

- Assault rifles and other rapid-fire battlefield weapons such as AK-47's, Uzi's and TEC-9's are freely available in the U.S. A weapon like the SKS 7.62-millimeter semiautomatic assault rifle can be purchased for under \$200. In 2005 the Government Accountability Office reported that 47 individuals on a federal terrorism watch list were actually permitted to legally buy guns in 2004.
- A standard M-24 sniper rifle with day and night scope can be carried in a canvas bag and fires 7.62-millimeter ammunition targeting up to 3000 feet.
- A .50-caliber Barrett rifle, which can be purchased for \$1000 on the internet, weighs a mere 30 lbs and can hit targets up to 6000 feet away with armor-piercing bullets that can blow a hole through a concrete bunker, bring down a helicopter or pierce an armored vehicle.
- A rocket propelled grenade launcher is re-loadable, can fire at the speed of 400 feet per second and can blow a vehicle into the air.
- A TOW missile is an accessible form of military hardware used in over 40 countries and can be fired from a launcher on a flatbed truck. A 1998 test TOW fired into a nuclear waste transport cask (which is more robust than many on-site nuclear waste storage casks) blew out a hole the size of a grapefruit. The Kornet-E missile, developed by the Soviets and sold to Iraq, can travel over 3 miles and cut through over 3 feet of steel. The world's arms market is awash in thousands of Milan missiles. The 60-70 lb Milan missile system has an effective range of over 5000 feet and can blow a hole through more than 3 feet of armor plate.
- The deployment of increasingly powerful and sophisticated explosives, including shaped charges and explosively formed penetrators (or E.F.P.s) by terrorists and insurgents in Iraq show that the explosives use capabilities of enemies of the United States should not be underestimated. Notably, the 18 men arrested in Australia in November 2005, and believed to have been planning an attack on an Australian nuclear reactor, had allegedly been stockpiling materials used to make the explosive triacetone triperoxide, or TATP. Terrorists targeting a U.S. nuclear power plant may very well be able to draw on expertise developed during the Iraq insurgency as well as military experts and rocket scientists from the former Iraq government or from hostile nations such as Iran. In addition, the strategic utility

of explosives is magnified when bombers are willing to blow themselves up. Suicide bombers able to gain access to the internal areas of a nuclear power plant during the course of an attack could cause untold destruction.

- Perhaps the most intractable military hardware threat is posed by shoulder-fired missiles such as Stingers, SA-7's, SA-14's and SA-18's. An estimated 500,000 such systems are scattered throughout the world and have been found in the possession of at least 27 terrorist or guerrilla groups. Some can be bought easily on the black market for as little as several thousand dollars each. Critically, shoulder-fired missiles are easy to operate (Al Qaeda training videos offer instruction) and are designed for portability, typically being 5-6 feet long and weighing 35 lbs. They can be transported by and fired from a van, S.U.V., pickup truck or recreational boat. Even a single terrorist armed with a shoulder-fired missile can cause immediate and substantial damage to a targeted structure. Traveling at more than 1,500 miles per hour, a typical shoulder-launched missile has a range of over 12,000 feet. If the target remains intact following the initial strike, the terrorist can attach a new missile tube to the grip stock launcher and fire again.

WATERBORN ATTACKS

Waterborne defenses of nuclear plants adjacent to navigable waterways must be significantly enhanced. Facilities must either be engineered to withstand damage from a waterborne attack or suited with physical barriers that prevent entry to the plant and/or critical cooling intake equipment.

Continual cooling is an essential component of nuclear plant safety. A meltdown can be triggered even at a scrammed reactor if cooling is obstructed. Water intake is also essential to the proper function of spent fuel pools. Yet at certain nuclear plants, cooling systems may be highly vulnerable. At both Indian Point and Millstone Power Station, in particular, water intake pipes have been identified by engineering experts as exposed and susceptible to waterborne sabotage.

One or more boats laden with high energy explosives could severely compromise cooling water intakes easily and quickly. Indian Point, for instance, is located on the banks of the Hudson River in an area heavily trafficked by commercial and recreational vessels. The 900 foot "Exclusion Zone" –marked only by buoys– could be traversed by speed boats in 30 - 40 seconds, well before any Coast Guard or other patrol boat could react. Patrol boats could also be readily taken out by suicide bomber boats crashing into them (in the manner a small explosives laden boat targeted the destroyer the USS Cole in 2000) or by weaponry like shoulder-fired missiles or rocket propelled grenades.

AERIAL ASSAULT

According to a terrorist "threat matrix" issued by the National Research Council and the National Academies of Sciences and Engineering following the September 2001 attack, "Nuclear power plants may present a tempting high-visibility target for terrorist attack, and the potential for a September 11-type surprise attack in the near term using U.S. assets such as airplanes appears to be high."

In March 2005, a joint FBI and Department of Homeland Security assessment stated that commercial airlines are "likely to remain a target and a platform for terrorists" and that "the largely unregulated" area of general aviation (which includes corporate jets, private airplanes, cargo planes, and chartered flights) remains especially vulnerable. The assessment further noted that Al Qaeda has "considered the use of helicopters as an alternative to recruiting operatives for fixed-wing operations," adding that the maneuverability and "non-threatening appearance" of helicopters, even when flying at low altitudes, makes them "attractive targets for use during suicide attacks or as a medium for the spraying of toxins on targets below."

The vulnerability of nuclear power plants to malevolent airborne attack is detailed extensively in the Petition filed by the National Whistleblower Center and Randy Robarge in 2002 pursuant to 10 CFR Sec. 2.206. A number of studies of the issue are also reviewed in Appendix A to these Comments. The particular vulnerability of nuclear spent fuel pools to this kind of attack is detailed in the January 2003 report of Dr. Gordon Thompson, director of the Institute for Resource and Security Studies entitled "Robust Storage of Spent Nuclear Fuel: A Neglected Issue of Homeland Security" and in the findings of a multi-institution team study led by Frank N. Von Hippel, a physicist and co-director of the Program on Science and Global Security at Princeton University and published in the spring 2003 edition of the Princeton journal *Science and Global Security* under the title "Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States." It is worthy of note that, even post-9/11, general aviation aircraft have circled or flown closely over commercial nuclear facilities without military interception.

The NRC's sole present strategy for averting a kamikaze attack upon a nuclear power plant is reliance upon aviation security upgrades implemented by the Transportation Security Administration and the Federal Aviation Administration and faith that U.S. intelligence will provide ample warning.

It is this kind of governmental agency pass-the-buck mindset that brought the nation Katrina.

The NRC's conjecture also betrays a reality disconnect reminiscent of the federal response to Katrina. Since 2001 there have been numerous breaches of airport security throughout the nation. Notably, in late 2005, there were three serious security breaches at Newark International Airport, one of the points of departure used by the September 11 hijackers. The most serious occurred on November 12, 2005, when a man driving a large S.U.V. barreled through the armed security checkpoint and drove in a secured area for 45 minutes before being found by NY/NJ Port Authority officers. Just this year, gaping holes in airport security were exposed when workers with access to secure areas were able to carry firearms in their carry-on bags onto a commercial jet departing from Florida.

The PRSR must furthermore be upgraded to include high-speed attack by a jumbo jet of the maximum size anticipated to be in commercial use (such as the expanded version of the Boeing 747 and the Airbus A380) as well as unexpected attack by general aviation aircraft and helicopters. The PRSR must contemplate all such aircraft to be fully loaded, fueled and armed with explosives.

It is essential that the PRSR address not only the direct effect of impact, but the full potential aftereffects of (A) induced vibrations; (B) dislodged debris falling onto sensitive equipment; (C) a fuel fire; and (D) the combustion of aerosolized fuel (especially in combination with pre-existing on-site gases such as hydrogen).

The PRSR must further take into consideration the cascading consequences of aerial assault on the full spectrum of plant installations. Inarguably, there is a wide range of on-site structures, not within hardened containment, that are critical to the safe operation of a nuclear plant. Spent fuel pools are of particular concern because the disposition of water could uncover the fuel. If plant workers are unable to effectuate replacement of the water (either because of fire or because they are otherwise incapacitated), experts warn, an exothermic reaction could cause the zirconium clad spent fuel rods to ignite a nuclear waste conflagration that would very likely spew the entire radioactive contents of the spent fuel pool into the atmosphere.

Without question, hardening a nuclear power plant against aerial threat will necessitate significant upgrades in plant fortification. However even relatively modest measures such as the installation of Beamhenge and the placement of all sufficiently cooled spent fuel into Hardened On-Site Storage Systems (known as H.O.S.S.) would add measurable protection.

STRATEGIC USES OF RIGS, TRUCKS AND S.U.V.'S

In June 1991, the NRC denied the truck bomb petition of the Committee to Bridge the Gap and the Nuclear Information Resource Service, on the grounds that it was not realistic to believe a truck bomb would be employed in the U.S. Two years later, on February 26, 1993, terrorists drove a rented van packed with explosives into the underground garage of the World Trade Center, lighted a fuse and fled. Just a couple of weeks before that, a mentally unstable individual crashed his station wagon through the gates of the protected area of the Three Mile Island nuclear power station and evaded security for several hours before finally wrecking his vehicle by crashing into the turbine building. Thereafter, the NRC reconsidered its earlier assessment and has, on a number of occasions, upgraded reactor security standard to include some protections against land vehicles. Such upgrades, however, are insufficient in a post-9/11 world.

Large Sport Utility Vehicles and pickup trucks on the road today can weigh over 8 tons, loaded, and -as do commercial vans- have considerably carrying capacity. Such vehicles could be used strategically in a number of ways.

The first is as a mobile short range projectile bomb. A large, heavy vehicle packed with high explosives, even if not successful in penetrating concrete barriers, could result in the death or incapacitation of large numbers of plant workers, including security, personnel. Such casualties would be particularly likely to materialize if the vehicle bomb followed a previous diversionary event intended to draw security personnel to the plant perimeter.

The second is as a transport vehicle for one team of attackers who are themselves armed or who wear explosive belts and could then themselves penetrate other areas of the facility. A terrorist wearing an explosive body belt can, in effect, be a precision guided weapon.

The third and fourth scenarios are variations of the first two, with chemical agents substituted for or combined with explosives. (Indeed, insurgents in Iraq are increasingly combining explosives with chlorine gas and other chemical payloads in truck bomb detonations.) One or two such vehicles packed with the right toxins, could be expected to kill or disable a substantial number of workers, again, especially if the release followed a prior event which drew security personnel to the area, or simply to areas outside facility enclosures. Certain toxins can be lethal to anyone within miles. Using such agents, attackers wearing protective gear could then gain access to other areas of the facility.

A fifth tactical use of vehicles would not even occur on site. Vehicles carrying explosives and/or chemical agents could be set off at critical regional transportation arteries such as major bridges, tunnels and highways. Notably, such incidents could be staged in a way that would not even alert authorities to the onset of terrorist activity. In the New York metropolitan region in which Indian Point is sited, for example, a series of major accidents occurring at or about the same time would not be an unusual occurrence. In fact, on July 25, 2003, the very day the Federal Emergency Management Agency declared that the Indian Point emergency plan provided "adequate" assurance of protection to the public, the entire New York metropolitan region was brought to a virtual traffic standstill after a tractor-trailer hit a beam on the George Washington Bridge and burst into flames, several minor accidents and a car fire took place on Interstate 95, and a truck got jammed under an overpass of the Hutchinson River Parkway. In 2006, a tanker truck carrying 8000 gallons of gasoline overturned on one of New York City's busiest highways, igniting a blaze that burned for hours and weakening the steel beams of an above bridge. Earlier this month a liquid propane explosion closed a 23 mile stretch of the New York State Thruway for hours, while firefighters had to stand by and watch the fire burn out because it was too hot to approach.

The staging of a couple of incidents like those just noted, combined with an "accident" involving a tanker carrying hazardous gasses or liquids like liquefied ammonia, propane, chlorine, or vinyl chloride, prior to an assault would almost assuredly forestall the provision of outside assistance to a nuclear facility under attack.

PLANTS MUST BE ABLE TO MOUNT A FULL DEFENSE WITHOUT RELIANCE ON OUTSIDE ASSISTANCE

Whether or not an attack employs strategies designed to obstruct regional transportation routes, numerous studies and the actual events of 9/11, Katrina, and Rita (as well as relatively minor events such as the January 18, 2006 wind storm in NY) demonstrate beyond cavil that first responder forces and the National Guard do not have the resources, manpower, equipment or communications capabilities to swiftly and adequately respond to a major assault on a nuclear facility. Just this very month, a report of the Commission on the National Guard and Reserves detailed the ongoing problem of inadequate human, equipment, communications and financial resources plaguing the National Guard. This report calls into question the ability of the government to bring all necessary assets to bear in the immediate aftermath of a major domestic incident.

In some regions - most notably the New York Metropolitan region, in which Indian Point is sited - roadway logistics and regular congestion alone would likely prevent assisting forces from reaching a nuclear plant under attack in time. It bears mention that SWAT team assembly takes approximately 2 hours, whereas an assault could be over in a matter of minutes.

It is accordingly crucial that the NRC cedes the faulty assumption that plant personnel need only fend off attackers until law enforcement or military aid arrives. The fact that most regional first responders have little detailed knowledge of either the operational or internal layout of nuclear facilities further testifies to the folly of reliance upon the "cavalry".

ELEVATED VULNERABILITY TO INFILTRATION DURING EVENT

During a crisis event at a nuclear plant there also exists an elevated threat of infiltration by terrorists posing as first responders or National Guard. And in fact the imposter tactic has been used by terrorists in recent years with substantial success.

Terrorists disguised as firefighters could take particularly strong advantage of this stratagem. Outside firefighters often respond to fires at nuclear power plants and many attack scenarios would be expected to involve fire. Firefighters would presumptively be seen as benign by plant personnel and would have a legitimate reason to move throughout a facility and "check" components such as electrical wiring. Moreover, bulky firefighter uniforms and equipment can hold and hide a host of articles that could be used for destructive purposes.

DEFENSE AGAINST A SIZABLE MULTI-TEAM, MULTI-DIRECTIONAL FORCE

In January 1991, the Nuclear Information Resource Service and the Committee to Bridge the Gap filed a joint Petition with the NRC requesting, *inter alia*, that the DBT be upgraded to 20 external attackers. The NRC rejected the petition in June 1991, asserting that an attack involving more than 3 assailants was unrealistic.

September 11 was a demonstration of the profound limitations of governmental foresight.

The September 11 plot involved 20 attackers (although only 19 were ultimately able to participate). The tragic 2004 siege at a school in Beslan, Russia involved more than 30 armed terrorists. It should be beyond question at this point that a terrorist attack could involve scores of attackers.

Accordingly, the PRSR must assume at least two dozen attackers. Lessons learned from 9/11 and the many multiple coordinated terrorist actions that have transpired in Europe, Asia and the Middle East since then, also mandate the premise that attackers will act in several teams and that some of those teams may be sizable.

Any carefully planned attack on a nuclear facility by knowledgeable individuals, would also involve several different *modus operandi*. The PRSR should therefore take into account the consequences of near-simultaneous damage to different plant installations,

systems and personnel (e.g., the effect of a small explosive-laden plane diving into the roof of a spent fuel pool coupled with the waterborne sabotage of the spent fuel pool intake system).

A COORDINATED ATTACK ON MULTIPLE ON AND OFF-SITE TARGETS

A related point is that, following 9/11, the NRC can no longer ignore the very real possibility that an attack on a nuclear power plant would occur commensurate with an attack on other regional infrastructure such as chemical plants and bridges. A coordinated attack designed to effectively eradicate a region would very likely preliminarily target communication, electrical power and/or transportation infrastructures. This would ensure that (A) the targeted region is reduced to mass confusion, (B) local and federal officials and responders would be overwhelmed, and (C) law enforcement and other first responders would be impeded from gaining access to the nuclear plant site.

Certain areas of the U.S. offer a plethora of target opportunities and thus are particularly vulnerable to multiple target scenarios. Prime among them is the greater New York Metropolitan area (already in the terrorists' crosshairs) which contains numerous national landmarks, corporate headquarters, reservoirs, bridges, airports, transportation arteries and hazardous chemical plants, all in near vicinity to Indian Point, a mere 24 miles north of New York City.

A CREDIBLE NUCLEAR PLANT SECURITY FORCE TESTING PROGRAM

The deficiencies, failures, and chicanery that have long plagued the various manifestations of nuclear power industry security drills and force-on-force (FOF) testing have been exhaustively documented in recent years. Noteworthy investigations in this regard have been conducted by the Project on Government Oversight (augmented by testimony provided in 2002 Senate Environment and Public Works Committee hearings) and the United States General Accounting Office (which reported its findings in a September 2003 report entitled "Oversight of Security at Commercial Nuclear Power Plants Needs to Be Strengthened") as well as by the press. Problems with the FOF program are also addressed in the July 2004 Petition for Rulemaking to amend 10 CFR Part 73 to upgrade the DBT filed by the Committee to Bridge the Gap and the Comments on the DBT filed in 2006 by the Union of Concerned Scientists. CIECP fully endorses the recommendations made in previous filings by the Committee to Bridge the Gap and the Union of Concerned Scientists.

CIECP urges the NRC in the strongest possible terms to upgrade drills and testing protocols to remedy the flaws that are a matter of public record and to take into account the realities noted herein. FOF tests must be sufficiently challenging to provide high confidence in the defensive capabilities of the security forces at the nation's 103 nuclear power plants. One clear failing of the FOF program to date has been the giving of excessive warning regarding upcoming tests. While some notice is necessary, one week should suffice. In addition, staff assignments should be frozen on the day of notice. This would eliminate the all too common practice of substituting a plant's most fit and accomplished security personnel in place of underachievers.

It is also critical that drills and the FOF program be revamped to eliminate manifest conflicts of interest. Examples of blatant conflicts of interest include: (1) The NRC allowing the nuclear industry's lobbying arm, the Nuclear Energy Institute (NEI) to award a FOF contract; and (2) The NEI, with NRC approval, then selecting Wackenhut, a corporation which contracts security guards to nuclear power plants in the U.S., to also be the contractor that supplies the mock adversary teams for the FOF tests.

Such problems have reduced the value of testing to the point where the FOF program lacks public confidence. The program must be redesigned and monitored by an independent entity such as the very capable U.S. military.

HIGH TARGET APPEAL REACTORS

Prior terrorist attacks and plots against the U.S. have focused on major cities. It is a matter of fundamental logic that plants sited in highly populated metropolitan areas, particularly those with high symbolic value, face the greatest risk of being selected as a target.

It is thus imperative that the PRSR be modified to mandate a customized approach to high target nuclear facilities.

SITE-SPECIFIC SAFETY-RELATED VULNERABILITIES

It is highly unrealistic to exclude from the PRSR calculus the reality of aging structures, deteriorated conditions and compromised systems that exist at various nuclear power plants in the U.S. A facility-customized approach must be taken which adds problems which are known or reasonably suspected and which could have a significant effect upon the ability of plant operators to maintain control during a major incident into the security equation.

Prime among factors which may be site-specific are:

- **Corrosion and Embrittlement:** For example, a risk of corrosion of the steel liner of the reactor containment at the Oyster Creek Nuclear Generating Station (Oyster Creek) was recently identified. A qualified corrosion expert has warned that the risk may be high enough to cause buckling and collapse. Manifestly, corrosion or embrittlement-weakened structures and components are more vulnerable to the effects of heat and combustion.
- **Vulnerability to Fire:** Fire detection and suppression equipment and fire barriers are crucial to reactor safety. Over 20 years ago a worker at the Brown's Ferry Unit 1 reactor accidentally started a fire which destroyed emergency cooling systems and severely compromised the plant's ability to monitor its condition. In response, the NRC increased fire safety standards. In recent years, the NRC has effectively relaxed those standards. This is exceedingly unwise. During the chaos and threat level that would surely exist during a terrorist attack, human beings cannot be presumed to be able to take the actions necessary to protect critical systems from fire. The systems themselves must have integral safeguards. Yet plants such as Arkansas Nuclear One, Catawba, Ginna, H.B.

Robinson, Indian Point, James A. Fitzpatrick, McGuire, Shearon Harris, Vermont Yankee and Waterford have been identified as having fire barrier wrap systems that failed fire tests. Fireproofing problems such as these jeopardize safe shutdown and must be recognized as a degradation of defense-in-depth protection. In addition, any plant fire hazard analyses must assume damage to multiple rooms and multiple structures, a circumstance that could easily result from an aircraft impact.

- Integrity of Structures that Support Mobility: While the focus of NRC regulatory review is on structures and equipment directly related to safe operational function, the conditions that may prevail during an assault would likely require plant personnel to be able to move rapidly throughout the facility. The evaluation of the reliability of structural features such as stairways (which might buckle or melt during a fire) is accordingly critical.
- Electrical System Problems: In 2003, a cable failure knocked out power to approximately half the safety systems at Oyster Creek, including security cameras, alarms, sensors, pumps and valves. In February 2003, all 4 of the backup generators at Fermi became simultaneously inoperable. In December 2001, Indian Point reactor 2 lost power due to a malfunction of the turbine, then lost back-up power to the reactor coolant system because of a second electrical failure. During the August 2003 blackout that struck the Northeast, following the loss of off-site power, two of Indian Point's emergency backup generators (both of which had been previously flagged as having problems) failed to operate. In view of the severe consequences failures such as these could have were they to occur during a major incident, known plant electrical system vulnerabilities must be taken into consideration.
- Cooling System Problems: Cooling system problems and design deficiencies have plagued a number of plants in recent years. In some cases the NRC has allowed plants to operate for long periods with compromised emergency cooling systems. For example, the Salem nuclear power station had experienced two years of repeated malfunctions of its high-pressure coolant-injection system prior to the time, in October 2003, when operators unsuccessfully tried to use it to stabilize water levels following a steam pipe burst. And the NRC has allowed reactors with emergency sump pumps flagged as likely to become clogged and inoperative to remain in operation for many years without repair. The Los Alamos National Laboratory, for instance, concluded that the sump pumps at Indian Point reactors 2 and 3 could become clogged in as little as 23 minutes and 14 minutes, respectively. While, upgrades are being made, the failure of the NRC to mandate immediate correction of cooling system vulnerabilities calls its oversight capabilities seriously into question. Indeed the functional declination of critical systems must be deemed a constituent element of site-specific PRSR analyses.

ELIMINATE COMMERCIAL CONSIDERATIONS FROM THE PRSR CALCULUS

The commercial interests of the nuclear industry are of valid concern to nuclear utilities and the NEI; they should not be of concern to the NRC. There is no justification for

jeopardizing national security and the health and safety of the public - even to the smallest degree - to safeguard corporate profits.

The NRC has stated that its promulgated security standards are based upon the analysis of the largest threat against which a **"private security force could reasonably be expected to defend"** [*emphasis added*] 70 FR 67385.

Both the NRC and the industry have acknowledged that, in their estimation, a private guard force should not be reasonably expected to defend against a 9/11-type attack involving aircraft. Such an attack, apparently, is deemed to fall under the loophole of 10 CFR Sec. 50.13, which exempts reactor operators from defending against "an enemy of the United States, a foreign government or other person". The perimeter of this "enemy of the United States" provision has never been defined, so there is no way to know how far it extends. However, it is abundantly clear from the public record that the NRC has drawn the line at point where the profit margins of nuclear power operators might be significantly affected. Unfortunately, the terrorists are constrained by no such boundary.

Congress has charged the NRC with the obligation to protect the public health and safety. This must not be viewed simply as a guideline; it must be viewed as an uncompromised mandate.

If the NRC does not believe its licensees can afford the security upgrades necessary to protect the nation's nuclear reactors against the full potential threat, it must act with forthrightness and publicly demand that the Department of Homeland Security or the U.S. military assume responsibility for domestic nuclear power plant security.

CONCLUSION

The 9/11 Commission observed: "Across the government, there were failures of imagination, policy, capabilities... The most important failure was one of imagination. We do not believe leaders understood the gravity of the threat."

As a public interest group we ask: What needs to happen before the gravity of the threat is not only understood, but acted upon?

Respectfully submitted,

**COUNCIL ON INTELLIGENT ENERGY
& CONSERVATION POLICY**

(New York)

By

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Chairman

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APPENDIX A

Since September 11, 2001, there has been much speculation about the vulnerability of nuclear power plants to aerial attack. Certainty, however, is in short supply.

What is known is that none of the nuclear reactors presently operational in the United States were built to withstand the crash of a jumbo jet, much less the crash of super jumbo such as the A380 which will take to the air weighing 1.2 million pounds, has a wingspan almost as long as a football field, is 8 stories tall, and is 3 times as large as the 767s that brought down the Twin Towers.

Nevertheless studies that have addressed the prospect of planes hitting nuclear plants include the following:

1974: To date the only published peer reviewed study on the vulnerability of U.S. nuclear power plants was conducted by General Electric, the leading builder of nuclear plants, and published in the industry journal *Nuclear Safety*. GE looked at accidents – not terror attacks – and concluded that were a “heavy” airliner to hit a reactor building in the right place, it would almost certainly rip it apart. Such a hit would also most likely damage the reactor core and both the cooling and emergency cooling systems. [NOTE: The GE study defined a “heavy” plane as one weighing more than 6 tons. The Boeing 757 which gouged a 100 foot gash through the reinforced concrete of the Pentagon weighed between 80 and 100 tons. A fully loaded 767 weighs over 200 tons. The Airbus 380, expected to be launched into commercial use later this year, takes to the air weighing 1.2 million pounds, hundreds of thousands of pounds heavier than the Boeing 747, the current jumbo of the sky.]

1982: A technical report (previously publicly available) of a study conducted by the U.S. Army Corps of Engineers at the NRC’s behest focused on plane crash analyses at the Argonne National Laboratory. The Corps concluded that planes traveling at a speed of over 466 mph would crash through the average reactor containment structure noting “account has been taken of the internal concrete wall which acts as a missile barrier... It would appear, however, that this is too optimistic since vaporized fuel, hot gaseous reaction products, and to a certain extent portions of liquid fuel streams will flow around such obstructions and overwhelm internal defenses...” [NOTE: An FBI analysis estimated that American Airlines Flight 11, which hit the north tower of the World Trade Center, was traveling at a speed of 494 mph, and that United Airlines Flight 175, which hit the south tower, was traveling at 586 mph, a speed far exceeding its design limit for the altitude.]

2000: A NRC study published less than a year before September 11 calculated that 1 out of 2 commercial airplanes flying in the year 2000 were large enough to penetrate even a 5 foot thick reinforced concrete wall 45% of the time. Specifically, the study states, “aircraft damage can affect the structural integrity of the spent fuel pool or the availability of nearby support systems, such as power supplies, heat exchangers, or water makeup sources and may also affect recovery actions...It is estimated that half the commercial

aircraft now flying are large enough to penetrate the 5 foot thick reinforced concrete walls.” [NOTE: The thickness of the top of certain reactor domes is 3 and-a-half feet.]

2002: The German Reactor Safety Organization (GRS) a scientific-technical research group that works primarily for nuclear regulators in Germany conducted an extremely detailed study that determined that terrorists can, with a strategically targeted airplane crash, initiate a nuclear accident. (A secret Ministry document that summarized the report was leaked to the German and Austrian press and subsequently translated into English.) The GRS study used dynamic computation modeling that looked at the potential consequences of a wide range of impact possibilities on different plant equipment and installations. Different types of airplanes, velocities, angles of impact, weight loads and fuel effects were considered, as were various sequences of events. Aside from the basic finding of vulnerability, the GRS study is significant for recognizing the limitations of even its highly complex analyses. Key unknowns include the impacts of fire loads on many kind of materials and equipment as well as the behaviors of various combustive materials under the conditions of a plane crash.

2004: In 2004 the U.K. Parliamentary Office of Science and Technology (OST) issued a secret report on the risks of terrorist attacks on nuclear facilities to the U.K. House of Commons Defense Committee. The OST report was leaked to the magazine *New Scientist*, which reported the OST conclusion that a large plane crash into a nuclear reactor could release as much radiation as the 1986 accident at Chernobyl, while a crash into the nuclear waste tanks at the U.K.'s Sellafield facility could cause several million fatalities.

From these studies it is clear that there exists a reasonable basis for concern regarding malevolent deployment of aircraft against nuclear power facilities.

It should also be evident that all studies on this topic are, in substance, educated conjecture. The current state of computer modeling is not up to analyzing the full range of physical and chemical interactions that could occur under the incalculable range of different kinds of aircraft, approaching at different angles, at different speeds, hitting different structures, which all have facility-unique room and equipment layouts, and different substance, chemical, and ventilation-related conditions.

A lesson in the unpredictable consequences of airplane crashes was brought home on September 11 (when even the 47 story tall 7 World Trade Center that was not struck collapsed for reasons engineers have yet to fully determine). A lesson in the limitations of advanced computer modeling can also be learned from the Columbia space shuttle disaster.

[~DBT and PRSR]

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

In the Matter of)
Pa'ina Hawaii, LLC) Docket No. 030-36974
)
Materials License Application)
_____)

**DECLARATION OF DR. GORDON R. THOMPSON
IN SUPPORT OF PETITIONER'S AREAS OF CONCERN**

I, Gordon R. Thompson, declare that if called as a witness in this action I could testify of my own personal knowledge as follows:

I. INTRODUCTION

I-1. I am the executive director of the Institute for Resource and Security Studies (IRSS), a nonprofit, tax-exempt corporation based in Massachusetts. Our office is located at 27 Ellsworth Avenue, Cambridge, Massachusetts 02139. IRSS was founded in 1984 to conduct technical and policy analysis and public education, with the objective of promoting peace and international security, efficient use of natural resources, and protection of the environment. In addition to holding my position at IRSS, I am also a research professor at the George Perkins Marsh Institute, Clark University, Worcester, Massachusetts. My professional qualifications are discussed in Section II of this declaration.

I-2. I have been retained by Concerned Citizens of Honolulu as an expert witness in a proceeding before the US Nuclear Regulatory Commission (NRC), regarding an application by

Pa'ina Hawaii, LLC, for a license to build and operate a commercial pool-type industrial irradiator in Honolulu, Hawai'i, at the Honolulu International Airport.

I-3. The purpose of this declaration is to support Concerned Citizens' contention that "special circumstances" exist, precluding the NRC's use of a categorical exclusion from the National Environmental Policy Act's mandate to prepare either an environmental assessment (EA) or environmental impact statement (EIS) in the context of the proposed license.¹ In this declaration, I focus on the potential for acts of malice or insanity, related to the proposed Pa'ina Hawaii irradiator, to cause harm to people and/or the environment. As part of that focus, I address the potential to reduce the risk of harm by adopting alternatives to the proposed mode of construction and operation of the irradiator. Also, I address the processes whereby acts of malice or insanity could be considered in a licensing proceeding or during the preparation of an EA or EIS. My focus on the implications of potential acts of malice or insanity does not indicate that I regard other issues, relevant to licensing of the proposed irradiator, as having a lesser significance.

I-4. The remainder of this declaration has seven sections. Section II discusses my professional qualifications. Section III discusses some of the characteristics of the proposed Pa'ina Hawaii irradiator. The potential for commercial nuclear facilities, including irradiators, to be affected by acts of malice or insanity is addressed in Section IV. That discussion is continued in Section V, with a focus on irradiators. Section VI discusses the potential to reduce the risk of harm, arising from acts of malice or insanity, by adopting alternatives to the proposed design and mode of operation of the Pa'ina Hawaii irradiator. Section VII addresses the processes whereby acts of malice or insanity could be considered in a licensing proceeding, or during the

¹ 10 C.F.R. § 51.22(b); see also *id.* § 2.335(b); 40 C.F.R. § 1508.4.

preparation of an EA or EIS, for the Pa'ina Hawaii irradiator. Major conclusions are set forth in Section VIII. Documents cited in this declaration are listed in a bibliography that is appended to the declaration.

II. MY PROFESSIONAL QUALIFICATIONS

II-1. I received an undergraduate education in science and mechanical engineering at the University of New South Wales, in Australia. Subsequently, I pursued graduate studies at Oxford University and received from that institution a Doctorate of Philosophy in mathematics in 1973, for analyses of plasmas undergoing thermonuclear fusion. During my graduate studies I was associated with the fusion research program of the UK Atomic Energy Authority. My undergraduate and graduate work provided me with a rigorous education in the methodologies and disciplines of science, mathematics, and engineering.

II-2. Since 1977, a significant part of my work has consisted of technical analyses of safety, security and environmental issues related to nuclear facilities. These analyses have been sponsored by a variety of nongovernmental organizations and local, state and national governments, predominantly in North America and Western Europe. Drawing upon these analyses, I have provided expert testimony in legal and regulatory proceedings, and have served on committees advising US government agencies. In a number of instances, my technical findings have been accepted or adopted by relevant governmental agencies. To illustrate my expertise, I provide in the following paragraphs some details of my experience.

II-3. During the period 1978-1979, I served on an international review group commissioned by the government of Lower Saxony (a state in Germany) to evaluate a proposal for a nuclear fuel cycle center at Gorleben. I led the subgroup that examined safety and security risks, and identified alternative options with lower risk. One of the risk issues that I identified

and analyzed was the potential for self-sustaining, exothermic oxidation reactions of fuel cladding in a high-density spent-fuel pool if water is lost from the pool. Hereafter, for simplicity, this event is referred to as a "pool fire". In examining the potential for a pool fire, I identified partial loss of water as a more severe condition than total loss of water. I identified a variety of events that could cause a loss of water from a pool, including aircraft crash, sabotage, terrorism and acts of war. Also, I identified and described alternative spent-fuel-storage options with lower risk; these lower-risk options included design features such as spatial separation, natural cooling and underground vaults. The Lower Saxony government accepted my findings about the risk of a pool fire, and ruled in May 1979 that high-density pool storage of spent fuel was not an acceptable option at Gorleben. As a direct result, policy throughout Germany has been to use dry storage in casks, rather than high-density pool storage, for away-from-reactor storage of spent fuel.

II-4. My work has influenced decision making by safety officials in the US Department of Energy (DOE). During the period 1986-1991, I was commissioned by environmental groups to assess the safety of the military production reactors at the Savannah River Site, and to identify and assess alternative options for the production of tritium for the US nuclear arsenal. Initially, much of the relevant information was classified or otherwise inaccessible to the public. Nevertheless, I addressed safety issues through analyses that were recognized as accurate by nuclear safety officials at DOE. I eventually concluded that the Savannah River reactors could not meet the safety objectives set for them by DOE. The Department subsequently reached the same conclusion, and scrapped the reactors. Current national policy for tritium production is to employ commercial reactors, an option that I had concluded was technically attractive but problematic from the perspective of nuclear weapons proliferation.

II-5. In 1977, and again during the period 1996-2000, I examined the safety and security of nuclear fuel reprocessing and liquid high-level radioactive waste management facilities at the Sellafield site in the UK. My investigation in the latter period was supported by consortia of local governments in Ireland and the UK, and I presented findings at briefings in the UK and Irish parliaments in 1998. I identified safety issues that were not addressed in any publicly available literature about the Sellafield site. As a direct result of my investigation, the UK Nuclear Installations Inspectorate (NII) required the operator of the Sellafield site -- British Nuclear Fuels -- to conduct extensive safety analyses. These analyses confirmed the significance of the safety issues that I had identified, and in January 2001 the NII established a legally binding schedule for reduction of the inventory of liquid high-level radioactive waste at Sellafield. The NII took this action in recognition of the grave offsite consequences of a release to the environment from the tanks in which liquid high-level waste is stored. I had identified a variety of events that could cause such a release, including acts of malice or insanity.

II-6. In January 2002, I authored a submission to the UK House of Commons Defence Committee, addressing the potential for civilian nuclear facilities to be used by an enemy as radiological weapons. The submission drew upon my own work, and the findings of other analysts, dating back as far as the mid-1970s. My primary recommendation was that the Defence Committee should call upon the Parliamentary Office of Science and Technology (POST) to conduct a thorough, independent analysis of this threat. I argued that the UK government and nuclear industry could not be trusted to provide a credible analysis. The Defence Committee subsequently adopted my recommendation, and a study was conducted by POST.

II-7. I was the author or a co-author of two documents, published in 2003, that addressed the safety and security risks arising from the storage of spent fuel in high-density pools at US nuclear power plants.² This work expanded on analysis that I had first conducted in the context of the proposed nuclear fuel cycle center at Gorleben, as discussed in paragraph II-3, above. The two documents became controversial, and their findings and recommendations were challenged by the NRC. The US Congress recognized that our findings, if correct, would be significant for national security. Accordingly, Congress requested the National Academy of Sciences (NAS) to conduct an independent investigation of these issues. The Academy's report vindicated the work done by my co-authors and me.³

III. CHARACTERISTICS OF THE PROPOSED IRRADIATOR

III-1. According to the NRC, Pa'ina Hawaii has stated that the proposed irradiator would be used primarily for the irradiation of fresh fruit and vegetables bound for the US mainland. Other items to be irradiated would include cosmetics and pharmaceutical products.⁴ A story in the technical press has stated that the irradiator would be the Genesis model manufactured by Gray-Star, using a 1 million-Curie Cobalt-60 source located in a water-filled pool 22 feet deep.⁵ Cobalt-60 is a radioactive isotope with a half-life of 5.3 years. According to an April 2004 NRC fact sheet, all US commercial irradiators regulated by the NRC currently use Cobalt-60; the amount used at each irradiator typically exceeds 1 million Curies and can range up to 10 million

² Thompson, 2003; Alvarez et al, 2003.

³ NAS, 2005.

⁴ NRC, 2005.

⁵ Nuclear News, 2005.

Curies.⁶ The Cobalt-60 is present in the form of sealed sources typically consisting of metallic "pencils" said to be about one inch in diameter and one foot long.⁷

III-2. The version of Pa'ina Hawaii's license application that has been posted at the NRC website has major redactions. That document does not allow the reaching of any conclusion about the safety and security of the proposed irradiator.

IV. THE POTENTIAL FOR NUCLEAR FACILITIES TO BE AFFECTED BY ACTS OF MALICE OR INSANITY

IV-1. No commercial nuclear facility in the United States was designed to resist attack. Facilities have some capability in this respect by virtue of design for other objectives (e.g., resisting tornado-driven missiles). Beginning in 1994, with the NRC's promulgation of a vehicle-bomb rule, each US nuclear power plant has implemented site-security measures (e.g., barriers, guards) that have some capability to prevent attackers from damaging vulnerable parts of the plant. The scope of this defense was increased in response to the attacks of 11 September 2001. Nevertheless, it continues to reflect the NRC's judgment that a "light defense" of nuclear power plants, to use military terminology, is sufficient.⁸ This judgment is not supported by any published strategic analysis. The NRC takes the same approach in regulating nuclear facilities other than power plants, including commercial irradiators.

IV-2. A strategic analysis of needs and opportunities for security of a nuclear facility should have three parts. It should begin with an assessment of the scale of damage that could arise from an attack. A major determinant of this scale is the amount of radioactive material that is available for release to the atmosphere or a water body; other determinants are the

⁶ NRC, 2004b.

⁷ Kelly, 2002.

⁸ NRC, 2004a.

vulnerability of the facility to attack, and the consequences of attack.⁹ The second step in the strategic analysis should be to assess the future threat environment. The third step should be to assess the adequacy of present measures to defend the facility, and to identify options for providing an enhanced defense.

IV-3. The analyst should seek to understand the interests and perspectives of potential attackers. To illustrate, a sub-national group that is a committed enemy of the United States might perceive two major incentives for attacking a US commercial nuclear facility. First, release of a large amount of radioactive material could cause major, lasting damage to the United States. Second, commercial nuclear technology could symbolize US military dominance through nuclear weapons and associated technologies such as guided missiles; a successful attack on a commercial nuclear facility could challenge that symbolism. Conversely, the group might perceive three major disincentives for attack. First, nuclear facilities could be less vulnerable than other potential targets. Second, radiological damage from the attack would be indiscriminate, and could occur hundreds of km downwind in non-enemy locations (e.g., Mexico). Third, the United States could react with extreme violence.

IV-4. The threat environment must be assessed over the entire period during which a nuclear facility is expected to operate. For spent-fuel storage facilities, that period could exceed a century. The risk of attack will accumulate over the period of operation. Forecasting international conditions over several decades is a notoriously difficult and uncertain enterprise. Nevertheless, an implicit or explicit forecast must underlie any decision about the level of security that is provided at a nuclear facility. Prudence dictates that a forecast in this context

⁹ Direct release of radioactive material is not the only potential consequence of an attack on a nuclear facility. There is also concern that radioactive or fissile material could be removed from the facility and incorporated into a radiological or nuclear weapon.

should err on the side of pessimism. Decision makers should, therefore, be aware of a literature indicating that the coming decades could be turbulent, with a potential for higher levels of violence.¹⁰ One factor that might promote violence is a perception of resource scarcity. It is noteworthy that many analysts are predicting a peak in world oil production within the next few decades.¹¹ Also, a recent international survey shows significant degradation in the Earth's ability to provide ecosystem services.¹²

IV-5. The potential for attacks on nuclear facilities has been studied for decades.¹³ Nevertheless, the NRC remains convinced that these facilities require only a light defense. The NRC's position fails to account for the growing strategic significance of sub-national groups as potential enemies. Various groups of this kind could possess the motive and ability to mount an attack on a US nuclear facility with a substantial probability of success. The unparalleled military capability of the United States cannot deter such a threat if the attacking group has no territory that could be counter-attacked. Moreover, use of US military capability could be counter-productive, creating enemies faster than they are killed or captured. Many analysts believe that the invasion of Iraq has produced that outcome.

IV-6. The discussion in the preceding paragraphs shows that it would be prudent to consider options for providing an enhanced defense of nuclear facilities. Design studies have identified a large potential for increasing the robustness of new facilities.¹⁴ This finding argues for careful consideration of alternative options during the licensing of a new facility. At existing facilities, there is usually less opportunity for increasing robustness. Nevertheless, there are

¹⁰ Kugler, 1995; Raskin et al, 2002.

¹¹ Hirsch et al, 2005.

¹² Stokstad, 2005.

¹³ Ramberg, 1984.

¹⁴ Hannerz, 1983.

many opportunities to enhance the defenses of an existing facility. I have identified such opportunities in a number of instances. For example, I have identified a set of measures that could provide an enhanced defense of the San Onofre nuclear power plant.¹⁵

V. POTENTIAL ACTS OF MALICE OR INSANITY IN THE CONTEXT OF IRRADIATORS

V-1. Section IV, above, shows that it would be prudent, in the licensing and regulation of a range of nuclear facilities, to consider the implications of potential acts of malice or insanity. Commercial irradiators, such as that proposed by Pa‘ina Hawaii, are among the facilities for which this consideration would be prudent. The reason is that these irradiators contain large amounts of Cobalt-60. If that material were removed from its containment and brought into proximity to humans and other life forms or their habitats, significant harm could occur. The nature of that harm is illustrated by a case study that is discussed in paragraph V-3, below.

V-2. An act of malice or insanity could remove Cobalt-60 from its containment, and bring this material into potential proximity to life forms, in two ways. First, a violent event involving mechanisms such as blast, impact and fire could release Cobalt-60 to the atmosphere from the irradiator facility or during transport of Cobalt-60 sealed sources to or from the facility.¹⁶ This violent event could be a deliberate attack or, conceivably, a collateral event deriving from an attack directed elsewhere. Second, Cobalt-60 sealed sources could be removed intact from the irradiator facility or during transport to or from the facility, and these sources could be used to deliberately irradiate life forms or their habitats. This irradiation could be accomplished by atmospheric dispersal of Cobalt-60 from a sealed source, with or without

¹⁵ Thompson, 2004.

¹⁶ After release to the atmosphere, the Cobalt-60 would be present in fragments or particles of various sizes, which would eventually be deposited on the ground around or downwind of the point of release.

chemical and physical manipulation of the source prior to dispersal.¹⁷ An explosive charge could be used to achieve dispersal, a process that is commonly described as the use of a "dirty bomb". Atmospheric dispersal might also be achieved, after chemical and physical manipulation of the source, through mechanisms such as spraying and combustion. As an alternative to atmospheric dispersal, hostile irradiation could be accomplished by clandestinely placing sealed sources, or fragments thereof, in locations (e.g., bus or train stations) where targeted populations are likely to be present.¹⁸

V-3. Findings of a theoretical case study on atmospheric dispersal of Cobalt-60 were summarized in Congressional testimony by the Federation of American Scientists in 2002.¹⁹ The case study assumed that one Cobalt-60 "pencil" from a commercial irradiator would be explosively dispersed at the lower tip of Manhattan. The results were compared with those from an assumed dispersal of radioactive cesium, in the following statement:²⁰

"Again, no immediate evacuation would be necessary, but in this case [the Cobalt-60 dispersal], an area of approximately one thousand square kilometers, extending over three states, would be contaminated. Over an area of about three hundred typical city blocks, there would be a one-in-ten risk of death from cancer for residents living in the contaminated area for forty years. The entire borough of Manhattan would be so contaminated that anyone living there would have a one-in-a-hundred chance of dying from cancer caused by the residual radiation. It would be decades before the city was inhabitable again, and demolition might be necessary."

V-4. Following an atmospheric dispersal of radioactive material such as Cobalt-60, the area of land that would be regarded as contaminated, and the overall economic consequences of the event, would depend on the contamination standard that would apply.²¹ At present, there are

¹⁷ Zimmerman and Loeb, 2004.

¹⁸ NRC, 2003.

¹⁹ Kelly, 2002.

²⁰ Kelly, 2002.

²¹ Reichmuth et al, 2005.

competing standards, and no clarity about which one would apply.²² Resolving this issue could be politically difficult, either before or after a dispersal event. A further complicating factor is the exclusion of radiation risk from virtually all insurance policies written in the United States.²³

V-5. A malicious actor who seeks to expose a population to radioactive material, such as Cobalt-60, could have a range of goals including: (i) causing prompt casualties; (ii) spreading panic; (iii) recruitment to the actor's cause; (iv) asset denial; (v) economic disruption; and (vi) causing long-term casualties.²⁴

V-6. Many public officials in the United States and elsewhere are aware of the threat of malicious exposure to radioactive material. At times, substantial resources have been allocated to addressing this threat. For example, a major US government effort was mounted in December 2003 to detect "dirty bombs" in various US cities.²⁵ Recently, the Australian government has located large, unsecured radioactive sources in two countries in Southeast Asia. At least one of these sources was Cobalt-60.²⁶ Acting in a manner that invites comparison with licensing of the proposed Pa'ina Hawaii irradiator, the National Nuclear Security Administration (NNSA) removed Cobalt-60 from an irradiator at the University of Hawai'i in March 2005.²⁷ This removal occurred during the same week in which the NRC issued a Notice of Violation that responded to an NRC-observed security breach at the irradiator in March 2003.²⁸ It is said that

²² Medalia, 2004; Zimmerman and Loeb, 2004.

²³ Zimmerman and Loeb, 2004.

²⁴ Medalia, 2004.

²⁵ Mintz and Schmidt, 2004.

²⁶ Eccleston and Walters, 2005.

²⁷ NNSA, 2005.

²⁸ Environment Hawai'i, 2005b.

the irradiator contained about 1,000 Curies of Cobalt-60.²⁹ An NNSA official described the removal of this Cobalt-60 as follows:³⁰

"The removal of these radiological sources has greatly reduced the chance that radiological materials could get into the wrong hands. The university of Hawaii, its surrounding neighbors and the international community are safer today as [a] result of this effort."

V-7. There is a comparatively small technical literature on the safety and security of commercial irradiators, although it is known that safety and security incidents have occurred at these facilities.³¹ Irradiators represent one application of sealed radioactive sources. Overall, the use of those sources has created grounds for concern from the perspective of security. According to NRC data, there were more than 1,300 instances of lost, stolen and abandoned sealed sources in the United States between 1998 and 2002.³²

V-8. In June 2003, the NRC issued its first security order requiring enhanced security at large commercial irradiators.³³ The nature and scope of the required security measures have not been publicly disclosed. It is noteworthy that NRC officials have said that the NRC lacks sufficient staff to conduct inspections of all sealed-source licensees that are expected to receive security orders.³⁴

V-9. If provided with relevant information about the design of commercial irradiators, and the security measures that are in effect at these facilities, independent analysts could assess the vulnerability of these facilities to potential acts of malice or insanity. That assessment could be performed in a manner such that sensitive information is not publicly disclosed. The

²⁹ Environment Hawai'i, 2005a.

³⁰ NNSA, 2005.

³¹ NRC, 1983.

³² GAO, 2003, page 17.

³³ GAO, 2003, page 28.

³⁴ GAO, 2003, page 31.

assessment could, for example, assess the vulnerability of irradiators to shaped charges.³⁵ Also, the assessment could examine the NRC's undocumented assertion that it has "preliminarily determined that it would be extremely difficult for someone to explode a cobalt-60 source in a way that could cause widespread contamination".³⁶ As explained in paragraph V-2, above, explosive dispersal of an intact Cobalt-60 sealed source is one, but not the only, mechanism whereby Cobalt-60 could be brought into proximity to targeted populations.

VI. ALTERNATIVE OPTIONS

VI-1. The currently-proposed design and mode of operation of the Pa'ina Hawaii irradiator implies a risk of harm to people and/or the environment, arising from potential acts of malice or insanity. Assessment of the nature and scale of that risk must await the provision of more information about the facility than is now publicly available. It is, however, already clear that lower-risk options exist. These options could be systematically examined in an EIS.

VI-2. Two options are available that could eliminate the risk. One such option would be to adopt non-irradiative methods of treating fresh fruit and vegetables. The second option would be to use an irradiator that does not require radioactive material such as Cobalt-60. In this context, it is noteworthy that an existing commercial irradiator in Hawai'i employs electron-beam technology. This facility, known as Hawai'i Pride, was built at Kea'au in 2000. Some observers question whether two irradiators, or even one, can be economically viable in Hawai'i.³⁷

VI-3. If the Pa'ina Hawaii irradiator were to be built and operated, using Cobalt-60, its design, location and mode of operation could be modified to reduce the risk of harm arising from potential acts of malice or insanity. For example, site security and the robustness of the facility

³⁵ Walters, 2003.

³⁶ NRC, 2004b.

³⁷ Environment Hawai'i, 2005c.

could be enhanced. Alternative locations could potentially reduce the risk in two ways. First, the currently-proposed location might be especially attractive to attackers because of the proximity of military and symbolic targets including Hickam Air Force Base and Pearl Harbor. Second, the currently-proposed location at Honolulu International Airport might facilitate attack from the air by, for example, an explosive-laden general aviation aircraft. Full delineation of potential modifications, and assessment of their costs and contributions to risk reduction, must await the provision of more information about the facility than is now publicly available.

VII. CONSIDERATION OF ACTS OF MALICE OR INSANITY IN A LICENSE PROCEEDING, EA, OR EIS

VII-1. During an open session of a license proceeding, or in the published version of an EA or EIS, it would be inappropriate to disclose information that could assist the perpetrator of an act of malice or insanity that affects a nuclear facility. It does not follow, however, that acts of malice or insanity cannot be considered in a license proceeding, an EA, or an EIS. Well-tested procedures are available whereby this consideration could occur without publicly disclosing sensitive information. In the context of a license proceeding, some of the sessions, and the accompanying documents, could be open only to authorized persons. Similarly, an EA or EIS could contain sections or appendices that are available only to authorized persons. Interested parties, including public-interest groups, could nominate representatives, attorneys and experts who can become authorized persons on their behalf.

VIII. MAJOR CONCLUSIONS

VIII-1. It would be prudent, in the licensing and regulation of a range of nuclear facilities, to consider the implications of potential acts of malice or insanity. Commercial

irradiators, such as that proposed by Pa'ina Hawaii, are among the facilities for which this consideration would be prudent.

VIII-2. The currently-proposed design and mode of operation of the Pa'ina Hawaii irradiator implies a risk of harm to people and/or the environment, arising from potential acts of malice or insanity. Assessment of the nature and scale of that risk must await the provision of more information about the facility than is now publicly available. It is, however, already clear that lower-risk options exist. These options could be systematically examined in an EIS.

VIII-3. Well-tested procedures are available whereby acts of malice or insanity could be considered in a license proceeding, an EA, or an EIS related to the proposed Pa'ina Hawaii irradiator.

I declare under penalty of perjury that I have read the foregoing declaration and know the contents thereof to be true of my own knowledge.

Dated at Cambridge, Massachusetts, 3 October 2005.

GORDON R. THOMPSON

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ROBUST STORAGE OF SPENT NUCLEAR FUEL:
A Neglected Issue of Homeland Security

by

Gordon Thompson

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About IRSS

The Institute for Resource and Security Studies (IRSS) is an independent, non-profit corporation. It was founded in 1984 to conduct technical and policy analysis and public education, with the objective of promoting international security and sustainable use of natural resources. IRSS projects always reflect a concern for practical solutions to resource, environment and security problems. Projects include detailed technical studies, participation in public education and debate, and field programs that promote the constructive management of conflict.

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Dr. Gordon Thompson is the executive director of IRSS and a research professor at Clark University. He received an undergraduate education in science and mechanical engineering in Australia and a doctorate in applied mathematics from Oxford University. Thompson has extensive experience in assessing the safety and security hazards associated with nuclear facilities, and in identifying alternative designs and modes of operation that can reduce a facility's hazard potential.

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Abstract

The prevailing practice of storing most US spent nuclear fuel in high-density pools poses a very high risk. Knowledgeable attackers could induce a loss of water from a pool, causing a fire that would release to the atmosphere a huge amount of radioactive material. Nuclear reactors are also vulnerable to attack. Dry-storage modules used in independent spent fuel storage installations (ISFSIs) have safety advantages in comparison to pools and reactors, but are not designed to resist a determined attack. Thus, nuclear power plants and their spent fuel can be regarded as pre-deployed radiological weapons that await activation by an enemy. The US government and the Nuclear Regulatory Commission seem unaware of this threat.

This report sets forth a strategy for robust storage of US spent fuel. Such a strategy will be needed whether or not a repository is opened at Yucca Mountain. This strategy should be implemented as a major element of a defense-in-depth strategy for US civilian nuclear facilities. In turn, that defense-in-depth strategy should be a component of a homeland-security strategy that provides solid protection of our critical infrastructure.

The highest priority in a robust-storage strategy for spent fuel would be to re-equip spent-fuel pools with low-density, open-frame racks. As a further measure of risk reduction, ISFSIs would be re-designed to incorporate hardening and dispersal. Preliminary analysis suggests that a hardened, dispersed ISFSI could be designed to meet a two-tiered design-basis threat. The first tier would require high confidence that no more than a small release of radioactive material would occur in the event of a direct attack on the ISFSI by various non-nuclear instruments. The second tier would require reasonable confidence that no more than a specified release of radioactive material would occur in the event of attack using a 10-kilotonne nuclear weapon.

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1. Introduction

"One fact dominates all homeland security threat assessments: terrorists are strategic actors. They choose their targets deliberately based on the weaknesses they observe in our defenses and our preparations. They can balance the difficulty in successfully executing a particular attack against the magnitude of loss it might cause."

National Strategy for Homeland Security¹

It is well known that nuclear power plants and their spent fuel contain massive quantities of radioactive material. (Note: Irradiated fuel discharged from a nuclear reactor is described as "spent" because it is no longer suitable for generating fission power.) Consequently, throughout the history of the nuclear power industry, informed citizens have expressed concern that a substantial amount of this material could be released to the environment. One focus of concern has been the possibility of an accidental release caused by human error, equipment failure or natural forces (e.g., an earthquake). In response to citizens' demands and events such as the Three Mile Island reactor accident of 1979, the US Nuclear Regulatory Commission (NRC) has taken some actions that address this threat.

To date, citizens have been much less successful in forcing the NRC to address a related threat -- the possibility that a release of radioactive material will be caused by an act of malice or insanity. The citizens' failure is not for lack of effort. For many years, citizen groups have petitioned the NRC and engaged in licensing interventions, seeking to persuade the NRC to address this threat. Yet, the agency has responded slowly, reluctantly and in limited ways, even after the terrorist attacks of 11 September 2001. This limited response is not unique to the NRC. The US government in general seems unwilling to address the possibility that an enemy, domestic or foreign, will exploit a civilian nuclear facility as a radiological weapon.

The terrorist attacks of September 2001 demonstrated the vulnerability of our industrial society to determined acts of malice, and cruelly validated long-neglected warnings by many analysts and concerned citizens. In response, the United States employed its military capabilities in Afghanistan and has signaled its willingness to use those capabilities in Iraq and elsewhere. Yet, nothing significant has been done to defend US nuclear power plants and their spent fuel against attack. There is much discussion in the media about "dirty bombs" that disperse radioactive material, but decision makers seem

¹ Office of Homeland Security, 2002, page 7.

largely unaware that civilian nuclear facilities contain massive quantities of radioactive material and are vulnerable to attack.

What is Robust Storage?

This report addresses robust storage of spent fuel from nuclear power plants. Here, the term "robust" means that a facility for storing spent fuel is made resistant to attack. The provision of robust storage would substantially reduce the potential for a maliciously-induced release of radioactive material from spent fuel, and would thereby enhance US homeland security. Robust storage of spent fuel should be viewed as a component of a national strategy for reducing the vulnerability of all civilian nuclear facilities, within the context of homeland security. This report takes such a view.

A spent-fuel-storage facility can be made resistant to attack in three ways. First, the facility can be made passively safe, so that spent fuel remains in a safe state without needing electrical power, cooling water or the presence of an operating crew. Second, the facility can be "hardened", so that the spent fuel and its containment structure are protected from damage by an instrument of attack (e.g., an anti-tank missile). For a facility at ground level, hardening involves the provision of layers of concrete, steel, gravel or other materials above and around the spent fuel. Third, the facility can be "dispersed", so that spent fuel is not concentrated at one location, but is spread more uniformly across the site. Dispersal can reduce the magnitude of the radioactive release that would arise from a given attack.

At present, all but a tiny fraction of US spent fuel is stored at the nation's nuclear power plants. Most of this fuel is stored at high density in water-filled pools that are adjacent to, but outside, the containments of the reactors. This mode of storage does not meet any of the above-stated three conditions for robustness. High-density spent-fuel pools are not passively safe. Indeed, if water is lost from such a pool, which could occur in various ways, the fuel will heat up, self-ignite and burn, releasing a large amount of radioactive material to the environment. Spent-fuel pools are not hardened against attack, and a pool concentrates a large amount of spent fuel in a small space, which is the antithesis of dispersal.

A growing fraction of US spent fuel, now about 6 percent of the total inventory, is stored in dry-storage facilities at nuclear power plants. The storage is "dry" in the sense that the spent fuel is surrounded by a gas such as helium, rather than by water. The NRC describes a spent-fuel-storage facility, other than a spent-fuel pool at a nuclear power plant, as an independent

spent fuel storage installation (ISFSI).² All but two of the existing ISFSIs are at the sites of nuclear power plants, either operational plants or plants undergoing decommissioning.³ Future ISFSIs could be built at nuclear-power-plant sites or at away-from-reactor sites. An application to build an ISFSI at an away-from-reactor site -- Skull Valley, Utah -- is awaiting decision by the NRC. It should be noted that the nuclear industry is building dry-storage ISFSIs not as an alternative to high-density pools, but to accommodate the growing inventory of spent fuel as pools become full.

Dry-storage ISFSIs meet one of the above-stated three conditions for robust storage of spent fuel. They are passively safe, because their cooling depends on the natural circulation of ambient air. However, none of the existing or proposed ISFSIs is hardened, and none of them is dispersed across its site.

A Broader Context

This report describes the need for robust storage of all US spent fuel, whether in pools or dry-storage ISFSIs, and sets forth a strategy for meeting this need. As discussed above, a productive discussion of these issues must occur within a broader context, which is addressed in this report. The provision of robust storage of spent fuel must be viewed as a component of a national strategy for defending the nation's civilian nuclear industry, including all of the nuclear power plants and all of their spent fuel. That strategy must in turn be viewed as a component of homeland security in general. Finally, homeland security must be viewed as a key component of US strategy for national defense and international security.

The various levels of security, ranging from the security of nuclear facilities to the security of the nation and the international community, are linked in surprising ways. If our nuclear facilities and other parts of our infrastructure -- such as the airlines -- are poorly defended, we may feel compelled to use military force aggressively around the world, to punish or pre-empt attackers. Such action poses the risk of arousing hostility and promoting anarchy, leading to new attacks on our homeland. The potential exists for an escalating spiral of violence. If, however, our nuclear facilities and other critical items of infrastructure are strongly defended, we can gain a double benefit. First, the communities around each facility will receive direct protection. Second, we can take a more measured approach to national defense, with a greater prospect of detecting, deterring and apprehending potential attackers without undermining civil liberties or international

² One wet-storage ISFSI exists in the USA, at Morris, Illinois. All other existing ISFSIs, and all planned ISFSIs, employ dry storage.

³ The existing ISFSIs that are not at nuclear-power-plant sites are the small wet-storage facility at Morris and a facility in Idaho that stores fuel debris from Three Mile Island Unit 2.

security. Thus, a decision about the level of protection to be provided at a nuclear facility has wide-ranging implications.

The Need for Further Investigation

The investigation leading to this report has identified a number of technical issues that could not be resolved within the scope of the investigation. Issues of this kind are flagged in relevant parts of the report. Also, this report has a broad focus. It sets forth a strategy for providing robust storage of US spent fuel, and outlines a design approach for hardened, dispersed, dry storage. Additional analysis, supported by experiments, would be needed to test and refine this design approach and to determine the feasibility of implementing hardened, dispersed, dry storage at particular sites. That work would, in turn, set the stage for detailed, engineering-design studies that could lead to site-specific implementation. Moreover, a variety of governmental actions would be needed to support nationwide implementation of robust storage. For example, the NRC would need to develop new regulations and guidance. Also, the implementation program would require new financing arrangements, which would probably require new legislation.

Sensitive Information

An attack on a nuclear facility could be assisted by detailed information about the facility's vulnerability and the measures taken to defend the facility. Thus, certain categories of information related to a facility are not appropriate for general distribution. However, experience shows that secrecy breeds incompetence, complacency and conflicts of interest within the organizations that are shielded from public view.⁴ Thus, in the context of defending nuclear facilities, protection of the public interest requires that secrecy be limited in two respects. Firstly, the only information that should be withheld from the public is detailed technical information that would directly assist an attacker. Second, stakeholder groups should be fully engaged in the development and implementation of measures for defending nuclear facilities, through processes that allow debate but protect sensitive information.⁵ It should be noted that this report does not contain sensitive information and is suitable for general distribution.

⁴ Thompson, 2002a, Section X.

⁵ Thompson, 2002a, Sections IX and X.

Robust Storage and Related Concepts

Issues addressed in this report have been the subject of public debate around the United States, and this debate has been framed in a number of ways. One approach has been to speak of "risk reduction", whereby robust storage of spent fuel and related measures are used to reduce the risk of a maliciously-induced release of radioactive material from nuclear facilities. This approach explicitly recognizes that the risk can be reduced but, given the continued existence of radioactive material, cannot be eliminated. Another approach has been to speak of "hardened on-site storage" as a strategy for managing US spent fuel. This approach advocates the robust storage of all spent fuel, but only at the sites of nuclear power plants. A related but distinct approach is "nuclear guardianship", whose supporters argue that radioactive materials should be contained in accessible, monitored storage facilities for the foreseeable future. The robust-storage strategy that is outlined in this report is compatible with all three approaches, and with a prudent assessment of the likelihood and timeframe for development of a radioactive-waste repository at Yucca Mountain.

Structure of this Report

The remainder of this report begins, in Section 2, with the provision of some basic information about US nuclear power plants and their spent fuel. Then, Section 3 discusses the potential for attacks on nuclear facilities, describes the US government's response to this threat, and outlines a balanced response. Section 4 addresses the vulnerability of nuclear facilities to attack, describes the potential consequences of an attack, outlines a defense-in-depth strategy for a nuclear facility, and sets forth a national strategy for robust storage of spent fuel. Elaborating upon this proposed strategy for robust storage, Section 5 discusses the various factors that must be considered in planning hardened, dispersed, dry storage of spent fuel. Section 6 offers a design approach that accounts for these factors. A set of requirements for nationwide implementation of robust storage is described in Section 7. Conclusions are set forth in Section 8, and a bibliography is provided in Section 9. Documents cited in this report are, unless indicated otherwise, drawn from this bibliography.

2. Nuclear Power Plants and Spent Fuel in the USA

2.1 Status and Trends of Nuclear Power Plants and Spent Fuel

There are 103 commercial nuclear reactors operating in the USA at 65 sites in 31 states.⁶ Of these 103 reactors, 69 are pressurized-water reactors (PWRs), 9 with ice-condenser containments and 60 with dry containments. The remaining 34 reactors are boiling-water reactors (BWRs), 22 with Mark I containments, 8 with Mark II containments and 4 with Mark III containments. In addition there are 27 previously-operating commercial reactors in various stages of storage or decommissioning. As of December 2000, all but 2 of the 103 operating reactors had been in service for at least 9 years, and 55 reactors had been in service for at least 19 years.⁷ Thus, the reactor fleet is aging. The nominal duration of a reactor operating license is 40 years.

Four of the 103 operating reactors have design features intended to resist aircraft impact. The Limerick Unit 1, Limerick Unit 2 and Seabrook reactors were designed to withstand the impact of an aircraft weighing 6 tonnes, while the Three Mile Island Unit 1 reactor was designed to withstand the impact of an aircraft weighing 90 tonnes. No other US reactor was designed to withstand aircraft impact.⁸

Wet and Dry Storage of Spent Fuel

The core of a commercial nuclear reactor consists of several hundred fuel assemblies.⁹ Each fuel assembly contains thousands of cylindrical, uranium-oxide pellets stacked inside long, thin-walled tubes made of zirconium alloy. These tubes are often described as the "cladding" of the fuel. After several years of use inside an operating reactor, a fuel assembly becomes "spent" in the sense that it is no longer suitable for generating fission power. Then, the fuel is discharged from the reactor and placed in a water-filled pool adjacent to the reactor but outside the reactor containment. This fuel, although spent, contains numerous radioactive isotopes whose decay generates ionizing radiation and heat.

⁶ In addition, Browns Ferry Unit 1, a BWR with a Mark I containment, is nominally operational. However, it is defueled and not in service.

⁷ Data from the NRC website (www.nrc.gov), 24 April 2002.

⁸ Markey, 2002, page 73.

⁹ The number of fuel assemblies in a reactor core ranges from 121 (in some PWRs) to 764 (in some BWRs).

After a period of storage in a pool, the thermal power produced by a fuel assembly declines to a level such that the assembly can be transferred to a dry-storage ISFSI. Current practice is to allow a minimum cooling period of 5 years before transfer to dry storage. However, this cooling period reflects an economic and safety tradeoff rather than a fundamental physical limit. Fuel cooled for a shorter period than 5 years could be transferred to dry storage, but in that case fewer assemblies could be placed in each dry-storage container. Alternatively, older and younger spent fuel (counting age from the date of discharge from the reactor) could be co-located in a dry-storage container. The major physical limit to placement of spent fuel in dry storage is the maximum temperature of the cladding, which the NRC now sets at 400 degrees C. This temperature limit constrains the allowable heat output of the fuel, which in turn constrains the cooling period.

Development of ISFSIs

At present, there are 20 ISFSIs in the USA, of which 15 are at sites where commercial reactors are in operation.¹⁰ More ISFSIs will be needed, because the spent-fuel pools at operating reactors are filling up. Analysis by Allison Macfarlane of MIT shows that, by 2005, almost two-thirds of reactor licensees will face the need to acquire onsite dry-storage capacity, even if shipment of spent fuel away from the reactor sites begins in 2005.¹¹ NAC International, a consulting firm and vendor of dry-storage technology, reaches similar conclusions. NAC estimates that, at the end of 2000, about 6 percent of the US inventory of commercial spent fuel was stored in ISFSIs at reactor sites, whereas about 30 percent of the inventory will be stored in ISFSIs by 2010.¹² New ISFSIs entering operation by 2010 will generally be at reactor sites, although some might be at new sites. At present, only one proposed ISFSI at a new site -- Skull Valley, Utah -- seems to be a plausible candidate for operation by 2010.

Shipment of Spent Fuel from Reactor Sites

If spent fuel is shipped away from a reactor site, the fuel could have three possible destinations. First, fuel could be shipped to another reactor site, which Carolina Power and Light Co. is now doing, shipping fuel from its

¹⁰ Data from the NRC website (www.nrc.gov), 24 April 2002.

¹¹ Macfarlane, 2001a.

¹² NAC, 2001. NAC estimates that the end-2000 US inventory of spent fuel was 42,900 tonnes, of which 2,430 tonnes was in ISFSIs. Also, NAC estimates that the 2010 US inventory will be 64,300 tonnes, of which 19,450 tonnes will be in ISFSIs.

Brunswick and Robinson reactors to its Harris site.¹³ Second, fuel could be shipped to an ISFSI at an away-from-reactor site, such as Skull Valley. Third, fuel could be shipped to a repository at Yucca Mountain, Nevada. At Yucca Mountain, the fuel would be emplaced in underground tunnels. Under some scenarios for the operation of Yucca Mountain, emplacement would be preceded by a period of interim storage at the surface.

There seems to be no current planning for shipment of spent fuel to any reactor site other than Harris. Also, there are factors that argue against shipping fuel to an away-from-reactor ISFSI. First, such shipment would increase the overall transport risk, because fuel would be shipped twice, first from the reactor site to the ISFSI, and then from the ISFSI to the ultimate repository. Second, an away-from-reactor ISFSI would hold a comparatively large inventory of spent fuel, creating a potentially attractive target for an enemy.¹⁴ Third, shipment to an away-from-reactor ISFSI would not free most reactor licensees from the obligation to build some ISFSI capacity at each reactor site.¹⁵ Fourth, there is a risk that a large, away-from-reactor ISFSI would become, by default, a permanent repository, despite having no long-term containment capability. Finally, storage of spent fuel in reactor-site ISFSIs could be cheaper than shipping fuel to away-from-reactor ISFSIs.¹⁶ Time will reveal the extent to which these factors affect the development of away-from-reactor ISFSIs at Skull Valley or elsewhere.

Yucca Mountain

The Yucca Mountain repository project will not free reactor licensees from the obligation to develop ISFSI capacity, for three reasons. First, the Yucca Mountain repository may never open. This project is politically driven, does not have a sound scientific basis, and is going forward only because previously-specified technical criteria for a repository have been abandoned.¹⁷ These deficiencies add weight to the determined opposition to this project by the state of Nevada and other entities. That opposition will also be fueled by concern about the risk of transporting fuel to Yucca Mountain. Second, decades will pass before fuel can be emplaced in a repository at Yucca Mountain. The US Department of Energy (DOE) claims that it can open the repository in 2010, but the US General Accounting Office has determined that

¹³ The Harris site features one reactor and four spent-fuel pools, and thus has more pool-storage capacity than other reactor sites. Spent fuel that is shipped to Harris is placed in a pool, and there is no current plan to build an ISFSI at Harris.

¹⁴ The proposed Skull Valley ISFSI could hold 40,000 tonnes of spent fuel, according to the Private Fuel Storage website (www.privatefuelstorage.com), 4 October 2002.

¹⁵ Macfarlane, 2001a.

¹⁶ Macfarlane, 2001b.

¹⁷ Ewing and Macfarlane, 2002.

several factors, including budget limitations, could extend this date to 2015 or later.¹⁸ DOE envisions that, after the repository is opened, emplacement of fuel will occur over a period of at least 24 years and potentially 50 years.¹⁹ This vision may prove to be optimistic. Third, under present federal law the Yucca Mountain repository will hold no more than 63,000 tonnes of commercial spent fuel.²⁰ Yet, the cumulative amount of commercial spent fuel to be generated during the lifetimes of the 103 currently-licensed reactors is likely to exceed 80,000 tonnes.²¹ Reactor licensees have shown strong interest in obtaining license extensions which, if granted, would lead to the production of a substantial additional amount of spent fuel.

Summary

To summarize the preceding paragraphs, it is clear that thousands of tonnes of spent fuel will be stored at reactor sites for several decades to come, in pools and/or ISFSIs. Similar amounts of fuel might be stored at away-from-reactor ISFSIs. Moreover, it is entirely possible that the Yucca Mountain repository will not open, with the result that the entire national inventory of spent fuel will be stored for decades, perhaps for 100 years or more, at reactor sites (in pools and/or ISFSIs) and/or at away-from-reactor ISFSIs. It is therefore imperative that each ISFSI is planned to allow for its possible extended use. The NRC has begun to recognize this need, by performing research to determine if dry storage of spent fuel can safely continue for a period of up to 100 years.²²

2.2 Present Practice for Storing Spent Fuel

The technology that is currently used for storing spent fuel was developed without consideration of the possibility of an attack. Nor was there any consideration of the possibility that spent fuel would be stored for many decades. Instead, the technology has developed incrementally, in response to

¹⁸ Jones, 2002b.

¹⁹ DOE, 2002. DOE contemplates the construction of a surface facility for interim storage of spent fuel at Yucca Mountain, especially if emplacement of fuel occurs over a period of 50 years. However, given the cost of this surface facility, a more likely alternative is that fuel would remain in ISFSIs until it could be emplaced in the repository.

²⁰ DOE, 2002. The Nuclear Waste Policy Act limits the total amount of waste that can be placed in a first repository to 70,000 tonnes until a second repository is in operation. DOE plans to use 63,000 tonnes of this capacity for commercial spent fuel. DOE has studied the possible expansion of Yucca Mountain's capacity to include 105,000 tonnes of commercial spent fuel together with other wastes.

²¹ Macfarlane, 2001a.

²² "Radioactive Waste Safety Research", from NRC website (www.nrc.gov), 23 September 2002.

changing circumstances. Throughout this process, cost minimization has been a top priority.

When the present generation of nuclear power plants was designed, the nuclear industry and the US government both assumed that spent nuclear fuel would be reprocessed. Thus, spent-fuel pools were designed to hold only the amount of spent fuel that a reactor would discharge over a period of a few years. This was accomplished by equipping the pools with low-density, open-frame racks. However, in the mid-1970s the US government banned reprocessing, and the industry faced the prospect of an accumulating inventory of spent fuel.

High-Density Spent-Fuel Pools

Industry's response to growing spent-fuel inventories has been to re-rack spent-fuel pools at progressively higher densities, so that more fuel can be stored in a given pool. Now, pools across the nation are equipped with high-density, closed-frame racks that, in many instances, fill the floor area of the pool from wall to wall. The NRC has allowed this transition to occur despite the fact that a loss of water from a pool equipped with high-density racks can cause the zirconium cladding of the spent fuel to heat up, spontaneously ignite and burn, releasing a large amount of radioactive material to the atmosphere. This hazard is discussed further in Section 4.2.

Dry Storage as a Supplement to High-Density Pools

Consistent with the focus on cost minimization, the nuclear industry has turned to alternative methods of fuel storage only when pools have begun to fill up. Preventing a pool fire has not been a consideration. Thus, dry-storage ISFSIs have not been introduced as an alternative to high-density pool storage: Instead, standard industry practice is to fill a pool to nearly its maximum capacity, then to transfer older spent fuel from the pool to an ISFSI at a rate just sufficient to open up space in the pool for fuel that is discharged from the reactor.²³

As a part of this strategy, each ISFSI has a modular design. One or more concrete pads are laid in the open air. Each pad supports an array of identical fuel-storage modules that are purchased and installed as needed, so that the ISFSI grows incrementally. Additional pads can be laid as needed.

²³ In standard practice, the maximum storage capacity of a spent-fuel pool is less than the number of fuel-assembly slots in the pool, to allow for the possibility of offloading a full reactor core. However, preserving the capacity for a full-core offload is not a licensing requirement.

This modular approach to the development of ISFSIs has functional and cost advantages. However, the present implementation of the approach is not driven by security considerations, and is therefore proceeding slowly. Pools remain packed with fuel at high density, and can therefore be readily exploited as radiological weapons. Moreover, the ISFSIs themselves are not designed to resist attack.

Types of Dry-Storage Module

The NRC has approved 14 different designs of dry-storage module for general use in ISFSIs.²⁴ In each of these designs, the central component of the module is a cylindrical, metal container whose interior is equipped with a metal basket structure into which spent fuel assemblies can be inserted. This container is filled with spent fuel while immersed in a spent-fuel pool. Then, the container's lid is attached, the container is removed from the pool and sealed, its interior is dried and filled with an inert gas (typically helium), and it is transferred to the ISFSI.

Available designs of dry-storage modules for ISFSIs fall into two basic categories. In the first category, the metal container has a thick wall, and no enclosing structure is provided. This type of module is commonly described as a "monolithic cask". In the second category, the metal container has a thin wall and is surrounded by an overpack. Different overpacks are used during the three phases of spent-fuel management. First, during the initial transfer of fuel from a spent-fuel pool to an onsite ISFSI, the metal container is surrounded by a transfer overpack. Second, during storage in an ISFSI, the metal container is surrounded by a storage overpack. Third, if fuel is eventually shipped away from the site, the metal container would be placed inside a transport overpack. The second category of module is described here as an "overpack system".

A Typical Monolithic Cask

One example of a monolithic cask is the CASTOR V/21, which was approved by the NRC in 1990 for general use and is employed at the Surry ISFSI. This cask is about 4.9 meters long and 2.4 meters in diameter, and can hold 21 PWR fuel assemblies. In the storage position the cask axis is vertical. The cask body is made of ductile cast iron with a wall thickness of about 38 cm. Circumferential fins on the outside of the cask body facilitate cooling by natural circulation of ambient air. Fully loaded, this cask weighs about 98 tonnes.²⁵ The NRC has approved this cask for storage but not for transport,

²⁴ "Dry Spent Fuel Storage Designs: NRC Approved for General Use", from NRC website (www.nrc.gov), 20 September 2002.

²⁵ Raddatz and Waters, 1996.

although CASTOR casks are widely used in Europe for both purposes. CASTOR casks have not been popular in the US market.

Examples of Overpack Systems

One example of an overpack system is the NUHOMS design, which the NRC approved for general use in 1995. In this design, the metal container that holds the spent fuel is about 4.7 meters long and 1.7 meters in diameter, and has a wall thickness of 1.6 cm. This container, which is placed horizontally inside its storage overpack, is made of stainless steel and can hold 24 PWR fuel assemblies or 52 BWR fuel assemblies. The storage overpack is a reinforced-concrete box about 6.1 meters long, 4.6 meters high and 2.7 meters wide, with walls and roof 91 cm thick.²⁶ Ambient air passes into and out of this structure through vents, and cools the metal container by natural convection. NUHOMS modules are in use at the Davis-Besse site and some other reactor sites.

A second example of an overpack system is the NAC-UMS, which the NRC approved for general use in 2000. In this instance, the metal container is about 4.7 meters long and 1.7 meters in diameter, and has a wall thickness of 1.6 cm. This container, which is made of stainless steel, can hold 24 PWR fuel assemblies or 56 BWR fuel assemblies. The storage overpack is a vertical-axis reinforced-concrete cylinder about 5.5 meters high and 3.5 meters in diameter. The wall of this overpack consists of a steel liner 6.4 cm thick and a layer of concrete 72 cm thick. Ambient air passes into and out of the overpack through vents, and cools the metal container by natural convection. At the Maine Yankee nuclear power plant, which is being decommissioned, sixty NAC-UMS modules are being installed. Most of the modules will be used to store spent fuel discharged from the plant. Some modules will store pieces of the reactor core shroud, which is classified as greater-than-Class C (GTCC) waste.²⁷

Monolithic Casks versus Overpack Systems

The two categories of dry-storage module employ distinct design approaches. In a monolithic cask such as the CASTOR, spent fuel is contained within a thick-walled metal cylinder that is comparatively robust.²⁸ In an overpack system the fuel is contained within a thin-walled metal container that has a

²⁶ Ibid.

²⁷ Stone and Webster, 1999.

²⁸ The vendor of the CASTOR cask has developed a cheaper type of monolithic cask that is made as a steel-concrete-steel sandwich. This cask, known as CONSTOR, was developed for storage and transport of spent fuel from Russian reactors. The vendor states that the CONSTOR cask could be used in the USA. See: Peters et al, 1999.

limited capability to withstand impact, fire or corrosion. The storage overpack employs concrete -- a cheap material -- as its primary constituent. The transfer and transport overpacks can be used multiple times. Thus, an overpack system can be substantially cheaper -- about half as expensive per fuel assembly, according to some reports -- than a monolithic cask.

ISFSI Configuration

At ISFSIs in the USA, dry-storage modules are placed on concrete pads in the open air. This approach contrasts with German practice, where dry-storage modules -- usually CASTOR casks -- are placed inside buildings. These buildings are designed to have some resistance to attack from outside using anti-tank weapons. This aspect of their design has been informed by tests conducted in the period 1979-1980. At one German reactor site -- Neckarwestheim -- the ISFSI is inside a tunnel built into the side of a hill.²⁹

Another feature of the US approach to ISFSI design, consistent with the high priority assigned to cost minimization, is that dry-storage modules are packed closely together in large numbers. In illustration, consider the ISFSI that is proposed for the Diablo Canyon site in California. This facility would hold up to 140 of Holtec's HI-STORM 100 dry-storage modules, whose design is similar to the NAC-UMS system described above. These modules would sit on concrete pads, 20 casks per pad in a 4 by 5 array. Initially, two pads would be built. Ultimately, as the ISFSI expanded, seven pads would be positioned side by side, covering an area about 150 meters by 32 meters. Each module would be a vertical-axis cylinder about 3.7 meters in diameter and 5.9 meters high. The center-to-center spacing of modules would be about 5.5 meters, leaving a gap of 1.8 meters between modules. A security fence would surround the area needed for this array, at a distance of about 15 meters from the outermost modules. That fence would in turn be surrounded by a second fence, at a distance of about 30 meters from the outermost modules.³⁰

2.3 Present Security Arrangements

One could reasonably expect that the defense strategy for a nuclear-facility site would be a component of a strategy for homeland security, which would itself be a component of an overall strategy for national security. Moreover, one could expect that the site-level strategy would provide a defense in depth. (See Section 4.4 of this report for an explanation of defense in depth.) Logical planning of this kind may eventually occur. However, at present, the security

²⁹ Janberg, 2002.

³⁰ PG&E, 2001a.

arrangements for US nuclear facilities are not informed by any strategic vision.

Differing Positions on the Threat of Attack

For several decades it has been clear to many people that nuclear power plants and other commercial nuclear facilities are potential targets of acts of malice or insanity, including highly destructive acts. The NRC has repeatedly rebuffed citizens' requests that this threat be given the depth of analysis that would be expected, for example, in an environmental impact statement (EIS).³¹ This history is illustrated by a September 1982 ruling by the Atomic Safety and Licensing Board (ASLB) in the operating-license proceeding for the Harris plant. The intervenor, Wells Eddleman, had proffered a contention alleging, in part, that the plant's safety analysis was deficient because it did not consider the "consequences of terrorists commandeering a very large airplane.....and diving it into the containment." In rejecting this contention the ASLB stated:³²

"This part of the contention is barred by 10 CFR 50.13. This rule must be read *in pari materia* with 10 CFR 73.1(a)(1), which describes the "design basis threat" against which commercial power reactors *are* required to be protected. Under that provision, a plant's security plan must be designed to cope with a violent external assault by "several persons," equipped with light, portable weapons, such as hand-held automatic weapons, explosives, incapacitating agents, and the like. Read in the light of section 73.1, the principal thrust of section 50.13 is that military style attacks with heavier weapons are not a part of the design basis threat for commercial reactors. Reactors could not be effectively protected against such attacks without turning them into virtually impregnable fortresses at much higher cost. Thus Applicants are not required to design against such things as artillery bombardments, missiles with nuclear warheads, or kamikaze dives by large airplanes, despite the fact that such attacks would damage and may well destroy a commercial reactor."

In this statement, the ASLB correctly described the design basis for US nuclear power plants. However, other design bases are possible. In the early 1980s the

³¹ In illustration of this continuing policy, on 18 December 2002 the NRC Commissioners dismissed four licensing interventions calling for EISs that consider the potential for malicious acts at nuclear facilities. One intervention, by the state of Utah, addressed the proposed ISFSI at Skull Valley. The other three interventions, by citizen groups, addressed: a proposed spent-fuel-pool expansion at Millstone Unit 3; a proposed MOX-fuel-fabrication facility; and proposed license renewals for the McGuire and Catawba nuclear power plants.

³² ASLB, 1982.

reactor vendor ASEA-Atom developed a preliminary design for a commercial reactor known as the PIUS reactor. The design basis for the PIUS reactor included events such as equipment failures, operator errors and earthquakes, but also included: (i) takeover of the plant for one operating shift by knowledgeable saboteurs equipped with large amounts of explosives; (ii) aerial bombardment with 1,000-pound bombs; and (iii) abandonment of the plant by the operators for one week.³³ It seems likely that this design basis would also provide protection against a range of other assaults, including the impact of a large, fuel-laden aircraft. Clearly, ASEA-Atom foresaw a world in which acts of malice could pose a significant threat to nuclear facilities. The NRC has never exercised an equivalent degree of foresight.

A Brief History

Some US nuclear facilities have been specifically designed to resist attack. For example, in the early 1950s five heavy-water reactors were built at the Savannah River site in South Carolina, to produce plutonium and tritium for use in US nuclear weapons. In order to resist an attack by the USSR using nuclear weapons, the reactors were dispersed across a large site and hardened against blast. The reactor buildings were designed to withstand an external blast of 7 psi, the overpressure that could be experienced at about 2 miles from a 1-megatonne surface burst. However, the purpose was to preserve the reactors' ability to produce weapons material after an attack, rather than to protect the public from a release of radioactive material. Indeed, these reactors had minimal safety systems when they first entered service. Safety systems were added over the years, but the reactors' safety standards never approached the level that is expected for commercial reactors.³⁴

In 1950, the Reactor Safeguards Committee of the US Atomic Energy Commission (AEC) produced a report -- designated WASH-3 -- that considered the potential for reactor accidents and estimated the offsite effects of an accident. This report gave special attention to sabotage as a potentially important cause of reactor accidents. About 16 years later, during the construction license proceedings for Turkey Point Units 3 and 4 in Florida, an intervenor raised the question of an attack on these nuclear power plants from a hostile country (i.e., Cuba). The AEC held that it was not responsible for providing protection against such an attack.³⁵ This position remains enshrined in the NRC's regulation 10 CFR 50.13, which states:³⁶

³³ Hannerz, 1983.

³⁴ Thompson and Sholly, 1991.

³⁵ Okrent, 1981, pp 18-19.

³⁶ NRC Staff, 2002.

"An applicant for a license to construct and operate a production or utilization facility, or for an amendment to such license, is not required to provide for design features or other measures for the specific purpose of protection against the effects of (a) attacks and destructive acts, including sabotage, directed against the facility by an enemy of the United States, whether a foreign government or other person, or (b) use or deployment of weapons incident to US defense activities."

Pursuant to this regulation, the NRC's licensees are not required to design or operate nuclear facilities to resist enemy attack. However, events have forced the NRC to progressively modify this position, so as to require greater protection against acts of malice or insanity. A series of incidents, including the 1993 bombing of the World Trade Center in New York, eventually forced the NRC to introduce, in 1994, regulations requiring licensees to defend nuclear power plants against vehicle bombs. The terrorist events of 11 September 2001 forced the NRC to require additional, interim measures by licensees to protect nuclear facilities, and are also forcing the NRC to consider strengthening its regulations in this area. Nevertheless, present NRC regulations require only a light defense of nuclear facilities.

NRC Regulations for Defending Nuclear Facilities

Present NRC regulations for the defense of nuclear facilities are focused on site security. As described in Section 4.4, below, site security is one of four types of measure that, taken together, could provide a defense in depth against acts of malice or insanity. The other three types of measure are, with some limited exceptions, ignored in present NRC regulations and requirements.³⁷

At a nuclear power plant or an ISFSI, the NRC requires the licensee to implement a set of physical protection measures. According to the NRC, these measures provide defense in depth by taking effect within defined areas with increasing levels of security. In fact, these measures provide only a fraction of the protection that could be provided by a comprehensive defense-in-depth strategy. Within the outermost physical protection area, known as the Exclusion Area, the licensee is expected to control the area but is not required to employ fences and guard posts for this purpose. Within the Exclusion area is a Protected Area encompassed by physical barriers including one or more fences, together with gates and barriers at points of entry. Authorization for unescorted access within the Protected Area is based on background and behavioral checks. Within the Protected Area are Vital

³⁷ For information about the NRC's present regulations and requirements for nuclear-facility defense, see: the NRC website (www.nrc.gov) under the heading "Nuclear Security and Safeguards", 2 September 2002; Markey, 2002; Meserve, 2002; and NRC, 2002.

Areas and Material Access Areas that are protected by additional barriers and alarms; unescorted access to these locations requires additional authorization.

Associated with the physical protection areas are measures for detection and assessment of an intrusion, and for armed response to an intrusion. Measures for intrusion detection include guards and instruments whose role is to detect a potential intrusion and notify the site security force. Then, security personnel seek additional information through means such as direct observation and closed-circuit TV cameras, to assess the nature of the intrusion. If judged appropriate, an armed response to the intrusion is then mounted by the site security force, potentially backed up by local law enforcement agencies and the FBI.

The Design Basis Threat

The design of physical protection areas and their associated barriers, together with the design of measures for intrusion detection, intrusion assessment and armed response, is required to accommodate a "design basis threat" (DBT) that is specified by the NRC in 10 CFR 73.1. The DBT for an ISFSI is less demanding than that for a nuclear power plant. At a nuclear power plant, the dominant sources of hazard are the reactor and the spent-fuel pool(s). In theory, both of these items receive the same level of protection, but in practice the reactor has been the main focus of attention. At present, the DBT for a nuclear power plant has the following features:³⁸

"(i) A determined violent external assault, attack by stealth, or deceptive actions, of several persons with the following attributes, assistance and equipment: (A) Well-trained (including military training and skills) and dedicated individuals, (B) inside assistance which may include a knowledgeable individual who attempts to participate in a passive role (e.g., provide information), an active role (e.g., facilitate entrance and exit, disable alarms and communications, participate in violent attack), or both, (C) suitable weapons, up to and including hand-held automatic weapons, equipped with silencers and having effective long range accuracy, (D) hand-carried equipment, including incapacitating agents and explosives for use as tools of entry or for otherwise destroying reactor, facility, transporter, or container integrity or features of the safeguards system, and (E) a four-wheel drive land vehicle used for transporting personnel and their hand-carried equipment to the proximity of vital areas, and

³⁸ 10 CFR 73.1, Purpose and Scope, from the NRC web site (www.nrc.gov), 2 September 2002.

- (ii) An internal threat of an insider, including an employee (in any position); and
- (iii) A four-wheel drive land vehicle bomb."

For an ISFSI, the DBT is the same as for a nuclear power plant except that it does not include the use of a four-wheel-drive land vehicle, either for transport of personnel and equipment or for use as a vehicle bomb. This is true whether the ISFSI is at a new site or a reactor site. Thus, an ISFSI at a reactor site will be less protected than the reactor(s) and spent-fuel pool(s) at that site. At a reactor site or a new site, an ISFSI will be vulnerable to attack by a vehicle bomb. (Note: An NRC order of October 2002 to reactor-site ISFSI licensees, as discussed below, might require vehicle-bomb protection at reactor-site ISFSIs. Measures required by this order have not been disclosed.)

Interim, Additional Requirements by the NRC

After the events of 11 September 2001, the NRC concluded that its requirements for nuclear power plant security were inadequate. Accordingly, the NRC issued an order to licensees of operating plants in February 2002, and similar orders to licensees of decommissioning plants in May 2002 and reactor-site ISFSI licensees in October 2002, requiring "certain compensatory measures", also described as "prudent, interim measures", whose purpose is to "provide the Commission with reasonable assurance that the public health and safety and common defense and security continue to be adequately protected in the current generalized high-level threat environment".³⁹ The additional measures required by these orders have not been publicly disclosed, but the NRC Chairman has stated that they include:⁴⁰

- (i) increased patrols;
- (ii) augmented security forces and capabilities;
- (iii) additional security posts;
- (iv) vehicle checks at greater stand-off distances;
- (v) enhanced coordination with law enforcement and military authorities;
- (vi) additional restrictions on unescorted access authorizations;
- (vii) plans to respond to plant damage from explosions or fires; and
- (viii) assured presence of Emergency Plan staff and resources.

³⁹ The quoted language is from page 2 of the NRC's order of 25 February 2002 to all operating power reactor licensees. Almost-identical language appears in the NRC's orders of 23 May 2002 to all decommissioning power reactor licensees and 16 October 2002 to all ISFSI licensees who also hold 10 CFR 50 licenses.

⁴⁰ Meserve, 2002.

In addition to requiring these additional security measures, the NRC has established a Threat Advisory System that warns of a possible attack on a nuclear facility. This system uses five color-coded threat conditions ranging from green (low risk of attack) to red (severe risk of attack). These threat conditions conform with those used by the Office of Homeland Security. Also, the NRC is undertaking what it describes as a "top-to-bottom review" of its security requirements. The NRC has stated that it expects that this review will lead to revision of the present DBT. The review is not proceeding on any specific schedule.

Limitations of the Design Basis Threat

A cursory examination of the present DBT reveals significant limitations. For example, this threat does not include aircraft bombs (e.g., fuel-laden commercial aircraft, light aircraft packed with high explosive) or boat bombs.⁴¹ This threat does not include lethal chemical weapons as instruments for disabling security personnel. This threat allows for one vehicle bomb, but not for a subsequent vehicle bomb that gains access to a vital area after the first bomb has breached a security barrier. Also, this threat envisions a small attacking force equipped with light weapons, rather than a larger force (e.g., 20 persons) equipped with heavier weapons such as anti-tank missiles. In sum, the present DBT is inadequate in light of the present threat environment. The compensatory measures required by the NRC's recent orders do not correct this deficiency.⁴²

3. The Potential for Attacks on Nuclear Facilities

3.1 A Brief History

There is a rich history of events which show that acts of malice or insanity pose a significant threat to nuclear facilities around the world.⁴³ Consider some examples. Nuclear power plants under construction in Iran were repeatedly bombed from the air by Iraq in the period 1984-1987. Yugoslav Air Force fighters made a threatening overpass of the Krsko nuclear plant in Slovenia -- which was operating at the time -- a few days after Slovenia declared independence in 1991. So-called research reactors in Iraq were destroyed by aerial bombing by Israel in 1981 and by the United States in 1991. In 1987, Iranian radio threatened an attack by unspecified means on US nuclear plants if the United States attacked launch sites for Iran's Silkworm anti-ship missiles. Bombs damaged reactors under construction in Spain in

⁴¹ An NRC Fact Sheet (NRC, 2002) mentions new measures "against water-borne attacks", but it does not appear that these measures provide significant protection against boat bombs.

⁴² POGO, 2002.

⁴³ Thompson, 1996.

1977 and in South Africa in 1982. Anti-tank missiles struck a nuclear plant under construction in France in 1982. North Korean commandos were killed while attempting to come ashore near a South Korean plant in 1985. These and other events illustrate the "external" threat to nuclear plants. Numerous crimes and acts of sabotage by plant personnel illustrate the "internal" threat.

Vehicle Bombs

The threat posed to nuclear facilities by vehicle bombs became clearly apparent from an October 1983 attack on a US Marine barracks in Beirut. In a suicide mission, a truck was driven at high speed past a guard post and into the barracks. A gas-boosted bomb on the truck was detonated with a yield equivalent to about 5 tonnes of TNT, destroying the building and killing 241 Marines. In April 1984 a study by Sandia National Laboratories titled "Analysis of Truck Bomb Threats at Nuclear Facilities" was presented to the NRC. According to an NRC summary:⁴⁴ "The results show that unacceptable damage to vital reactor systems could occur from a relatively small charge at close distances and also from larger but still reasonable size charges at large setback distances (greater than the protected area for most plants)." Eventually, in 1994, the NRC introduced regulations that require reactor licensees to install defenses (gates, barriers, etc.) against vehicle bombs. The NRC was spurred into taking this action by two incidents in February 1993. In one incident, a vehicle bomb was detonated in a parking garage under the World Trade Center in New York. In the other incident, a man recently released from a mental hospital crashed his station wagon through the security gate of the Three Mile Island nuclear plant and rammed the vehicle under a partly-opened door in the turbine building.

Suicidal Aircraft Attack

The threat of suicidal aircraft attack on symbolic or high-value targets became clearly apparent from three incidents in 1994.⁴⁵ In April 1994 a Federal Express flight engineer who was facing a disciplinary hearing was travelling as a passenger on a company DC-10. He stormed the cockpit, severely wounded all three members of the crew with a hammer, and tried to gain control of the aircraft. The crew regained control with great difficulty. Federal Express employees said that the flight engineer was planning to crash into a company building. In September 1994 a lone pilot crashed a stolen single-engine Cessna into the grounds of the White House, just short of the President's living quarters. In December 1994 four Algerians hijacked an Air France Airbus 300, carrying 20 sticks of dynamite. The aircraft landed in

⁴⁴ Rehm, 1984.

⁴⁵ Wald, 2001.

Marseille, where the hijackers demanded that it be given a large fuel load -- three times more than necessary for the journey -- before flying to Paris. Troops killed the hijackers before this plan could be implemented. French authorities determined that the hijackers planned to explode the aircraft over Paris or crash it into the Eiffel Tower.

The Insider Threat

The incident involving the Federal Express flight engineer illustrates the vulnerability of industrial systems, including nuclear plants, to "internal" threats. That vulnerability is further illustrated by a number of incidents. In December 2000, Michael McDermott killed seven co-workers in a shooting rampage at an office building in Massachusetts. He had worked at the Maine Yankee nuclear plant from 1982 to 1988 as an auxiliary operator and operator before being terminated for exhibiting unstable behavior.⁴⁶ In 1997, Carl Drega of New Hampshire stockpiled weapons and killed four people -- including two state troopers and a judge -- on a suicide mission. He had passed security clearances at three nuclear plants in the 1990s.⁴⁷ In October 2000 a former US Army sergeant pleaded guilty to assisting Osama bin Laden in planning the bombing of the US embassy in Nairobi, which occurred in 1998.⁴⁸ In June 1999, a security guard at the Bradwell nuclear plant in Britain hacked into the plant's computer system and wiped out records. It emerged that he had never been vetted and had two undisclosed criminal convictions.⁴⁹ These and other incidents demonstrate clearly that it is foolish to ignore or downplay the "internal" threat of acts of malice or insanity at nuclear plants.

The General Threat of Terrorism

The events mentioned in the preceding paragraphs occurred against a background of numerous acts of terrorism around the world. Many of these acts have been highly destructive. US facilities have been targets on many occasions, as illustrated by the bombing of the US embassy in Beirut in 1983, the embassies in Nairobi and Dar es Salaam in 1998, and the USS Cole in 2000. There have been repeated warnings that the threat of terrorism is growing and could involve the US homeland. For example, in 1998 three authors with high-level government experience wrote:⁵⁰

⁴⁶ Barnard and Kerber, 2001.

⁴⁷ Ibid.

⁴⁸ Goldman, 2000.

⁴⁹ Maguire, 2001.

⁵⁰ Carter et al, 1998.

"Long part of the Hollywood and Tom Clancy repertory of nightmarish scenarios, catastrophic terrorism has moved from far-fetched horror to a contingency that could happen next month. Although the United States still takes conventional terrorism seriously, as demonstrated by the response to the attacks on its embassies in Kenya and Tanzania in August, it is not yet prepared for the new threat of catastrophic terrorism."

Some years ago the US Department of Defense established an advisory commission on national security in the 21st century. This commission -- often known as the Hart-Rudman commission because it was co-chaired by former Senators Gary Hart and Warren Rudman -- issued reports in September 1999, April 2000 and March 2001. The findings in the September 1999 report included the following:⁵¹

"America will become increasingly vulnerable to hostile attack on our homeland, and our military superiority will not entirely protect us.....States, terrorists and other disaffected groups will acquire weapons of mass destruction and mass disruption, and some will use them. Americans will likely die on American soil, possibly in large numbers."

It is clear that the potential for acts of malice or insanity at nuclear facilities -- including highly destructive acts -- has been foreseeable for many years, and has been foreseen. However, the terrorist attacks on the World Trade Center and the Pentagon on 11 September 2001 provided significant new information. These attacks conclusively demonstrated that the threat of highly-destructive acts of malice or insanity is a clear and present danger, and that no reasonable person can regard this threat as remote or speculative. According to press reports, US authorities have obtained information suggesting that the hijackers of United Airlines flight 93, which crashed in Pennsylvania on 11 September 2001, were planning to hit a nuclear plant.⁵² This may be true or false, or the truth may never be known. Whatever the truth is, it would be foolish to regard nuclear plants as immune from attack.

*Estimating the Probability of an Attack
on a Nuclear Facility*

The NRC has a longstanding policy of dismissing citizens' concerns about nuclear-facility accidents if the probability of such accidents is, in the agency's judgement, low. A body of analytic techniques known as probabilistic risk

⁵¹ Commission on National Security, 1999.

⁵² Rufford et al, 2001.

assessment (PRA) has been developed to support such judgements.⁵³ However, the NRC Staff has conceded that it cannot provide a quantitative assessment of the probability of an act of malice at a nuclear facility. In a memo to the NRC Commissioners, the Staff has stated:⁵⁴

"The staff, as a result of its ongoing work with the Federal national security agencies, has determined that the ability to quantify the likelihood of sabotage events at nuclear power plants is not currently supported by the state-of-the-art in PRA methods and data. The staff also believes that both the NRC and the other government stakeholders would need to conduct additional research and expend significant time and resources before it could even attempt to quantify the likelihood of sabotage events. In addition, the national security agencies, Intelligence Community, and Law Enforcement Agencies do not currently quantitatively assess the likelihood of terrorist, criminal, or other malevolent acts."

To date, there has been no determined attack on a US civilian nuclear facility. At present, we cannot quantitatively estimate the probability of such an attack in the future. However, from a qualitative perspective, it is clear that the probability is significant.

3.2 The Strategic Context

In considering the need to defend civilian nuclear facilities, one is obliged to take a broad view of the security environment. An ISFSI, for example, may remain in service for 100 years or more. During that period the level of risk will vary but the cumulative risk will continue to grow. Thus, the ISFSI's designer should take a conservative position in specifying a DBT. That position should be informed by a sober assessment of the range of threats that may be manifested over coming decades.

A Turbulent World?

A number of strategic analysts have warned that world affairs may become more turbulent over the coming decades. Analysts have pointed to destabilizing factors that include economic inequality, poverty, political grievances, nationalism, environmental degradation and the weakening of international institutions. For example, a 1995 RAND study for the US Department of Defense contains the statement:⁵⁵

⁵³ The state of the art of PRA can be illustrated by: NRC, 1990. For a critique of PRA, see: Hirsch et al, 1989.

⁵⁴ Travers, 2001.

⁵⁵ Kugler, 1995, page xv.

"If the worst does transpire, the world could combine the negative features of nineteenth-century geopolitics, twentieth-century political passions, and twenty-first century technology: a chronically turbulent world of unstable multi-polarity, atavistic nationalism, and modern armaments."

As another example, the Stockholm Environment Institute (SEI) has identified a range of scenarios for the future of the world over the coming decades, and has studied the policies and actions that will tend to make each scenario come true. In summarizing this work, SEI states:⁵⁶

"In the critical years ahead, if destabilizing social, political and environmental stresses are addressed, the dream of a culturally rich, inclusive and sustainable world civilization becomes plausible. If they are not, the nightmare of an impoverished, mean and destructive future looms. The rapidity of the planetary transition increases the urgency for vision and action lest we cross thresholds that irreversibly reduce options -- a climate discontinuity, locking-in to unsustainable technological choices, and the loss of cultural and biological diversity."

SEI has specifically considered the implications of the September 2001 terrorist attacks, concluding:⁵⁷

"Certainly the world will not be the same after 9/11, but the ultimate implications are indeterminate. One possibility is hopeful: new strategic alliances could be a platform for new multinational engagement on a wide range of political, social and environmental problems. Heightened awareness of global inequities and dangers could support a push for a more equitable form of global development as both a moral and a security imperative. Popular values could eventually shift toward a strong desire for participation, cooperation and global understanding. Another possibility is ominous: an escalating spiral of violence and reaction could amplify cultural and political schisms; the new military and security priorities could weaken democratic institutions, civil liberties and economic opportunity; and people could grow more fearful, intolerant and xenophobic as elites withdraw to their fortresses."

⁵⁶ Raskin et al, 2002, page 11.

⁵⁷ Ibid.

Nuclear Facilities as Symbolic Targets

In view of the range of possibilities for world order or turbulence over the coming decades, it would be prudent to assume that any US civilian nuclear facility could be the subject of a determined attack. Moreover, civilian nuclear facilities may be especially prime targets because of their symbolic connection with nuclear weapons. The US government flaunts its superiority in nuclear weapons and rejects any constraint on these weapons through international law.⁵⁸ At the same time, the government has signaled its willingness to attack Iraq because that country might acquire a nuclear weapon. It would be prudent to assume that this situation will motivate terrorist groups to search for ways to attack US nuclear facilities. For example, a terrorist group possessing a crude nuclear weapon might choose to use that weapon on a US civilian nuclear facility for two reasons. First, because the target would be highly symbolic. Second, because the radioactive fallout from the weapon would be greatly amplified.

The Domestic Threat

There is a natural tendency to look outside the country for sources of threat. However, an attack on a nuclear facility could also originate within the United States. The national strategy for homeland security contains the statement:⁵⁹

"Terrorist groups also include domestic organizations. The 1995 bombing of the Murrah Federal Building in Oklahoma City highlights the threat of domestic terrorist acts designed to achieve mass casualties. The US government averted seven planned terrorist acts in 1999 -- two were potentially large-scale, high-casualty attacks being organized by domestic extremist groups."

3.3 The US Government's Response to this Threat

The preceding discussion shows that there is a significant potential for a determined attack on a US civilian nuclear facility. Such an attack could employ a level of sophistication and violence that is characteristic of military operations. However, in most attack scenarios the attacking group would have a negligible capability for direct confrontation with US military forces. Thus, it is appropriate to think of an attack of this kind as a form of asymmetric warfare. The attacking group, be it domestic or foreign, will have

⁵⁸ Deller, 2002; Scarry, 2002.

⁵⁹ Office of Homeland Security, 2002, page 10.

a set of political objectives. For symbolic and practical reasons, the attackers will prefer to obtain their weapons and logistical resources inside the USA.

*US Strategy for National Security
and Homeland Security*

The White House has recently articulated a national security strategy for the United States.⁶⁰ This strategy rests primarily on the use of military force outside the country, to deter, disrupt or punish potential attackers. In support of this concept, the strategy asserts the right to conduct unilateral, pre-emptive attacks around the world, and repudiates the International Criminal Court. Homeland security is regarded as a secondary form of defense, as illustrated by the statement:⁶¹

"While we recognize that our best defense is a good offense, we are also strengthening America's homeland security to protect against and deter attack."

A strategy for homeland security has been articulated by the White House.⁶² This document contains a section titled "Defending against Catastrophic Threats", and that section begins with an aerial photograph of a nuclear power plant. Yet, the section does not mention civilian nuclear facilities or the NRC. Thus, at the highest levels of strategic planning, the US government has nothing to say about the potential for an attack on a nuclear facility, or about the measures that could be taken to defend against such attacks. In fact, the US government seems largely unaware of this threat, and has delegated its responsibility to the NRC. As described in Section 2.3 of this report, the NRC's response to the threat has been limited and ineffectual.

*Imbalance in National Security
and Defense Planning*

Inattention to the vulnerability of nuclear facilities is symptomatic of a larger imbalance in national security and defense planning. As another example of imbalance, consider the threat of attack on the United States by inter-continental ballistic missiles (ICBMs). Large expenditures are devoted to the development of technologies that might, ultimately, allow missile warheads to be intercepted. Yet, in considering the respective risks of attack by missiles or other means, the US National Intelligence Council has stated:⁶³

⁶⁰ White House, 2002.

⁶¹ Ibid, page 6.

⁶² Office of Homeland Security, 2002.

⁶³ National Intelligence Council, 2001, page 18.

"Nonmissile means of delivering weapons of mass destruction [WMD] do not provide the same prestige or degree of deterrence and coercive diplomacy associated with ICBMs. Nevertheless, concern remains about options for delivering WMD to the United States without missiles by state and nonstate actors. Ships, trucks, airplanes, and other means may be used. In fact, the Intelligence Community judges that US territory is more likely to be attacked with WMD using nonmissile means, primarily because such means:

- Are less expensive than developing and producing ICBMs.
- Can be covertly developed and employed; the source of the weapon could be masked in an attempt to evade retaliation.
- Probably would be more reliable than ICBMs that have not completed rigorous testing and validation programs.
- Probably would be much more accurate than emerging ICBMs over the next 15 years.
- Probably would be more effective for disseminating biological warfare agent than a ballistic missile.
- Would avoid missile defenses."

The defense analyst John Newhouse has contrasted the high level of attention given to the ICBM threat with the lack of effort in other areas of defense. He notes that the State Department advised US embassies in early 2001 that the principal threat to US security is the use of long-range missiles by rogue states, and comments:⁶⁴

"This dubious proposition -- an article of faith within parts of the defense establishment -- obscured existing and far more credible threats from truly frightful weapons, some of which are within the reach of terrorists. They include Russia's shaky control of its nuclear weapons and weapons-usable material; the vulnerability of US coastal cities and military forces stationed abroad to medium-range missile systems, ballistic and cruise; the vulnerabilities of all cities to chemical and biological weapons, along with so-called suitcase weapons and other low-tech delivery expedients. Vehicles that contain potentially destructive amounts of stored energy are a major source of concern, as is one of their most attractive potential targets, a nuclear spent-fuel storage facility."

⁶⁴ Newhouse, 2002, page 43.

Nuclear Facilities as Targets

It is clear that US civilian nuclear facilities are candidates for attack under conditions of asymmetric warfare. They are large, fixed targets that are, at present, lightly defended. In the eyes of an enemy, they can be regarded as pre-deployed radiological weapons. They can be attacked using comparatively low levels of technology. Given the United States' overt reliance on nuclear weapons as offensive instruments, civilian nuclear facilities offer highly symbolic targets. In light of these considerations, it is remarkable that the US government has largely ignored this threat.

The Danger of an Offense-Dominated Strategy

At present, US policy for national security assigns a higher priority to offensive actions worldwide than to defensive actions within the homeland. This is a tradition of many years' standing. However, in the contemporary era of asymmetric warfare, this policy can be dangerous.⁶⁵ If our vulnerable infrastructure -- including nuclear facilities, the airlines, etc. -- is poorly defended, we may feel compelled to use military force aggressively around the world, in order to pre-empt or punish attackers. Such action poses the risk of arousing hostility and promoting anarchy, leading to new attacks on our homeland. The potential exists for an escalating spiral of violence. Strategic analysts have warned of this danger, both before and after the terrorist events of September 2001.⁶⁶

3.4 A Balanced Response to the Threat

The United States needs a balanced, mature strategy for national defense and international security. Within that strategy, it needs a balanced strategy for homeland security. Finally, as a part of homeland security, the nation needs a defense-in-depth strategy to protect its civilian nuclear facilities. At present, all three levels of strategy are deficient.

The Role of Protection in a Balanced Response

Articulation of a balanced strategy at all three levels is a task beyond the scope of this report. However, this report does articulate, in Sections 4.4 and 4.5

⁶⁵ A recent essay (Betts, 2003) argues that US decision makers have neglected the risk that Iraq's leaders will strike back at the US homeland if we attack Iraq. Betts' essay focusses on the potential for Iraq to use chemical or biological weapons on US territory, but the same general arguments apply to the potential for an attack on a US civilian nuclear facility.

⁶⁶ See, for example: Sloan, 1995; Martin, 2002 (see especially the chapter by Conrad Crane in this volume); Mathews, 2002; Conetta, 2002; Crawford, 2003; and Newhouse, 2002.

respectively, a defense-in-depth strategy for nuclear facilities and a national strategy for robust storage of spent fuel. As an illustration of how these protective measures could fit within a higher-level strategy, consider Carl Conetta's suggestion of a four-pronged campaign against the terrorist group al-Qaeda. The four prongs would be:⁶⁷

- "(i) squeeze the blood flow of the organization -- its financial support system;
- (ii) throw more light on the organization's members and components through intelligence gathering activities;
- (iii) impede the movement of the organization by increasing the sensitivity of screening procedures at critical gateways -- borders, financial exchanges, arms markets, and transportation portals; and
- (iv) improve the protection of high-value targets."

The importance of protecting high-value targets is emphasized in the recent report of a high-level task force convened by the Council on Foreign Relations and chaired by former Senators Gary Hart and Warren Rudman. One of the report's major findings is:⁶⁸

"Homeland security measures have deterrence value: US counterterrorism initiatives abroad can be reinforced by making the US homeland a less tempting target. We can transform the calculations of would-be terrorists by elevating the risk that (1) an attack on the United States will fail, and (2) the disruptive consequences of a successful attack will be minimal. It is especially critical that we bolster this deterrent now since an inevitable consequence of the US government's stepped-up military and diplomatic exertions will be to elevate the incentive to strike back before these efforts have their desired effect."

The Need for Proactive Planning

Other findings by the Council on Foreign Relations' task force also deserve attention. For example, their report points out that proactive planning will yield better protection at lower cost than reacting after each new attack.⁶⁹ This point is especially important in an era of asymmetric warfare, when opponents will employ unfamiliar tactics. Planning techniques such as "competitive strategies" and "net assessment" have been developed to accommodate such situations. In discussing net assessment, one author has stated:⁷⁰

⁶⁷ Conetta, 2002, page 3.

⁶⁸ Hart et al, 2002, pp 14-15.

⁶⁹ Ibid, page 16.

⁷⁰ Hoffman, 2002, pp 3-4.

"One of the advantages of such an approach is that it credits the opponent with having a brain and a will, which Clausewitz suggested is also fundamental to war. Rarely do US strategists credit adversaries with being as cunning or adaptive as they usually turn out to be. It is well to be reminded on occasion that any opponent has strategies and options at his disposal too. The essence of the homeland security challenge is based on this consideration."

4. Defending Nuclear Power Plants and Spent Fuel

4.1 Potential Modes and Instruments of Attack

It is not appropriate to publish a detailed discussion of scenarios whereby a nuclear power plant or a spent-fuel-storage facility might be successfully attacked. However, it must be assumed that attackers are technically sophisticated and possess considerable knowledge about individual nuclear facilities. For decades, engineering drawings, photographs and technical analyses have been openly available for every civilian nuclear facility in the USA. This material is archived at many locations around the world. Thus, a public discussion, in general terms, of potential modes and instruments of attack will not assist attackers. Indeed, such a discussion is needed to ensure that appropriate defensive actions are taken.

Safety Systems and their Vulnerability

The safe operation of a US commercial reactor or a spent-fuel pool depends upon the fuel in the reactor or the pool being immersed in water. Moreover, that water must be continually cooled to remove fission heat or radioactive decay heat generated in the fuel. A variety of systems are used to ensure that water is available and is cooled, and that other safety-related functions -- such as shutdown of the fission reaction when needed -- are performed. Some of the relevant systems -- such as the switchyard -- are highly vulnerable to attack. Other systems are located inside reinforced-concrete structures -- such as the reactor auxiliary building -- that provide some degree of protection against attack. The reactor itself is inside a containment structure. At some plants, but not all, the reactor containment is a concrete structure that is highly reinforced and comparatively robust. Spent-fuel pools have thick concrete walls but are typically covered by lightweight structures.

Attack through Brute Force or Indirectly?

A group of attackers equipped with highly-destructive instruments could take a brute-force approach to attacking a reactor or a spent-fuel pool. Such an

approach would aim to directly breach the reactor containment and primary cooling circuit, or to breach the wall or floor of a spent-fuel pool. Alternatively, the attacking group could take an indirect approach, and many such approaches will readily suggest themselves to technically-informed attackers. Insiders, or outsiders who have taken over the plant, could obtain a release of radioactive material without necessarily employing destructive instruments. Some attack scenarios will involve the disabling of plant personnel, which could be accomplished by armed attack, use of lethal chemical weapons, or radioactive contamination of the site by an initial release of radioactive material.

Vulnerability of ISFSIs

Dry-storage ISFSIs differ from reactors and spent-fuel pools in that their operation is entirely passive. Thus, each dry-storage module in an ISFSI must be attacked directly. To obtain a release of radioactive material, the wall of the fuel container must be penetrated from the outside, or the container must be heated by an external fire to such an extent that the containment envelope fails. The attack could also exploit stored chemical energy in the zirconium cladding of spent fuel inside the module. Combustion of this cladding in air, if initiated, would generate heat that could liberate radioactive material from the fuel to the outside environment. A knowledgeable attacker could combine penetration of the fuel container with the initiation of combustion.

Relevance of Site-Security Barriers

In some attack scenarios that involve the use of destructive instruments, the attackers may need to carry these instruments, by hand or in a vehicle, to the point of application. Such an action would require the overcoming of site-security barriers. In other scenarios, the instruments could be launched from a position outside some or all of these barriers.

Commercial Aircraft as Instruments of Attack

One instrument that an attacking group will consider is a fuel-laden commercial aircraft. As indicators of the forces that could accompany the impact of such an aircraft, consider the weights and fuel capacities of some typical jetliners.⁷¹ The Boeing 737-300 has a maximum takeoff weight of 56-63 tonnes and a fuel capacity of 20-24 thousand liters. The Boeing 747-400 has a maximum takeoff weight of 363-395 tonnes and a fuel capacity of 204-217 thousand liters. The Boeing 757 has a maximum takeoff weight of 104-116 tonnes and a fuel capacity of 43 thousand liters. The Boeing 767 has a

⁷¹ Jackson, 1996.

maximum takeoff weight of 136-181 tonnes and a fuel capacity of 63-91 thousand liters.

Commercial jet fuel typically has a heat of combustion of about 38 MJ per liter. For comparison, 1 kilogram of TNT will yield 4.2 MJ of energy. Thus, complete combustion of 1 liter of jet fuel will yield energy equivalent to that from 9 kilograms of TNT. Complete combustion of 100 thousand liters of jet fuel -- about half the fuel capacity of a Boeing 747-400 -- will yield energy equivalent to that from 900 tonnes of TNT. Thus, the impact of a fuel-laden aircraft could lead to a violent fuel-air explosion. Fuel-air munitions have been developed that yield more than 5 times the energy of their equivalent weight in TNT, and create a blast overpressure exceeding 1,000 pounds per square inch.⁷² A fuel-air explosion arising from an aircraft impact will be less efficient than a munition in converting combustion energy into blast, but could generate a highly-destructive blast if fuel vapor accumulates in a confined space before igniting.

Explosive-Laden, General-Aviation Aircraft

The attacking group might choose to use an explosive-laden, general-aviation aircraft as an instrument of attack. Such an aircraft could be much easier to obtain than a large commercial aircraft. In 1999, about 219,000 general-aviation aircraft were in use in the USA.⁷³ Of these, about 172,000 had piston engines, 5,700 were turboprops, 7,100 were turbojets and 7,400 were helicopters.⁷⁴ In the piston-engine category, about 21,000 aircraft had two engines, the remainder having one engine. The general-aviation fleet in 2002 must be similar to that in 1999.

It is clear that terrorist groups can readily obtain and use explosive materials. Such use is a tragic accompaniment to political disputes around the world. Moreover, explosives are easily obtainable within the USA. In 2001, about 2.4 million tonnes of explosives were sold in the USA. Most of this material consisted of blasting agents and oxidizers used for mining, quarrying and construction. Much of the blasting material consisted of mixtures of ammonium nitrate and fuel oil, which are readily-available materials. It is also noteworthy that current law in many US states allows high explosives to be purchased without a permit or a background check.⁷⁵

⁷² Gervasi, 1977.

⁷³ Data from the website of the General Aviation Manufacturers Association (www.generalaviation.org), 30 September 2002.

⁷⁴ The remainder of the fleet consisted of gliders, balloons/blimps and experimental aircraft.

⁷⁵ Information from the website of the Institute of Makers of Explosives (www.ime.org), 30 September 2002.

Anti-Tank Missiles

Another instrument of attack that could be used is an anti-tank missile. Large numbers of these missiles exist around the world, and they can be obtained by many terrorist groups. As an example, consider the tube-launched, optically-tracked, wire-guided (TOW) anti-tank missile system, which is now marketed by Raytheon.⁷⁶ This system is said to be the most successful anti-tank missile system in the world. It first entered service with the US Army in 1970 and is currently in use by more than 40 military forces. As of 1991, more than 460,000 TOW missiles had been produced, and the cumulative production up to 2002 must be substantially higher. The TOW missile has a maintenance-free storage life of 20 years, and all versions of the missile can be fired from any TOW launcher. TOW systems have been sold to countries such as Colombia, Iran, Lebanon, Pakistan, Somalia, Yugoslavia and South Yemen, so it must be presumed that they can be obtained by terrorist groups. There is no indication from available literature that the TOW missile or launcher is self-disabling if it passes into inappropriate hands. In connection with the availability of systems of this kind, it is interesting to note that, in August 2002, federal agents seized more than 2,300 unregistered armor-piercing missiles from a private, counter-terrorism training school in New Mexico.⁷⁷

Modern anti-tank missiles are reliable, accurate and easy to use. They are capable of penetrating considerable thicknesses of armor plate using a shaped-charge warhead that is designed for this purpose. Some types of missile can also be equipped with a general-purpose warhead that would be used for attacking targets such as fortified bunkers and gun emplacements. All types can be set up and reloaded comparatively quickly. Consider the TOW missile system as an example. The launcher can be mounted on a light vehicle or carried a short distance and mounted on the ground on a tripod. A late-model TOW launcher weighs about 93 kilograms, the guidance set about 24 kilograms and each missile about 22 kilograms. A rate of fire of about two rounds per minute can be sustained, and the missile has a range in excess of 3,000 meters. It is reported that an early-model TOW missile can blow a hole as much as two feet in diameter in the armor of a Soviet T-62 tank, or cut through three feet of concrete. Later-model TOW missiles are more capable.⁷⁸

⁷⁶ Information from: Hogg, 1991; Gervasi, 1977; Raytheon website (www.raytheon.com), 26 September 2002; US Marine Corps website (www.hqmc.usmc.mil), 26 September 2002; and Canadian Army website (www.army.forces.gc.ca), 27 September 2002.

⁷⁷ Reuters, 2002.

⁷⁸ Information from: Hogg, 1991; Gervasi, 1977; Raytheon website (www.raytheon.com), 26 September 2002; US Marine Corps website (www.hqmc.usmc.mil), 26 September 2002; and Canadian Army website (www.army.forces.gc.ca), 27 September 2002.

Nuclear Weapons

A nuclear weapon could be used to attack a civilian nuclear facility. This possibility was a source of concern during the Cold War, and there is a body of technical and policy literature on this subject.⁷⁹ Russia retains the capability to attack US nuclear facilities using ICBMs with thermonuclear warheads, and might be motivated at some future date to threaten or implement such an attack. A greater concern in the current period is that a sub-national group, with or without the assistance of a government, might use a comparatively low-yield fission weapon -- perhaps one with an explosive yield in the vicinity of 10 kilotonnes of TNT equivalent -- to attack a US nuclear facility. The means of delivery might be a land vehicle or a general-aviation aircraft. Such a weapon would be difficult to obtain, but many knowledgeable experts have warned that the fissionable material for a simple nuclear weapon could be diverted from poorly-secured stocks in Russia and elsewhere.⁸⁰ There is even the possibility that a complete nuclear weapon will be diverted. A high-level group advising the US government has examined the security of nuclear weapons and fissile material in Russia, concluding:⁸¹

"The most urgent unmet national security threat to the United States today is the danger that weapons of mass destruction or weapons-usable material in Russia could be stolen and sold to terrorists or hostile nation states and used against American troops abroad or citizens at home. This threat is a clear and present danger to the international community as well as to American lives and liberties."

Summary

Table 1, on the following page, briefly summarizes the characteristics of some potential modes of attack on civilian nuclear facilities, and the present defense against each mode. Other modes of attack can be identified, and an attacking group might use several modes simultaneously or in sequence. The characteristics of each mode are, of course, more complex and varied than is shown in Table 1. Nevertheless, this table shows that determined, knowledgeable attackers have a range of options available to them.

⁷⁹ See, for example: Fetter, 1982; Fetter and Tsipis, 1980; Ramberg, 1984; and SIPRI, 1981.

⁸⁰ See, for example: Baker, Cutler et al, 2001; Bunn et al, 2002; and Sokolski and Riisager, 2002.

⁸¹ Baker, Cutler et al, 2001, first page of Executive Summary.

MODE OF ATTACK	CHARACTERISTICS	PRESENT DEFENSE
Commando-style attack	<ul style="list-style-type: none"> • Could involve heavy weapons and sophisticated tactics • Successful attack would require substantial planning and resources 	Alarms, fences and lightly-armed guards, with offsite backup
Land-vehicle bomb	<ul style="list-style-type: none"> • Readily obtainable • Highly destructive if detonated at target 	Vehicle barriers at entry points to Protected Area
Anti-tank missile	<ul style="list-style-type: none"> • Readily obtainable • Highly destructive at point of impact 	None if missile launched from offsite
Commercial aircraft	<ul style="list-style-type: none"> • More difficult to obtain than pre-9/11 • Can destroy larger, softer targets 	None
Explosive-laden smaller aircraft	<ul style="list-style-type: none"> • Readily obtainable • Can destroy smaller, harder targets 	None
10-kilotonne nuclear weapon	<ul style="list-style-type: none"> • Difficult to obtain • Assured destruction if detonated at target 	None

TABLE 1

SOME POTENTIAL MODES OF ATTACK ON
 CIVILIAN NUCLEAR FACILITIES

4.2 Vulnerability to Attack

The preceding section of this report describes, in deliberately general terms, the potential modes and instruments of attack on a nuclear power plant or an ISFSI. No sensitive information is disclosed. In discussing the vulnerability of nuclear facilities to such attacks, one must be similarly careful to avoid disclosing sensitive information. In this context, the word "vulnerability" refers to the potential for an act of malice or insanity to cause a release of radioactive material to the environment. At the site of a nuclear power plant or an ISFSI, most of the radioactive material at the site is in the reactor(s), the spent-fuel pool(s) and the ISFSI modules.

Requirements for a Vulnerability Study

Every US commercial reactor has been subjected to a PRA-type study by the licensee. This study addressed the reactor's potential to experience accidents, but did not consider acts of malice or insanity. No spent-fuel pool or ISFSI has been subjected to a PRA-type study or a study of its vulnerability to acts of malice or insanity. Indeed, there has never been a comprehensive, published study of the vulnerability of any US nuclear facility to acts of malice or insanity. Spurred by the terrorist events of September 2001, the NRC has sponsored secret, ongoing studies on the vulnerability of nuclear facilities to impact by a large commercial aircraft. Available information suggests that these studies are narrow in scope and will provide limited guidance regarding the overall vulnerability of nuclear facilities.

A comprehensive study of a facility's vulnerability would begin by identifying a range of potential attacks on the facility. The probability of each potential attack would be qualitatively estimated, with consideration of the factors (e.g., international events, changing availability of instruments of attack) that could alter the probability over time. Site-specific factors affecting the feasibility and probability of attack scenarios include local terrain and the proximity of coastlines, airports, population centers and national symbols. A variety of modes and instruments of attack would be considered, of the kind discussed in Section 4.1.

After identifying a range of potential attacks, a comprehensive study would examine the vulnerability of the subject facility to those attacks. This could be done by adapting and extending known techniques of PRA, with an emphasis on the logical structure of PRA rather than the numerical probabilities of events. The analysis would consider the potential for interactions among facilities at a site. For example, a potentially important interaction could be the prevention of personnel access at one facility (e.g., a spent-fuel pool) due

to a release of radioactive material at another facility (e.g., a reactor). Attention would be given to the potential for "cascading" scenarios in which attacks at some parts of a nuclear-power-plant site (e.g., control room, switchyard, diesel generators) lead to releases from reactors and/or spent fuel pools that were not directly attacked.

Working with Partial or Misleading Information

In the absence of any comprehensive study of vulnerability, one is obliged to rely upon partial information. Also, one must contend with misleading information disseminated by the nuclear industry. An egregious example is a recent paper in *Science*, a journal that is usually sound.⁸² Two points illustrate the low scientific quality of this paper. First, the paper cites an experiment performed at Sandia National Laboratories as proof that an aircraft cannot penetrate the concrete wall of a reactor containment. In response, Sandia officials have stated that the test has no relevance to the structural behavior of a containment wall, a fact that is readily evident from the nature of the test.⁸³ Second, the paper states, in connection with the vulnerability of spent-fuel shipping casks, that "there is virtually nothing one could do to these shipping casks that would cause a significant public hazard".⁸⁴ A report prepared by Sandia for the NRC is cited in support of this statement.⁸⁵ Yet, examination of the Sandia report reveals that it considers only the effects on a shipping cask of impact and fire pursuant to a truck or train accident. The Sandia report does not address the effects of, for example, attack by a TOW missile, a vehicle bomb, or a manually-placed charge.

Aircraft Impact

A rough, preliminary indication of the vulnerability of a nuclear power plant to aircraft impact can be obtained from the PRA for the Seabrook reactor. This reactor is a 4-loop Westinghouse PWR with a large, dry containment, and is one of only four US reactors that were specifically designed to resist impact by an aircraft, a 6-tonne aircraft in the case of Seabrook.⁸⁶ The Seabrook PRA finds that any direct impact on the containment by an aircraft weighing more than 37 tonnes will lead to penetration of the containment and a breach in the reactor coolant circuit. Also, the Seabrook PRA finds that a similar impact on the control building or auxiliary building will inevitably lead to a core melt.⁸⁷ All of the typical, commercial aircraft mentioned in Section 4.1 of this

⁸² Chapin et al, 2002.

⁸³ Jones, 2002a.

⁸⁴ Chapin et al, 2002, page 1997.

⁸⁵ Sprung et al, 2000.

⁸⁶ Markey, 2002, page 73.

⁸⁷ PLG, 1983, pp 9.3-10 to 9.3-11.

report weigh considerably more than 37 tonnes. Moreover, the Seabrook PRA does not consider the effects of a fuel-air explosion and/or fire as an accompaniment to an aircraft impact. Finally, this PRA, like other PRAs, does not consider malicious acts. Thus, it does not consider, for example, an attack on the Seabrook reactor by an explosive-laden, general-aviation aircraft.

Analytic techniques are available for estimating the effects that aircraft impact will have on the structures and equipment of a nuclear facility. Two recent studies illustrate the use of such techniques. First, the Nuclear Energy Institute (NEI), an industry lobbying organization, has released some preliminary findings from an analysis of aircraft impact on reactor containments and spent-fuel facilities.⁸⁸ The analysis itself will not be published, so the findings cannot be verified. Second, a group at Purdue University has released the results of its simulation of the aircraft impact on the Pentagon that occurred on 11 September 2001.⁸⁹ A simulation of this kind could be performed for aircraft impact on a nuclear facility. The Purdue group employs commercially-available software and, in contrast to NEI, seems willing to publish its analysis.

The analytic techniques discussed in the preceding paragraph focus on the kinetic energy of the impacting aircraft and its contents. Effects of an accompanying fuel-air explosion and/or fire are given, at best, a crude analysis. A 1982 review by Argonne National Laboratory of the state of the art for aircraft-impact analysis stated:⁹⁰

"Based on the review of past licensing experience, it appears that fire and explosion hazards have been treated with much less care than the direct aircraft impact and the resulting structural response. Therefore, the claim that these fire/explosion effects do not represent a threat to nuclear power plants has not been clearly demonstrated."

Examination of PRAs and related studies for nuclear facilities shows that the Argonne statement remains valid today. Indeed, in view of the large amount of energy that can be liberated in a fuel-air fire or explosion, previous analyses of aircraft impacts may have substantially underestimated the vulnerability of nuclear facilities to such impacts.

⁸⁸ NEI, 2002.

⁸⁹ Purdue, 2002; Sozen et al, 2002.

⁹⁰ Kot et al, 1982, page 78.

Vulnerability of Spent-Fuel Pools

The vulnerability of spent-fuel pools deserves special attention because these pools contain large amounts of long-lived radioactive material that could be liberally released to the atmosphere during a fire.⁹¹ The potential for such a fire exists because the pools have been equipped with high-density racks. In the 1970s, the spent-fuel pools of US nuclear power plants were typically equipped with low-density, open-frame racks. If water were partially or totally lost from such a pool, air or steam could circulate freely throughout the racks, providing convective cooling to the spent fuel. By contrast, the high-density racks that are used today have a closed structure. To suppress criticality, each fuel assembly is surrounded by solid, neutron-absorbing panels, and there is little or no gap between the panels of adjacent cells. In the absence of water, this configuration allows only one mode of circulation of air and steam around a fuel assembly -- vertically upward within the confines of the neutron-absorbing panels.

If water is totally lost from a high-density pool, air will pass downward through available gaps such as the gap between the pool wall and the outer faces of the racks, will travel horizontally across the base of the pool, will enter each rack cell through a hole in its base, and will rise upward within the cell, providing cooling to the spent fuel assembly in that cell. If the fuel has been discharged from the reactor comparatively recently, the flow of air may be insufficient to remove all of the fuel's decay heat. In that case, the temperature of the fuel cladding may rise to the point where a self-sustaining, exothermic oxidation reaction with air will begin. In simple terms, the fuel cladding -- which is made of zirconium alloy -- will begin to burn. The zirconium-alloy cladding can also enter into a self-sustaining, exothermic oxidation reaction with steam. Other exothermic oxidation reactions can also occur. For simplicity, the occurrence of one or more of the possible reactions can be referred to as a pool fire.

In many scenarios for loss of water from a pool, the flow of air that is described in the preceding paragraph will be blocked. For example, a falling object (e.g., a fuel-transfer cask) might distort rack structures, thereby blocking air flow. As another example, an attack might cause debris (e.g., from the roof of the fuel handling building) to fall into the pool and block air flow. The presence of residual water in the bottom of the pool would also block air flow. In most scenarios for loss of water, residual water will be present for significant periods of time. Blockage of air flow, for whatever reason, will lead to ignition of fuel that has been discharged from a reactor for long

⁹¹ The NRC has published a variety of technical documents that address spent-fuel-pool fires. The most recent of these documents is: Collins et al, 2000.

periods -- potentially 10 years or longer.⁹² The NRC Staff failed to understand this point for more than two decades.⁹³

Loss of Water from a Pool

Partial or total loss of water from a spent-fuel pool could occur through leakage, evaporation, siphoning, pumping, displacement by objects falling into the pool, or overturning of the pool. These modes of loss of water could arise, directly or indirectly, through a variety of attack scenarios. As a simple example, consider leakage as a direct result of aircraft impact on the wall of a pool. This example represents a brute-force attack on the model of 11 September 2001. Other attack options will suggest themselves to knowledgeable attackers.

An NRC Staff study includes a crude, generic analysis of the conditional probability that aircraft impact will cause a loss of water from a spent fuel pool.⁹⁴ The pool is assumed to have a 5-ft-thick reinforced-concrete wall. Impacting aircraft are divided into the categories "large" (weight more than 5.4 tonnes) and "small" (weight less than 5.4 tonnes). The Staff estimates that the conditional probability of penetration of the pool wall by a large aircraft is 0.45, and that 50 percent of penetration incidents involve a loss of water which exposes fuel to air. Thus, the Staff estimates that, for impact of a large aircraft, the conditional probability of a loss of water sufficient to initiate a pool fire is 0.23 (23 percent).

Facility Interactions and Cascading Scenarios

An earlier paragraph in Section 4.2 of this report mentions the potential for interactions among facilities on a site, and points out that a potentially important interaction could be the prevention of personnel access at one facility (e.g., a spent-fuel pool) due to a release of radioactive material at another facility (e.g., a reactor). This type of interaction was partially addressed during a licensing proceeding for the Harris nuclear power plant. In that proceeding, the NRC Staff conceded that a fire in one spent-fuel pool would preclude the provision of cooling and makeup to nearby pools, thereby leading to evaporation of water from the nearby pools followed by fires in those pools.⁹⁵ This situation would arise mostly because the initial fire would contaminate the site with radioactive material, generating high radiation fields that preclude personnel access. An analogous situation could

⁹² The role of residual water in promoting ignition of old fuel is discussed in: Thompson, 1999, Appendix D.

⁹³ Thompson, 2002a, Section II.

⁹⁴ Collins et al, 2000, page 3-23 and Appendix 2D.

⁹⁵ Parry et al, 2000, paragraph 29.

arise in which the release of radioactive material from a damaged reactor precludes the provision of cooling and makeup to nearby pools. For example, an attack on a reactor could lead to a rapid-onset core melt with an open containment, accompanied by a raging fire. That event would create high radiation fields across the site, potentially precluding any access to the site by personnel. One can envision a variety of "cascading" scenarios, in which there might eventually be fires in all of the pools at a site, accompanied by core-melt events at all of the reactors.

Progression of a Pool Fire

A pool fire could begin comparatively soon after water is lost from a pool. For example, suppose that most of the length of the fuel assemblies is exposed to air, but the flow of air to the base of the racks is precluded by residual water or a collapsed structure. In that event, fuel heatup would be approximately adiabatic. Fuel discharged for 1 month would ignite in less than 2 hours, and fuel discharged for 3 months would ignite in about 3 hours. The fire would then spread to older fuel. Once a fire has begun, it could be impossible to extinguish. Spraying water on the fire could feed an exothermic zirconium-steam reaction that would generate flammable hydrogen. High radiation fields could preclude the approach of firefighters.

Vulnerability of Dry-Storage Modules

The dry-storage modules used at ISFSIs are passively safe, as discussed in Section 4.1 of this report. Thus, an attacking group that seeks to obtain a radioactive release from an ISFSI must attack each module directly. To obtain a release of radioactive material, the wall of the fuel container must be penetrated from the outside, or the container must be heated by an external fire to such an extent that the containment envelope fails. In addition, a technically-informed and appropriately-equipped attacker could exploit stored chemical energy in the zirconium cladding of the stored spent fuel. Such an attacker would arrange for penetration of the container to be accompanied by the initiation of combustion of the cladding in air. Combustion would generate heat that could liberate radioactive material from the fuel to the outside environment. Initiation of combustion could be facilitated by the presence of zirconium hydride in the fuel cladding, which is a characteristic of high-burnup fuel. The NRC Staff has noted that zirconium hydride can experience auto-ignition in air.⁹⁶ This point had been brought to the Staff's attention by the NRC's Advisory Committee on Reactor Safeguards.⁹⁷

⁹⁶ Collins et al, 2000, page A1B-3.

⁹⁷ Powers, 2000, page 3.

There is a body of literature that addresses aspects of the vulnerability of dry-storage modules for ISFSIs. Consider some examples. First, NAC International has analyzed the impact of a Boeing 747-400 aircraft on a NAC-UMS storage module of the type discussed in Section 2.2 of this report.⁹⁸ According to NAC, this analysis shows that failure of the fuel container would not occur, either from impact or fire. Second, analyses of aircraft impact have been done in Germany in connection with the licensing of ISFSIs that employ CASTOR casks. In Germany, ISFSIs are typically located inside buildings to provide some protection against anti-tank missiles, a practice which creates the potential for pooling of jet fuel following an aircraft impact. As a result, the intensity and duration of fire has become a key issue in technical debates about the release of radioactive material following an aircraft impact.⁹⁹ Third, in a test done in Germany in 1992, a shortened CASTOR cask containing simulated fuel assemblies made from depleted uranium was penetrated by a static, shaped charge, in order to simulate attack by an anti-tank missile.¹⁰⁰ The metal jet created by the shaped charge caused a small amount of finely-divided uranium to be released from the cask, but this test did not account for several important factors that are discussed in the following paragraph. Fourth, analyses of aircraft, cruise-missile and dummy-bomb impact on a dry-storage module have been done in connection with the licensing of the proposed Skull Valley ISFSI. The accompanying technical debate suggests that the magnitude of the radioactive release following penetration of a fuel container would be sensitive to the fraction of a fuel assembly's inventory of radionuclides, such as cesium-137, that would be present in the pellet-cladding gap region.¹⁰¹

*Requirements for a Comprehensive Study
of Dry-Storage Vulnerability*

The literature that is exemplified in the preceding paragraph addresses only some of the attack scenarios and physical-chemical phenomena that would be addressed in a comprehensive assessment of the vulnerability of dry-storage modules. Such an assessment would consider a range of instruments of attack, including anti-tank missiles, manually-placed charges, a vehicle bomb or an aircraft bomb. Modes of attack that promote zirconium ignition would be considered. Factors that would be accounted for include: (i) the presence of zirconium hydride in fuel cladding; (ii) radioactive-decay heat in fuel pellets; (iii) a pre-attack temperature characteristic of an actual, operating module; and (iv) source-term phenomena (such as the gap inventory of radionuclides) that are characteristic of high-burnup fuel. There is no evidence from

⁹⁸ McCough and Pennington, 2002.

⁹⁹ Hirsch, 2002.

¹⁰⁰ Lange et al, 2002.

¹⁰¹ Resnikoff, 2001.

published literature that a comprehensive vulnerability assessment of this kind has been made. Some components of a comprehensive assessment may have been performed secretly. For example, there are rumors of NRC-sponsored tests that have combined penetration of a fuel container with incendiary effects. Given the information that is available, it is prudent to assume that a variety of modes and non-nuclear instruments of attack could release to the atmosphere a substantial fraction of the radioactive inventory of a dry-storage module.

Attack Using a Nuclear Weapon

As indicated in Section 4.1 of this report, it is prudent to assume that a low-yield nuclear weapon (with a yield of perhaps 10 kilotonnes of TNT equivalent) might be used as an instrument of attack at a nuclear power plant or an ISFSI. A thorough assessment of the vulnerability to such an attack of the reactor(s), spent-fuel pool(s) and ISFSI modules at a site would require detailed analysis. Absent such an analysis, rough judgements can be made.

Consider, for example, a 10-kilotonne ground burst at an unhardened, surface-level ISFSI of the usual US type. It seems reasonable to assume that any module within the crater area would, as a result of blast effects and heating by the fireball, become divided into fragments, many of them small enough to travel downwind for many kilometers before falling to earth. A 10-kilotonne ground burst over sandstone, which is perhaps representative of an ISFSI, would yield a crater about 68 meters in diameter and 16 meters deep.¹⁰²

As an indication of the potential release of radioactive material following a nuclear detonation at an ISFSI, consider a 10-kilotonne groundburst at an ISFSI that employs vertical-axis fuel-storage modules with a center-to-center distance of 5.5 meters, as would be the case for the proposed Diablo Canyon facility. Given a large, square array of such modules, about 120 modules would fall within the 68-meter diameter of the anticipated crater. Thus, it is plausible to assume that 100 percent of the volatile radionuclides (such as cesium-137) in 120 modules, together with a lesser fraction of the non-volatile radionuclides, would be carried downwind in a radioactive plume. This quantity could be an over-estimate, because the ISFSI has finite dimensions and is not an infinite array, or it could be an under-estimate, because damage to modules outside the crater is not considered. Note that a NAC-UMS module, as used at Maine Yankee, can hold 24 PWR fuel assemblies or 56

¹⁰² Glasstone, 1962, Chapter VI.

BWR fuel assemblies.¹⁰³ The HI-STORM 100 modules that would be used at the proposed Diablo Canyon ISFSI can each hold 32 PWR fuel assemblies.¹⁰⁴

Comparative Risks of Attack Options

Section 4.1 of this report shows that a determined, knowledgeable group has available to it a range of options for attacking reactors, spent-fuel pools and ISFSIs. The preceding paragraphs of Section 4.2 provide a brief discussion of the vulnerability of reactors, pools and ISFSI modules to such options. These topics could be discussed more comprehensively, but that task was beyond the scope of this report. A comprehensive assessment -- whose underlying technical analysis should not, for obvious reasons, be openly published -- would identify a wide range of attack scenarios and would estimate their outcomes. Such an assessment could provide a perspective on the comparative risks of attack options.

As an illustration of comparative risk, consider three potential options for obtaining a release of radioactive material. Option I would be an attack on an ISFSI using a 10-kilotonne nuclear weapon delivered by a general-aviation aircraft. Delivery of the weapon could be straightforward, given the lack of air defense at ISFSIs, but the weapon would be difficult to obtain. Thus, this attack option seems to have a comparatively low probability. However, it would yield a large release of radioactive material. Option II would be a commando-style attack in which the attackers seize control of a nuclear power plant, initiate a reactor-core melt, breach the reactor containment, and initiate the removal of water from the spent-fuel pool(s) by siphoning and/or breaching the pool(s). Such an attack is feasible but would require substantial planning and resources and might be repulsed. Thus, this attack option may have a comparatively low probability. It would, however, yield a large release of radioactive material. Option III would be an attack on one or more ISFSI modules using anti-tank missiles fired from one or more offsite locations. In a plausible time window the attackers might, for example, be able to obtain 10 hits. The probability of this option is presumably substantially greater than the probability of Options I and II, but the release of radioactive material would be considerably smaller.

4.3 Consequences of Attack

The offsite radiological consequences of a potential attack on a nuclear facility can be estimated with widely-used, computer-based models. In order to apply such a model, one must have an estimate of the accident "source term". The

¹⁰³ Stone and Webster, 1999.

¹⁰⁴ PG&E, 2001a.

source term is a set of characteristics -- magnitude, timing, etc. -- that describe a potential release of radioactive material to the atmosphere. Using this source term, together with weather data for the release site, the model can estimate the magnitude of each of a range of radiological impacts at specified locations downwind.

Cesium-137 as an Indicator

A full analysis of this type is beyond the scope of this report. Instead, some scoping calculations are presented here, focussing on one radioactive isotope - cesium-137. This isotope is a useful indicator of the potential, long-term consequences of a release of radioactive material. Cesium-137 has a half-life of 30 years, and accounts for most of the offsite radiation exposure that is attributable to the 1986 Chernobyl reactor accident, and for about half of the radiation exposure that is attributable to fallout from nuclear weapons tests in the atmosphere.¹⁰⁵ Cesium is a volatile element that would be liberally released during nuclear-facility accidents or attacks. For example, an NRC study has concluded that a generic estimate of the release fraction of cesium isotopes during a spent-fuel-pool fire -- that is, the fraction of the pool's inventory of cesium isotopes that would reach the atmosphere -- is 100 percent.¹⁰⁶ It is reasonable to assume such a high release fraction because cesium is volatile, because a fire in a high-density pool, once initiated, would eventually involve all of the fuel in the pool, and because pool buildings are not designed as containment structures.

Inventories of Cesium-137 at Indian Point

The Indian Point site provides an illustration of the inventories of cesium-137 at nuclear facilities. Three nuclear power plants have been built at this site. Unit 1 had a rated power of 590 MW (thermal) and operated from 1962 to 1974.¹⁰⁷ Unit 2 has a rated power of 2,760 MW (thermal), commenced operating in 1974, and remains operational. Unit 3 has a rated power of 2,760 MW (thermal), commenced operating in 1976, and remains operational. Unit 2 and Unit 3 each employ a four-loop Westinghouse PWR with a large, dry containment. The reactor cores of Unit 2 and Unit 3 each contain 193 fuel assemblies.¹⁰⁸

Unit 2 and Unit 3 are each equipped with one spent-fuel pool. The capacity of the Unit 2 pool is 1,374 fuel assemblies, while the capacity of the Unit 3 pool is

¹⁰⁵ DOE, 1987.

¹⁰⁶ Sailor et al, 1987.

¹⁰⁷ Thompson and Beckerley, 1973, Table 4-1.

¹⁰⁸ Larson, 1985, Table A-2.

1,345 fuel assemblies.¹⁰⁹ Both pools employ high-density racks. As of November 1998, the Unit 2 pool contained 917 fuel assemblies, while the Unit 3 pool contained 672 fuel assemblies.¹¹⁰ It can be assumed that the number of fuel assemblies in each pool has increased since November 1998.

The inventory of cesium-137 in the Indian Point pools can be readily estimated. Three parameters govern this estimate -- the number of spent fuel assemblies, their respective burnups, and their respective ages after discharge. Assuming a representative, uniform burnup of 46 GW-days per tonne, one finds that the 917 fuel assemblies that were in the Unit 2 pool in November 1998 now contain about 42 million Curies (460 kilograms) of cesium-137. The 672 fuel assemblies that were in the Unit 3 pool in November 1998 now contain about 31 million Curies (350 kilograms) of cesium-137. Additional amounts of cesium-137 would be present in any fuel assemblies that have been added to these pools since November 1998.

For comparison, the cores of the Indian Point Unit 2 and Unit 3 reactors each contain about 6 million Curies (67 kilograms) of cesium-137. Also, it should be noted that the Chernobyl reactor accident of 1986 released about 2.4 million Curies (27 kilograms) of cesium-137 to the atmosphere. That release represented 40 percent of the Chernobyl reactor core's inventory of 6 million Curies (67 kg) of cesium-137.¹¹¹ Also, atmospheric testing of nuclear weapons led to the deposition of about 20 million Curies (220 kilograms) of cesium-137 across the land and water surfaces of the Northern Hemisphere.¹¹²

As another comparison, consider a HI-STORM 100 dry-storage module that contains 32 PWR fuel assemblies. Assuming that these fuel assemblies have an average post-discharge age of 20 years, this module would contain about 1.3 million Curies (14 kilograms) of cesium-137.

Inventories of Cesium-137 at Vermont Yankee

The Vermont Yankee site provides a second illustration of the inventories of cesium-137 at nuclear facilities. At this site there is a single BWR with a rated power of 1,590 MW (thermal) and a Mark I containment. This plant commenced operating in 1972 and remains operational. The reactor core contains 368 fuel assemblies.¹¹³ One spent-fuel pool is provided at this plant.

¹⁰⁹ "Reactor Spent Fuel Storage", from NRC website (www.nrc.gov), 30 May 2001.

¹¹⁰ *Ibid.*

¹¹¹ Krass, 1991.

¹¹² DOE, 1987.

¹¹³ Larson, 1985, Table A-1.

The pool is equipped with high-density racks and has a capacity of 2,870 fuel assemblies, with a possible recent increase in this capacity.¹¹⁴

In 2000, the Vermont Yankee pool contained 2,439 fuel assemblies.¹¹⁵ Licensee projections done in 1999 showed the pool inventory increasing to a maximum of 2,687 assemblies in 2004, after which the inventory would decrease until the pool would be empty in 2017. These projections assumed continuing operation of the plant until 2012, transfer of spent fuel from the pool to an on-site ISFSI beginning in 2004, and shipment of fuel to Yucca Mountain beginning in 2010.¹¹⁶ To date, there has been no license application for an ISFSI at Vermont Yankee. Thus, transfer of fuel to an on-site ISFSI in 2004 is unlikely. As discussed in Section 2.1 of this report, shipment of fuel to Yucca Mountain in 2010 is unlikely.

The inventories of cesium-137 in the Vermont Yankee pool and reactor can be estimated as described above for Indian Point. One can assume that the Vermont Yankee pool now (in January 2003) contains 2,639 fuel assemblies, which have been discharged from the reactor during refuelling outages since 1972.¹¹⁷ Thus, the pool now contains about 35 million Curies (390 kilograms) of cesium-137. The Vermont Yankee reactor contains about 2.3 million Curies (26 kilograms) of cesium-137.

Land Contamination by Cesium-137
After a Pool Fire

Now consider the potential for a spent-fuel-pool fire at Indian Point or Vermont Yankee. As explained above, it is reasonable to assume that 100 percent of the cesium-137 in a pool would be released to the atmosphere in the event of a fire. The cesium-137 would be released to the atmosphere in small particles that would travel downwind and be deposited on the ground and other surfaces. The deposited particles would emit intense gamma radiation, leading to external, whole-body radiation doses to exposed persons. Cesium-137 would also contaminate water and foodstuffs, leading to internal radiation doses.

¹¹⁴ According to information compiled by licensee staff in February 1999 (Weyman, 1999), the licensed storage limit for the Vermont Yankee pool was 2,870 fuel assemblies in 1999, and was projected to increase to 3,355 fuel assemblies in 2001. According to information compiled by the NRC, the capacity of the Vermont Yankee pool in November 1998 was 2,863 assemblies; see "Reactor Spent Fuel Storage", from NRC website (www.nrc.gov), 30 May 2001.

¹¹⁵ Vermont Yankee, 2000.

¹¹⁶ Weyman, 1999.

¹¹⁷ *Ibid.*

One measure of the scope of radiation exposure attributable to deposition of cesium-137 is the area of land that would become uninhabitable. For illustration, one can assume that the threshold of uninhabitability is an external, whole-body dose of 10 rem over 30 years. This level of radiation exposure, which would represent about a three-fold increase above the typical level of background (natural) radiation, was used in the NRC's 1975 Reactor Safety Study as a criterion for relocating populations from rural areas.

A radiation dose of 10 rem over 30 years corresponds to an average dose rate of 0.33 rem per year.¹¹⁸ The health effects of radiation exposure at this dose level have been estimated by the National Research Council's Committee on the Biological Effects of Ionizing Radiations.¹¹⁹ This committee has estimated that a continuous lifetime exposure of 0.1 rem per year would increase the incidence of fatal cancers in an exposed population by 2.5 percent for males and 3.4 percent for females.¹²⁰ Incidence would scale linearly with dose, in this low-dose region.¹²¹ Thus, an average lifetime exposure of 0.33 rem per year would increase the incidence of fatal cancers by about 8 percent for males and 11 percent for females. About 21 percent of males and 18 percent of females normally die of cancer.¹²² In other words, in populations residing continuously at the threshold of uninhabitability (an external dose rate of 0.33 rem per year), about 2 percent of people would suffer a fatal cancer that would not otherwise occur.¹²³ Internal doses from contaminated food and water could cause additional cancer fatalities.

The increased cancer incidence described in the preceding paragraph would apply at the boundary of the uninhabitable area. Within that area, the external dose rate from cesium-137 would exceed the threshold of 10 rem over 30 years. At some locations, the dose rate would exceed this threshold by orders of magnitude. Therefore, persons choosing to live within the uninhabitable area would experience an incidence of fatal cancers at a level higher than is set forth above.

¹¹⁸ At a given location contaminated by cesium-137, the resulting external, whole-body dose received by a person at that location would decline over time, due to radioactive decay and weathering of the cesium-137. Thus, a person receiving 10 rem over an initial 30-year period would receive a lower dose over the subsequent 30-year period.

¹¹⁹ National Research Council, 1990.

¹²⁰ *Ibid*, Table 4-2.

¹²¹ The BEIR V committee assumed a linear dose-response model for cancers other than leukemia, and a model for leukemia that is effectively linear in the low-dose range. See National Research Council, 1990, pp 171-176.

¹²² National Research Council, 1990, Table 4-2.

¹²³ For males, $0.08 \times 0.21 = 0.017$. For females, $0.11 \times 0.18 = 0.020$.

Area of Uninhabitable Land
After a Pool Fire at Indian Point or Vermont Yankee

For a postulated release of cesium-137 to the atmosphere, the area of uninhabitable land can be estimated from calculations done by Dr Jan Beyea.¹²⁴ Four releases of cesium-137 are postulated here. The first postulated release is 42 million Curies, representing the fuel that was present in the Indian Point Unit 2 pool in November 1998. The second postulated release is 31 million Curies, representing the fuel that was present in the Indian Point Unit 3 pool in November 1998. (Actual, present inventories of cesium-137 in the Unit 2 and Unit 3 pools are higher than these numbers, assuming that fuel has been added since November 1998.) The third postulated release is 35 million Curies, representing the present (January 2003) inventory of fuel in the Vermont Yankee pool. The fourth postulated release is 1 million Curies, representing the cesium-137 inventory in a dry-storage ISFSI module that contains 32 PWR fuel assemblies. This fourth release does not represent a pool fire or a predicted release from an ISFSI. Instead, it is a notional release that provides a scale comparison.

For typical weather conditions, assuming that the radioactive plume travels over land rather than out to sea, a release of 42 million Curies of cesium-137 would render about 95,000 square kilometers of land uninhabitable. Under the same conditions, a release of 31 million Curies would render about 75,000 square kilometers uninhabitable, and a release of 35 million Curies would render about 80,000 square kilometers uninhabitable. A release of 1 million Curies would render uninhabitable about 2,000 square kilometers. For comparison, note that the area of New York state is 127,000 square kilometers, while the combined area of Vermont, New Hampshire and Massachusetts is 70,000 square kilometers. The use of a little imagination shows that a spent-fuel-pool fire at Indian Point or Vermont Yankee would be a regional and national disaster of historic proportions, with health, environmental, economic, social and political dimensions.

Cesium-137 Fallout From a Nuclear Detonation

For attack scenarios involving the use of a nuclear weapon on a spent-fuel-storage facility, it is instructive to compare the long-term radiological significance of the nuclear detonation itself with the significance of the release that the detonation could induce. For example, detonation of a 10-kilotonne fission weapon would directly generate about 2 thousand Curies (21

¹²⁴ Beyea et al, 1979.

grams) of cesium-137.¹²⁵ Yet, this weapon could release to the atmosphere tens of millions of Curies of cesium-137 from a spent-fuel pool or an unhardened, undispersed ISFSI.

4.4 Defense in Depth

Four types of measure, taken together, could provide a comprehensive, defense-in-depth strategy against acts of malice or insanity at a nuclear facility. The four types of measure, which are described in the following paragraphs, are in the categories: (i) site security; (ii) facility robustness; (iii) damage control; and (iv) emergency response planning. The degree of protection provided by these measures would be greatest if they were integrated into the design of a facility before its construction. However, a comprehensive set of measures could provide significant protection at existing facilities.

Site Security

Site-security measures are those that reduce the potential for implementation of destructive acts of malice or insanity at a nuclear site. Two types of measure fall into this category. Measures of the first type would be implemented at offsite locations, and the implementing agencies might have no direct connection with the site. Airline or airport security measures are examples of measures in this category. Measures of the second type would be implemented at or near the site. Implementing agencies would include the licensee, the NRC and, potentially, other entities (e.g., National Guard, Coast Guard). The physical protection measures now required by the NRC, as discussed in Section 2.3 of this report, are examples of site-security measures of the second type. More stringent measures could be introduced, such as:

- (i) establishment of a mandatory aircraft exclusion boundary around the site;
- (ii) deployment of an approaching-aircraft detection system that triggers a high-alert status at facilities on the site;
- (iii) expansion of the DBT, beyond that now applicable to a nuclear power plant, to include additional intruders, heavy weapons, lethal chemical weapons and more than one vehicle bomb; and
- (iv) any ISFSI on the site to receive protection equivalent to that provided for a nuclear power plant.

¹²⁵ SIPRI, 1981, page 76.

Facility Robustness

Facility-robustness measures are those that improve the ability of a nuclear facility to experience destructive acts of malice or insanity without a significant release of radioactive material to the environment. In illustration, the PIUS reactor design, as discussed in Section 2.3, was intended to withstand aerial bombardment by 1,000-pound bombs without suffering core damage or releasing a significant amount of radioactive material to the environment. An ISFSI could be constructed with a similar degree of robustness. At existing facilities, a variety of opportunities are available for enhancing robustness. As a high-priority example, the spent-fuel pool(s) at a nuclear power plant could be re-equipped with low-density racks, so that spent fuel would not ignite if water were lost from a pool. As a second example, the reactor of a nuclear power plant could be permanently shut down, or the reactor could operate at reduced power, either permanently or at times of alert. Other robustness-enhancing opportunities could be identified. For a nuclear power plant whose reactor is not permanently shut down, robustness could be enhanced by an integrated set of measures such as:

- (i) automated shutdown of the reactor upon initiation of a high-alert status at the plant, with provision for completion of the automated shutdown sequence if the control room is disabled;
- (ii) permanent deployment of diesel-driven pumps and pre-engineered piping to be available to provide emergency water supply to the reactor, the steam generators (at a PWR) and the spent fuel pool(s);
- (iii) re-equipment of the spent fuel pool(s) with low-density racks, excess fuel being stored in an onsite ISFSI; and
- (iv) construction of the ISFSI to employ hardened, dispersed, dry storage.

Damage Control

Damage-control measures are those that reduce the potential for a release of radioactive material from a facility following damage to that facility due to destructive acts of malice or insanity. Measures of this kind could be ad hoc or pre-engineered. One illustration of a damage control measure would be a set of arrangements for patching and restoring water to a spent fuel pool that has been breached. Many other illustrations can be provided. It appears, from the list of additional measures set forth in Section 2.3 of this report, that the NRC's recent orders have required licensees to undertake some planning for damage control following explosions or fires. Additional measures would be appropriate. For example, at a site housing one or more nuclear power plants and an ISFSI, the following damage-control measures could be implemented:

- (i) establishment of a damage control capability at the site, using onsite personnel and equipment for first response and offsite resources for backup;
- (ii) periodic exercises of damage-control capability;
- (iii) establishment of a set of damage-control objectives -- to include patching and restoring water to a breached spent fuel pool, fire suppression in the ISFSI, and provision of cooling to a reactor whose support systems and control room are disabled -- with accompanying plans; and
- (iv) provision of equipment and training to allow damage control to proceed on a radioactively-contaminated site.

Offsite Emergency Response

Emergency-response measures are those that reduce the potential for exposure of offsite populations to radiation, following a malice- or insanity-induced release of radioactive material from a nuclear facility. Measures in this category would in many respects be similar to emergency planning measures that are designed to accommodate "accidental" releases of radioactive material arising from human error, equipment failure or natural forces (e.g., earthquake). However, there are two major ways in which malice- or insanity-induced releases might differ from accidental releases. First, a malice- or insanity-induced release might be larger and begin earlier than an accidental release.¹²⁶ Second, a malice- or insanity-induced release might be accompanied by deliberate degradation of emergency response capabilities (e.g., the attacking group might block an evacuation route). Accommodating these differences could require additional measures of emergency response. Overall, an appropriate way to improve emergency-response capability at a nuclear-power-plant site could be to implement a model emergency response plan that was developed by a team based at Clark University in Massachusetts.¹²⁷ This model plan was specifically designed to accommodate radioactive releases from spent-fuel-storage facilities, as well as from reactors. That provision, and other features of the plan, would provide a capability to accommodate both accidental releases and malice- or insanity-induced releases. Major features of the model plan include:¹²⁸

¹²⁶ Present plans for emergency response do not account for the potential for a large release of radioactive material from spent fuel, as would occur during a pool fire. The underlying assumption is that a release of this kind is very unlikely. That assumption cannot be sustained in the present threat environment.

¹²⁷ Golding et al, 1992.

¹²⁸ Ibid, pp 8-13.

- (i) structured objectives;
- (ii) improved flexibility and resilience, with a richer flow of information;
- (iii) precautionary initiation of response, with State authorities having an independent capability to identify conditions calling for a precautionary response¹²⁹;
- (iv) criteria for long-term protective actions;
- (v) three planning zones, with the outer zone extending to any distance necessary¹³⁰;
- (vi) improved structure for accident classification;
- (vii) increased State capabilities and power;
- (viii) enhanced role for local governments;
- (ix) improved capabilities for radiation monitoring, plume tracking and dose projection;
- (x) improved medical response;
- (xi) enhanced capability for information exchange;
- (xii) more emphasis on drills, exercises and training;
- (xiii) improved public education and involvement; and
- (xiv) requirement that emergency preparedness be regarded as a safety system equivalent to in-plant systems.

4.5 A Strategy for Robust Storage of Spent Fuel

The preceding section of this report sets forth a defense-in-depth strategy for nuclear facilities. This strategy could be implemented at every civilian nuclear facility in the United States. Within the context of that strategy, it would be necessary to establish a nationwide strategy for the robust storage of spent fuel. The strategy must protect all spent fuel that has been discharged from a reactor but has not been emplaced in a repository. Available options for storing this fuel are wet storage in pools and dry storage in ISFSIs.

Timeframe for a Robust-Storage Strategy

As pointed out in Section 2.1 of this report, thousands of tonnes of US spent fuel will remain in interim storage for decades, even if a repository opens at Yucca Mountain. If a repository does not open, the entire national inventory of spent fuel will remain in interim storage for many decades. Thus, the robust-storage strategy for spent fuel must minimize the overall risk of interim storage throughout a period that may extend for 100 years or longer.

¹²⁹ A security alert could be a condition calling for a precautionary response.

¹³⁰ The inner and intermediate zones would have radii of 5 and 25 miles, respectively. As an example of the planning measures in each zone, potassium iodide would be pre-distributed within the 25-mile zone and made generally accessible nationwide.

Moreover, this interim storage strategy must be compatible with the eventual emplacement of the spent fuel in a repository in a manner that minimizes long-term risk.

Reactor Risk and Spent-Fuel Risk

This report focusses on the risk of a radioactive release from spent fuel. It also, by necessity, discusses the risk of a similar release from a reactor. These risks are closely intertwined in two practical ways. First, many scenarios for a spent-fuel-pool fire involve interactions between the affected pool(s) and the reactor(s) on the site. Second, the security of an at-reactor ISFSI is an adjunct to the security of a nuclear-power-plant site.

A robust-storage strategy for spent fuel could substantially reduce the risk of a radioactive release from spent fuel, at a comparatively low cost. Given the design of US nuclear power plants, there is no obvious strategy for achieving a comparable reduction in reactor risk. Thus, even if a defense-in-depth strategy is implemented for every reactor, a substantial fraction of the present reactor risk will continue to exist as long as the reactors continue to operate.

What should be the risk target for a robust-storage strategy? There are three major considerations that argue for seeking a spent-fuel risk that is substantially lower than the reactor risk. First, measures are available for substantially reducing the spent-fuel risk at a comparatively low cost. Second, storing spent fuel creates no benefit to offset its risk, whereas reactors generate electricity. Third, spent fuel may be in interim storage for 100 years or longer, whereas the present reactors will operate for at most a few more decades.

Elements of a Robust-Storage Strategy

From Sections 4.2 and 4.3 of this report, it is evident that storing spent fuel in high-density pools poses a very high risk. Dry storage of spent fuel, even employing the present practice that is described in Section 2.3, poses a lower risk. Thus, a robust-storage strategy must assign its highest priority to re-equipping each spent fuel pool with low-density racks, in order to reduce the pool's inventory of fuel and to prevent self-ignition and burning of fuel if water is lost from the pool.¹³¹ The excess fuel, for which space would no longer be available in pools, would be transferred to ISFSIs. When a nuclear power plant is shut down, the fuel remaining in its pool(s) would be transferred to an ISFSI after an appropriate period of cooling. These steps would dramatically reduce the overall risk of spent-fuel storage. A further,

¹³¹ Further protection of the spent fuel that remains in pools could be provided by a variety of site-security, facility-robustness and damage-control measures of the kind that are described in Section 4.4 of this report.

substantial reduction of the overall risk would be obtained by employing hardened, dispersed, dry storage at every ISFSI.

Figure 1, on the following page, shows how a robust-storage strategy for spent fuel would operate in a larger context. The robust-storage strategy would have the three elements represented by the three boxes at the base of the figure: low-density pools; hardened dry-storage modules; and dispersed dry-storage modules. In turn, the robust-storage strategy would be one of the elements of facility robustness, which itself would be one of four components of a defense in depth for US civilian nuclear facilities. This defense would contribute to homeland security and national security.

Away-from-Reactor ISFSIs

In a robust-storage strategy, any ISFSI would employ hardened, dispersed dry storage. The essential principles would be the same whether the ISFSI is at a nuclear-power-plant site or at another site such as Skull Valley.

Section 2.1 of this report discusses factors that argue against shipping spent fuel to an away-from-reactor ISFSI. Some of these factors are economic in nature. However, three factors affect the overall risk of interim storage. First, shipment to an away-from-reactor ISFSI would increase the overall transport risk, because fuel would be shipped twice, first from the reactor site to the ISFSI, and then from the ISFSI to the ultimate repository. Second, an away-from-reactor ISFSI would hold a comparatively large inventory of spent fuel, creating a potentially attractive target for an enemy. Third, there is a risk that a large, away-from-reactor ISFSI would become, by default, a permanent repository, despite having no long-term containment capability. These three factors must be considered in minimizing the overall risk of interim storage.

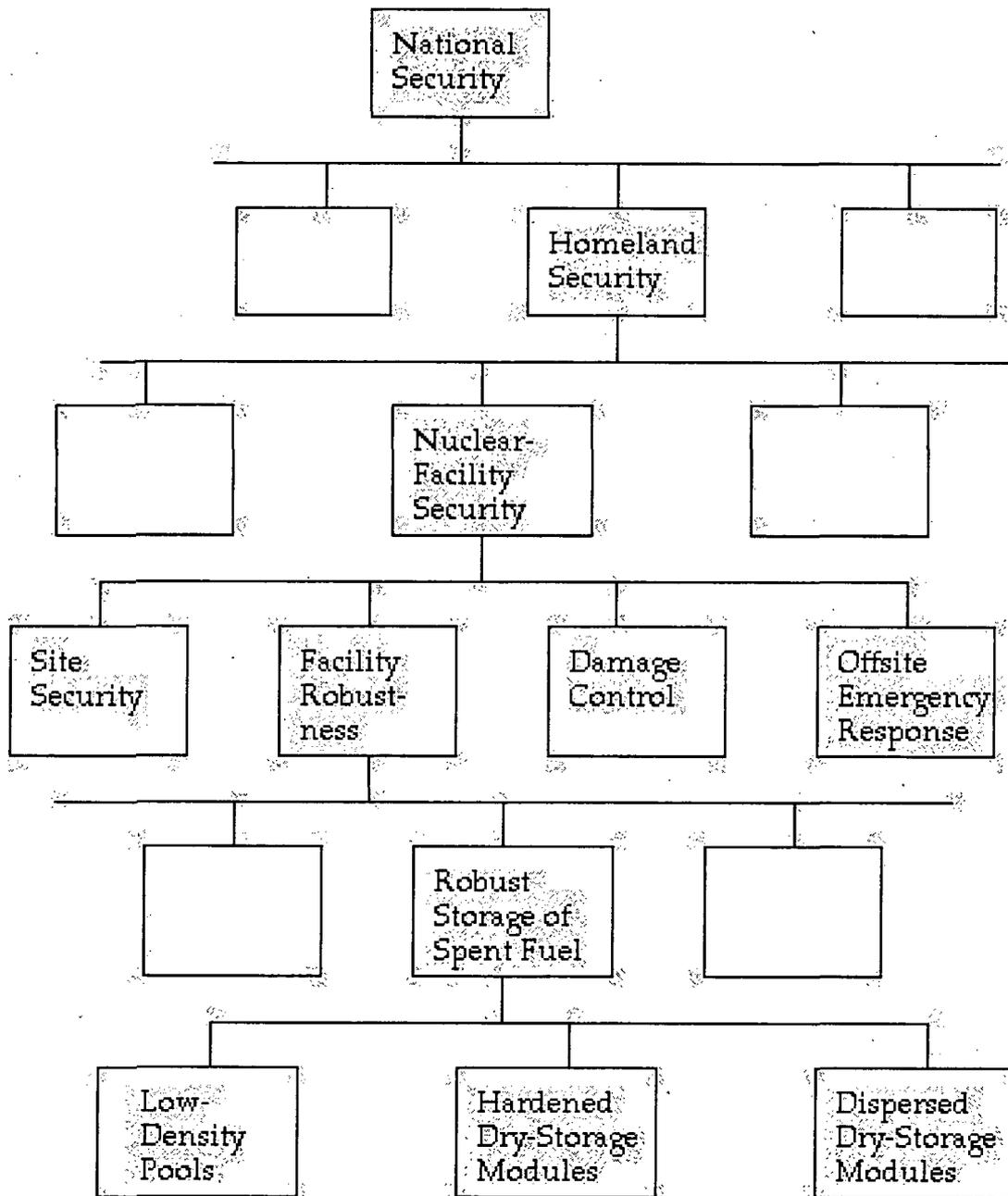


FIGURE 1

**ROBUST STORAGE OF SPENT FUEL
IN THE CONTEXT OF NATIONAL SECURITY**

5. Considerations in Planning Hardened, Dispersed, Dry Storage

5.1 Balancing Short- and Long-Term Risks

Interim storage of spent fuel could lead to eventual emplacement of the fuel in a repository at Yucca Mountain. In this case, fuel would remain in interim storage for several decades. That period is long enough to require action to reduce the very high risk that is posed by pool storage, and the smaller but still significant risk that is posed by unhardened, undispersed ISFSIs. However, in this case the long-term risk posed by spent-fuel management would not be relevant to interim storage. The long-term risk, which will be significant for many thousands of years, would be associated with the Yucca Mountain repository.

Avoiding a Repository by Default

If a repository does not open, a different problem will arise. That problem is the possibility that society will extend the life of interim-storage facilities until they become, by default, repositories for spent fuel. These facilities would function poorly as repositories, and the environment around each facility would become contaminated by radioactive material leaking from the facility. This outcome would pose a substantial long-term risk. The prospect of society acting in this improvident manner may seem far-fetched, but becomes more credible when one examines the history of the Yucca Mountain project. That project is politically driven, and is going forward only because previously-specified technical criteria for a repository have been abandoned.¹³²

Any current planning for the implementation of interim storage must account for the possibility that a repository will not open at Yucca Mountain. Thus, the design approach that is adopted for a hardened, dispersed, dry-storage ISFSI must balance two objectives. The first objective is that the facility should be comparatively robust against attack. The second objective is that the facility should not have features that encourage society to allow the facility to become, by default, a repository.

Consideration of the second objective dictates that the ISFSI should not, unless absolutely necessary, be located underground. Therefore, the first objective should be pursued through a design in which the ISFSI modules are stored at grade level (i.e., at the general level of the site). Hardening would then be achieved by placing steel, concrete, gravel or other materials above

¹³² Ewing and Macfarlane, 2002.

and around each module. The remaining protection would be provided by dispersal of the storage modules.

5.2 Cost and Timeframe for Implementation

As discussed in Section 2.1 of this report, forecasts show a rapid expansion in dry-storage capacity across the USA over the coming years. NAC International predicts that about 30 percent of US commercial spent fuel will be in dry-storage ISFSIs by 2010, as compared with 6 percent at the end of 2000. Vendors have developed a comparatively cheap technology for these ISFSIs, in response to industry preferences. This technology -- the overpack system -- involves the placement of spent fuel into thin-walled metal containers that are stored inside overpacks made primarily from concrete. The resulting modules are placed close together in large numbers on concrete pads in the open air. A preference for vertical-axis modules seems to be emerging.

Required Properties of Dry-Storage Modules

Re-equipping US spent fuel pools with low-density racks would create a large additional demand for dry-storage modules. This demand should be met as quickly as possible, in view of the very high risk that is posed by high-density pool storage. Also, the cost of the additional storage capacity should be minimized, consistent with the achievement of performance objectives. Thus, it is desirable that module designs already approved by the NRC be used. However, any module that is used for a hardened, dispersed ISFSI must be capable, when hardened, of resisting a specified attack. This requirement did not exist when module designs were approved by the NRC. Also, it is desirable that modules be capable of retaining their integrity for 100 years or more, which was not a requirement when module designs were approved by the NRC. A module that does not have a long-life capability may need to be replaced at some point if it is used in an ISFSI that serves for an extended period. Finally, the design of a module should allow for the eventual transport of spent fuel from an ISFSI to a repository.

Meeting the Requirements: Monolithic Casks versus Overpack Systems

Of the module designs already approved by the NRC, monolithic casks such as the CASTOR are probably more capable of meeting attack-resistance and long-life requirements than are modules that employ a thin-walled metal container inside a concrete overpack. However, monolithic casks are more expensive. Thus, it would be convenient if some of the cheaper and more widely-used module designs proved to be capable of meeting attack-resistance

and long-life requirements. This outcome would minimize the cost of offloading fuel from pools to hardened, dispersed dry storage, and would expedite this transition.

The development of detailed requirements for attack resistance and long life is a task beyond the scope of this report. Section 7 of the report sets forth a process for developing attack-resistance requirements, drawing upon experiments. When that process is completed, it will be possible to determine which of the already-approved module designs can be used for hardened, dispersed, dry storage.

5.3 Design-Basis Threat

The specification of a DBT for a nuclear facility inevitably reflects a set of tradeoffs. In the case of a hardened, dispersed, dry-storage ISFSI, five major considerations must be balanced. First, the ISFSI must protect spent fuel against a range of possible attacks. Second, the cost of the ISFSI should not be dramatically higher than the cost of an ISFSI built according to present practice. Third, the timeframe for building of the ISFSI should be similar to the timeframe for building an ISFSI according to present practice. Fourth, the ISFSI should not, unless absolutely necessary, be built underground. Fifth, it should be possible to construct an ISFSI of this kind at every US nuclear-power-plant site.

These considerations suggest a two-tier DBT for a hardened, dispersed, dry-storage ISFSI. This DBT might have the following structure:

Tier I

There should be high confidence that the release of radioactive material from the ISFSI to the environment would not exceed a small, specified amount in the event of a direct attack on any part of the ISFSI by:

- (i) a TOW missile;
- (ii) a specified manually-placed charge;
- (iii) a specified vehicle bomb;
- (iv) a specified explosive-laden general-aviation aircraft; or
- (v) a fuel-laden commercial aircraft.

Tier II

There should be reasonable confidence that the release of radioactive material from the ISFSI to the environment would not exceed a specified amount in

the event of a ground burst, at any part of the ISFSI, of a 10-kilotonne nuclear weapon.

5.4 Site Constraints

At each ISFSI site there will be a site-specific set of constraints on the development of a hardened, dispersed ISFSI. Some constraints will be political, financial or in some other non-physical category. Other constraints will be physical, reflecting the geography of the site. Of the physical constraints, the most significant will be the land area required for dispersal of dry-storage modules.

At many nuclear-power-plant sites, ample land area will be available for dispersal. At some, smaller sites, it may not be possible to achieve the desired degree of dispersal, but this deficiency might be compensated by increased hardening. At the smallest sites, it might be necessary to relax the requirement that the ISFSI should not be built underground. This step would allow a substantial increase in hardening, to offset the limited degree of dispersal that could be achieved. At especially-constricted sites, it might be necessary to ship some spent fuel from the site to an ISFSI elsewhere.

6. A Proposed Design Approach for Hardened, Dispersed, Dry Storage

An ISFSI design approach that offers a prospect of meeting the above-specified DBT involves an array of vertical-axis dry-storage modules at a center-to-center spacing of perhaps 25 meters. Each module would be on a concrete pad slightly above ground level, and would be surrounded by a concentric tube surmounted by a cap, both being made of steel and concrete. This tube would be backed up by a conical mound made of earth, gravel and rocks. Further structural support would be provided by triangular panels within the mound, buttressing the tube. The various structural components would be tied together with steel rods. Air channels would be provided, to allow cooling of the dry-storage module. These channels would be inclined, to prevent pooling of jet fuel, and would be configured to preclude line-of-sight access to the dry-storage module. Figure 2, on the following page, provides a schematic view of the proposed design.

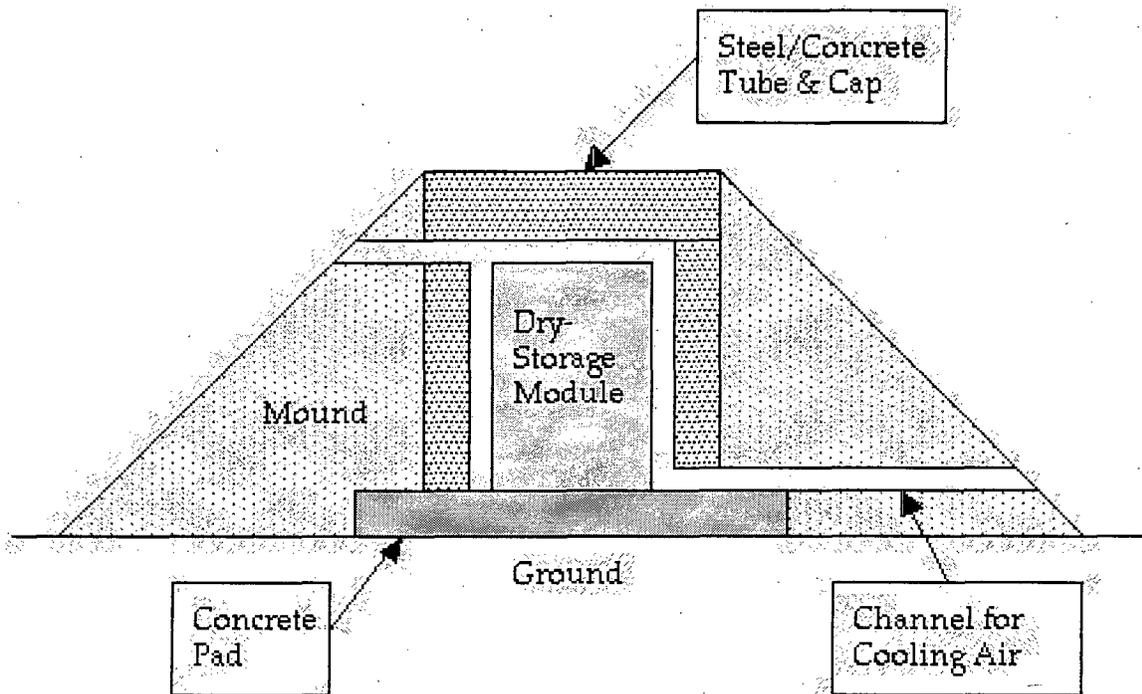


FIGURE 2

**SCHEMATIC VIEW OF PROPOSED DESIGN
FOR HARDENED, DRY STORAGE**

Notes

1. Cooling channels would be inclined, to prevent pooling of jet fuel, and would be configured to preclude line-of-sight access to the dry-storage module.
2. The tube, cap and pad surrounding the dry-storage module would be tied together with steel rods, and spacer blocks would prevent the module from moving inside the tube.
3. The steel/concrete tube could be buttressed by several triangular panels connecting the tube and the base pad.

Further analysis and full-scale experiments would be needed to determine whether this design approach, or something like it, could meet the DBT and other requirements that are set forth in Section 5, above. Ideally, these requirements could be met while using dry-storage modules that are approved by the NRC and are in common use. Another objective would be that the hardening elements (concentric tube, cap, tie rods, mound, etc.) could be built and assembled comparatively quickly and cheaply. These elements would not be high-technology items.

The Benefits of Dispersal

As an illustration of the benefits of dispersal, consider an attack on an ISFSI involving a ground burst of a 10-kilotonne nuclear weapon. In Section 4.2 of this report, it was noted that this attack could excavate a crater about 68 meters in diameter and 16 meters deep. If dry-storage modules had a center-to-center spacing of 5.5 meters, as is typical of present practice, about 120 modules could fall within the crater area and suffer destruction. However, if the center-to-center spacing were 25 meters, as is proposed here, only 6 modules could fall within the crater area and suffer destruction.

Site-Specific Tradeoffs

Within this design approach it would be possible to trade off, to some extent, hardening and dispersal. As suggested in Section 5.4, above, dispersal could be reduced and hardening could be increased at smaller sites. Detailed, site-specific analysis is needed to determine how such tradeoffs might work.

An alternative design approach might be used at a few sites where space is insufficient to allow wide dispersal. In this approach, a number of dry-storage modules would be co-located in an underground, reinforced-concrete bunker. Similar bunkers would be dispersed across the site to the extent allowed by the site's geography. At an especially-constricted site, it might be necessary to reduce the overall inventory of spent fuel in order to meet design objectives. Thus, some spent fuel from the site would be shipped to an ISFSI elsewhere.

7. Requirements for Nationwide Implementation of Robust Storage

7.1 Experiments on Vulnerability of Dry-Storage Options

Section 5.3 of this report outlines a DBT for hardened, dispersed, dry storage of spent fuel. Section 6 describes a design approach that offers a prospect of meeting a DBT of this kind, together with other requirements that are set forth in Section 5. Further investigation is needed to determine the extent to

which the various requirements can be met. This determination would be made at two levels. First, the investigation would determine if the DBT and other requirements set forth in Section 5 are broadly compatible with the proposed design approach or something like it. Second, assuming an affirmative determination at the first level, the investigation would go into more detail, exploring the various tradeoffs that could be made.

An essential part of this investigation would be a series of full-scale, open-air experiments. These experiments would be sponsored by the US government, and would be conducted at US government laboratories and testing centers. The experiments would involve a range of non-nuclear instruments of attack, including anti-tank missiles, manually-placed charges, vehicle bombs and aircraft bombs. Each instrument of attack would be tested against several test specimens that would simulate alternative design approaches for a hardened, dispersed ISFSI.

A separate set of experiments would be conducted in contained situations. These experiments would study the potential for release of radioactive material following penetration or prolonged heating of a fuel container.¹³³ Factors discussed in Section 4.2 of this report, such as the presence of zirconium hydride in fuel cladding, would be accounted for. The potential for auto-ignition of hydrided cladding when exposed to air deserves special attention in the experimental program, because this potential is relevant not only to the vulnerability of dry-storage modules, but also to the initiation of a fire in a spent-fuel pool.¹³⁴

7.2 Performance-Based Specifications for Robust Storage

The investigation called for in Section 7.1 would establish the technical basis for a set of performance-based specifications for hardened, dispersed, dry storage of spent fuel. These specifications would include a detailed, precise formulation of the DBT. Also included would be design guidelines for meeting the DBT, and an allowable range of design parameters within which tradeoffs could be made. The specifications would apply not only to the design of external, hardening elements, but also to dry-storage modules. Thus, some modification of the licensing basis for currently-licensed dry-storage modules may be required.

¹³³ The proposed experiments would simulate, among other events, an attack in which penetration of a fuel container is accompanied by incendiary effects.

¹³⁴ At the higher fuel burnups now commonly achieved, zirconium hydride forms in the fuel cladding. A potential for auto-ignition of zirconium hydride in air has been identified. See: Powers, 2000, page 3; Collins et al, 2000, page A1B-3.

Specifications for Low-Density Pool Storage

Performance specifications would also be required for the nationwide reversion to low-density pool storage. A primary objective would be to prevent the initiation of a pool fire in the event of a loss of water from a pool. This would be accomplished by reverting to low-density, open-frame racks that allow convective cooling of fuel by air or steam in the event of water loss, as discussed in Section 4.2. (Note: Low-density, open-frame racks would not necessarily preclude a pool fire after water loss if auto-ignition of zirconium hydride, as discussed in Section 7.1, could occur. Thus, it is important to empirically resolve the auto-ignition issue.)

At nuclear power plants with larger pools, reverting to low-density, open-frame racks will not conflict with other objectives. At plants with smaller pools, the pursuit of low density may conflict with other objectives, including: (i) preserving open spaces in the racks to allow offloading of the reactor core; (ii) allowing fuel to age for at least 5 years before transferring it to an ISFSI; and (iii) suppressing criticality of fresh or low-burnup fuel without relying on soluble boron in the pool water. Tradeoffs and technical fixes could resolve many of these conflicts.¹³⁵ New analysis, perhaps supplemented by some experiments, would establish the technical basis for performance specifications that include the necessary tradeoffs.

Establishing the Specifications

Establishing a comprehensive set of specifications for robust storage would call for the exercise of judgement. There is no purely objective basis for deciding upon one level of required performance as opposed to another. However, judgement must be exercised with full awareness of the wide-ranging implications of a particular choice. As discussed in Section 3 of this report, the defense of US nuclear facilities should be seen as a key component of homeland security and international security.

In view of the national importance of the needed set of specifications, these should be developed with the full engagement of stakeholders. Relevant stakeholders include citizen groups, local governments and state

¹³⁵ Examples of possible tradeoffs and technical fixes include: (i) relaxing the requirement to offload a full core; (ii) providing some high-density rack spaces for fresh fuel and core offload; (iii) relying on soluble boron in normal operation, with limited addition of unborated water if borated water is lost; (iv) adding some solid boron to rack structures while preserving an open-frame configuration; (v) relaxing the 5-year cooling period by partially filling some dry-storage modules or mixing younger fuel with older fuel in dry-storage modules; and (vi) shipping some fuel to plants with larger pools.

governments. Processes are available that could allow full engagement of stakeholders while protecting sensitive information.¹³⁶

7.3 A Homeland-Security Strategy for Robust Storage

A robust-storage strategy for US spent fuel would involve two major initiatives. The first initiative would be to re-equip the nation's spent-fuel pools with low-density racks and to provide other defense-in-depth measures to protect the pools. The second initiative would be to place all spent fuel, other than the residual amount that would then be stored in low-density pools, into hardened, dispersed, dry-storage ISFSIs.

Fast, effective implementation of this strategy would require decisive action by the US government. It would require expenditures that are comparatively small by national-security standards but are nonetheless significant. At present, there is no sign that the needed action will be taken. The US government in general seems largely unaware of the threat posed by the present practice of storing spent fuel. The NRC appears to be paralyzed, perhaps through fear of being criticized for its previous inattention to the threat of attack on nuclear facilities.

A new paradigm is needed, in which spent-fuel-storage facilities are seen as pre-deployed radiological weapons that await activation by an enemy. Correcting this situation is an imperative of national defense. If the NRC continues to undermine national defense, it should be bypassed. Citizens should insist that Congress and the executive branch promptly initiate a strategy for robust storage of spent fuel, as a key element of homeland security.

8. Conclusions

The prevailing practice of storing most US spent fuel in high-density pools poses a very high risk because knowledgeable attackers could induce a loss of water from a pool, causing a spent-fuel fire that would release a huge amount of radioactive material to the atmosphere. Nuclear reactors are also vulnerable to attack. Dry-storage modules used in ISFSIs have safety advantages in comparison to pools and reactors, but are not designed to resist a determined attack.

Thus, nuclear power plants and their spent fuel can be regarded as pre-deployed radiological weapons that await activation by an enemy. The US government in general and the NRC in particular seem unaware of this

¹³⁶ Thompson, 2002a, Sections IX and X.

threat. US nuclear facilities are lightly defended and are not designed to resist attack. This situation is symptomatic of an unbalanced US strategy for national security, which is a potentially destabilizing factor internationally.

A strategy for robust storage of US spent fuel is needed, whether or not a repository is opened at Yucca Mountain. This strategy should be implemented as a major element of a defense-in-depth strategy for US civilian nuclear facilities. In turn, that defense-in-depth strategy should be a component of a homeland-security strategy that provides solid protection of our critical infrastructure.

The highest priority in a robust-storage strategy for spent fuel would be to re-equip spent-fuel pools with low-density, open-frame racks. As a further measure of risk reduction, ISFSIs should be re-designed to incorporate hardening and dispersal. These measures should not be implemented in a manner such that an ISFSI may become, by default, a repository. Therefore, a hardened ISFSI should not, unless absolutely necessary, be built underground. Also, the cost and timeframe for implementing hardening and dispersal should be minimized. These considerations argue for the use, if possible, of dry-storage modules that are already approved by the NRC and are in common use.

Preliminary analysis suggests that a hardened, dispersed ISFSI meeting these criteria could be designed to meet a two-tiered DBT. The first tier would require high confidence that no more than a small release of radioactive material would occur in the event of a direct attack on the ISFSI by various non-nuclear instruments. The second tier would require reasonable confidence that no more than a specified release of radioactive material would occur in the event of attack using a 10-kilotonne nuclear weapon.

Three major requirements must be met if a robust-storage strategy for spent fuel is to be implemented nationwide. First, appropriate experiments are needed. Second, performance-based specifications for robust storage must be developed with stakeholder involvement. Third, robust storage for spent fuel must be seen as a vital component of homeland security.

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Introduction

This Worldwide Equipment Guide (WEG) serves as an interim guide for use in training, simulations, and modeling until the publication of FM 100-65, *Capabilities-Based Opposing Force: Worldwide Equipment Guide*. The WEG is designed for use with the FM 100-60 series of capabilities-based opposing force field manuals. It provides the basic characteristics of selected equipment and weapons systems readily available to the capabilities-based OPFOR, and generally listed in either *FM 100-61, Armor- and Mechanized-Based Opposing Force: Organization Guide* or *FM 100-63, Infantry-Based Opposing Force: Organization Guide*. Selected weapons systems and equipment are included in the categories of infantry weapons, infantry vehicles, reconnaissance vehicles, tanks/assault vehicles, antitank, artillery, air defense, engineer and logistic systems, and rotary-wing aircraft.

The pages in this WEG are designed for insertion into loose-leaf notebooks. Since this guide does not include all possible OPFOR systems identified in the OPFOR field manuals, equipment sheets covering additional systems not contained in this initial issue will be published periodically. Systems selected will be keyed directly to the baseline equipment contained in the 100-60 series and substitute systems found in the appropriate substitution matrix. The WEG is scheduled for eventual publication on the worldwide web for use by authorized government organizations.

WORLDWIDE OPFOR EQUIPMENT

Due to the proliferation of weapons through sales and resale, wartime capture, and licensed or unlicensed production of major end items, distinctions between equipment as friendly or OPFOR have blurred. Sales of upgrade equipment and kits for application to weapon systems have further blurred distinctions between old or obsolete systems and modern systems. This WEG describes base models listed in the FMs or upgrades of those base models, which reflect current capabilities. Many less common variants and upgrades are also addressed.

HOW TO USE THIS GUIDE

The WEG is organized by categories of equipment, in chapters. The format of the equipment pages is basically a listing of parametric data. This permits updating on a standardized basis as data becomes available. For meanings of acronyms and terms, see the Glossary. Please note that although most terms are the same as U.S. terminology, some reflect non-U.S. concepts and are not comparable or measurable against U.S. standards. For example, if an OPFOR armor penetration figure does not say RHA (rolled homogeneous armor), do not assume that is the standard for the figure. Please consult the Glossary often. If questions remain, contact this office.

Worldwide Equipment Guide

System names refer back to the field manuals. However, they also reflect intelligence community changes in naming methods. Alternative Designations include the manufacturer's name, as well as U.S./NATO designators. Note also that the WEG focuses on the complete weapon system (e.g., AT-4/5 antitank guided missile launcher or 9P148 ATGM launcher vehicle), versus a component or munition (9P135 launcher assembly or AT-4/5 ATGM).

Common and consistent technical notes and parameters are used in chapters 2 through 7, since the systems contained in those chapters have similar weapon and automotive technologies. Chapters 1 (Infantry Weapons), 8 (Engineer and Logistics) and 9 (Rotary-wing Aircraft) offer systems that have many unique parameters and therefore may not be consistent with those in other chapters.

We solicit your assistance in finding unclassified information which can be certified for use. Questions and comments on systems data should be addressed to the authors noted for each chapter. For questions concerning distribution to U.S. government organizations, please contact the local publications clerk, and:

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Units of Measure

The following symbols and abbreviations are used in this guide:

<u>Unit of Measure</u>	<u>Parameter</u>
(°)	degrees of slope/gradient, elevation, traverse
cal	caliber—(tube length in multiples of cannon bore)
GHz	gigahertz—frequency (GHz = 1 billion hertz)
hp	horsepower (kWx1.341 = hp)
Hz	hertz—unit of frequency
kg	kilogram(s) (2.2 lb.)
kg/cm ²	kg per square centimeter—pressure
km	kilometer(s)
km/h	km per hour
kW	kilowatt(s) (1 kW = 1,000 watts)
liters	liters—liquid measurement (1 gal. = 3.785 liters)
m	meter(s)—if over 1 meter use meters; if under use mm
m ³	cubic meter(s)
m ³ /hr	cubic meters per hour—earth moving capacity
m/hr	meters per hour—operating speed (earth moving)
MHz	megahertz—frequency (MHz = 1 million hertz)
min	minute(s)
mm	millimeter(s)
m/s	meters per second—velocity
mt	metric ton(s) (mt = 1,000 kg)
rd/min	rounds per minute—rate of fire
RHAe	rolled homogeneous armor (equivalent)
shp	shaft horsepower—helicopter engines (kWx1.341 = shp)
μm	micron/micrometer—wavelength for lasers, etc.

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Threat Support Directorate
Ft. Leavenworth, KS, 21 January 1999

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DISTRIBUTION RESTRICTION: Approved for public release; distribution is unlimited.

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Chapter 1 Infantry Weapons

This chapter provides the basic characteristics of selected infantry weapons either in use or readily available to the OPFOR and therefore likely to be encountered by U.S. forces in varying levels of conflict. The selection of weapons is not intended to be all inclusive, rather a representative sampling of weapons and equipment supporting various military capabilities.

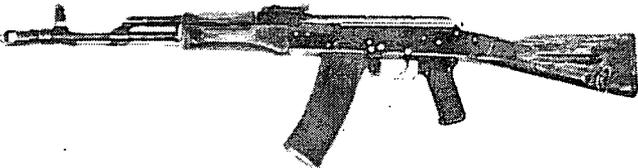
This chapter is divided into two categories—*small arms* and *recoilless weapons*. *Small arms* covers, in order, assault rifles, under-barrel grenade launchers, light machineguns, general purpose machineguns, heavy machineguns, and automatic grenade launchers. The second category, *recoilless weapons*, contains the US 106-mm Recoilless Rifle M40 and the Russian 73-mm Recoilless Gun SPG-9. This category also covers a rapidly growing segment of shoulder-fired (unguided) infantry weapons. While originally limited to shoulder-fired unguided antitank weapons such as the Russian 40-mm Antitank Grenade Launcher RPG-7, the utility of shoulder-fired weapons has expanded to include multi-purpose systems such as the Swedish 84-mm Recoilless Rifle Carl Gustaf M2. This field of weapons is often labeled “antitank” and also includes “bunker-buster” warheads, and weapons fired from close spaces such as the German 67-mm Disposable Antitank Grenade Launcher Armbrust.

Another emerging battle-tested, lethal, shoulder-fired weapon is the Russian Infantry Rocket Flame Weapon RPO-A Series (RPO-A/D/Z) capable of firing either a smoke, incendiary, or a thermobaric warhead to 600 meters. At 200 meters it is accurate to 0.5 m². The thermobaric warhead has a demolition effect corresponding to a round of 122-mm HE artillery. Due to the relative low cost, availability, versatility, transportability, trainability, and lethality of this category of infantry weapons, trainers should expect to encounter these systems in larger numbers with increasing levels of lethality, penetration, and utility. For information on guided antitank weapon systems see Chapter 5.

Questions and comments on data listed in this chapter should be addressed to:

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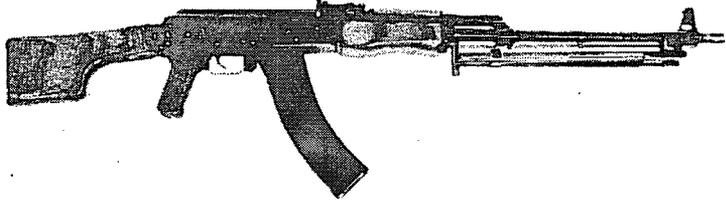
Russian 5.45-mm Assault Rifle AK-74

	<p>Ammunition Types</p> <p>5.45-mm cartridge Ball Ball-tracer Incendiary-T AP</p>	<p>Typical Combat Load</p> <p>300</p>
<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: 1974 Proliferation: Widespread</p> <p>Description: Weight (kg): Loaded (with magazine): 3.95 Empty (w/o magazine): 3.4 Length (mm): Overall: 880 (937 including muzzle brake) Barrel: 415 Rate of Fire (rd/min): Cyclic: 600 Practical: Automatic: 100 Semiautomatic: 40 Operation: Gas Feed: 30-rd detachable box magazine (40-rd used by RPK-74 LMG is interchangeable) Fire Mode: Selective, automatic or semi-automatic</p> <p>SIGHTS</p> <p>Name: INA Type: Fore, pillar; rear, U-notch Magnification: None Night Sights Available: Yes. AK-74M N3 mounts an NSPU-3</p>	<p>VARIANTS</p> <p>AKS-74: Folding-stock version with a Y-shaped, tubular stock. AK-74M: Improves the basic AK-74 design by adding a folding plastic stock, an improved mount for night vision or other sights. AKS-74U: Submachinegun: modified version with a much shorter barrel (207-mm) and a conical flash suppressor instead of a muzzle break. Its overall length is 492 with stock folded. AK-101: 5.56x45-mm (NATO) variant of the AK-74M. AK-102: 5.56x45-mm (NATO) short-barrel (314-mm) variant of the AK-74M. AK-103: 7.62x39-mm variant of the AK-74M. AK-104: 7.62x39-mm short-barrel (314-mm) variant of the AK-74M. AK-105: 5.45x39-mm short-barrel (314-mm) variant of the AK-74M.</p> <p>AMMUNITION</p> <p>Name: 7N6 Caliber/length: 5.45x39-mm Type: Ball Range (m): Effective: 500 Maximum: 800 Armor Penetration: INA Muzzle Velocity (m/s): 880</p> <p>Name: 7N10 Caliber/length: 5.45x39-mm Type: Armor piercing Range (m): Effective: INA for AK-74 (800 for RPK-74) Armor Penetration (mm): 16 @ 100 m 80% of time Muzzle Velocity (m/s): INA for AK-74 (960 for RPK-74)</p>	

NOTES

The AK-74 is basically an AKM rechambered and rebored to fire a 5.45-mm cartridge. The AK-74 can mount a 40-mm under-barrel grenade launcher and a passive image intensifier night sight. The AK-74 is also the basis for other 5.45-mm infantry weapons including the RPK-74 light machinegun.

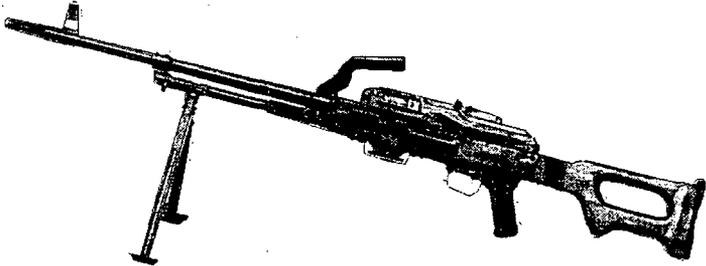
Russian 5.45-mm Light Machinegun RPK-74

	<p>Ammunition Types</p> <p>5.45-mm cartridge Ball Ball-tracer Incendiary-T AP</p>	<p>Typical Combat Load</p> <p>320</p>	
	<table border="1"> <tr> <td> <p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: Late 1970s Proliferation: Widespread</p> <p>Description: Weight (kg): Loaded (with magazine): 5.0 Empty (w/o magazine): 4.6 Length (mm): Overall: 1.07 m Barrel: 590 mm (including flash suppresser) Rate of Fire (rd/min): Cyclic: 600 Practical: Automatic: 150 Semiautomatic: 50 Operation: Gas Feed: 40-rd detachable box magazine (30-rd used by AK-74 is interchangeable) Fire Mode: Selective, automatic or semi-automatic</p> <p>SIGHTS</p> <p>Name: INA Type: Fore, cylindrical post; rear, tangent leaf with U-notch; adjustable to 1,000 m Magnification: None Night Sights Available: Yes. 1LH51 night sight</p> </td> <td> <p>VARIANTS</p> <p>RPKS-74: Folding stock</p> <p>AMMUNITION</p> <p>Name: 7N6 Caliber/length: 5.45x39-mm Type: Ball Range (m): Effective: 800 Maximum: 1,000 Armor Penetration: INA Muzzle Velocity (m/s): 960</p> <p>Name: 7N10 Caliber/length: 5.45x39-mm Type: AP Range (m): Effective: 800 Armor Penetration (mm): 16 @ 100 m 80% of time Muzzle Velocity (m/s): 960</p> </td> </tr> </table>		<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: Late 1970s Proliferation: Widespread</p> <p>Description: Weight (kg): Loaded (with magazine): 5.0 Empty (w/o magazine): 4.6 Length (mm): Overall: 1.07 m Barrel: 590 mm (including flash suppresser) Rate of Fire (rd/min): Cyclic: 600 Practical: Automatic: 150 Semiautomatic: 50 Operation: Gas Feed: 40-rd detachable box magazine (30-rd used by AK-74 is interchangeable) Fire Mode: Selective, automatic or semi-automatic</p> <p>SIGHTS</p> <p>Name: INA Type: Fore, cylindrical post; rear, tangent leaf with U-notch; adjustable to 1,000 m Magnification: None Night Sights Available: Yes. 1LH51 night sight</p>
<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: Late 1970s Proliferation: Widespread</p> <p>Description: Weight (kg): Loaded (with magazine): 5.0 Empty (w/o magazine): 4.6 Length (mm): Overall: 1.07 m Barrel: 590 mm (including flash suppresser) Rate of Fire (rd/min): Cyclic: 600 Practical: Automatic: 150 Semiautomatic: 50 Operation: Gas Feed: 40-rd detachable box magazine (30-rd used by AK-74 is interchangeable) Fire Mode: Selective, automatic or semi-automatic</p> <p>SIGHTS</p> <p>Name: INA Type: Fore, cylindrical post; rear, tangent leaf with U-notch; adjustable to 1,000 m Magnification: None Night Sights Available: Yes. 1LH51 night sight</p>	<p>VARIANTS</p> <p>RPKS-74: Folding stock</p> <p>AMMUNITION</p> <p>Name: 7N6 Caliber/length: 5.45x39-mm Type: Ball Range (m): Effective: 800 Maximum: 1,000 Armor Penetration: INA Muzzle Velocity (m/s): 960</p> <p>Name: 7N10 Caliber/length: 5.45x39-mm Type: AP Range (m): Effective: 800 Armor Penetration (mm): 16 @ 100 m 80% of time Muzzle Velocity (m/s): 960</p>		

NOTES

The RPK-74 is the machinegun version of the AK-74, firing the same ammunition. Instead of the prominent muzzle brake used on the AK-74, the machinegun is longer than that normally used with the AK-74, but the magazines are interchangeable. The RPK-74 has a bipod and is compatible with the front firing ports of BMPs. The RPK-74 is the standard squad machinegun in OPFOR infantry units. It generally replaces both the RPK and PKM 7.62-mm weapons.

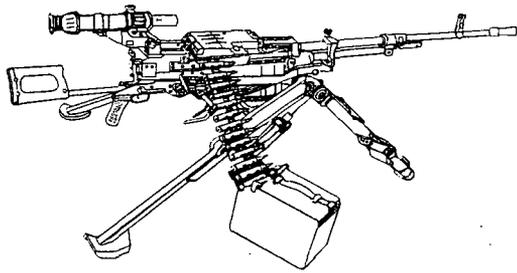
Russian 7.62-mm General Purpose Machinegun PKM

	<p>Ammunition Types</p> <p>7.62-mm cartridge Ball Ball-tracer Incendiary-ranging API API-T</p>	<p>Typical Combat Load</p> <p>INA</p>
<p>SYSTEM</p> <p>Alternative Designations: (see VARIANTS) Date of Introduction (PKM/PKT): 1971/1968 Proliferation: Widespread</p> <p>Description: Weight (kg): Empty (w/o magazine) (PKM/PKT) (kg): 8.4/10.66 Loaded (with magazine): Varies with magazine Ammo box (only) with 100/200-rd belt (kg): 3.9/8.0 Tripod (lightweight) (kg): 4.75 Length (mm): Overall (PKM/PKT): 1,160/1,080 On tripod (PKS): 1,267 Barrel: 658 Barrel Change: Yes Mount Type: Pintle, coaxial, bipod or tripod (Stepanov) Mounted On: (see VARIANTS) Rate of Fire (rd/min): Cyclic: 650 Practical: 250 Fire Mode: Automatic Operation: Gas Feed: Belt, 100-rd belt carried in a box fastened to the right side of the receiver. 25-rd belts can be joined in several combination lengths (100/200/250)</p>	<p>SIGHTS</p> <p>Name: INA Type: Open iron sights Sighting range (PKM/PKT) (m): 1,500/2,000 Magnification: None Night Sights Available: Yes</p> <p>VARIANTS</p> <p>PKM: Squad machinegun PKT: Tank-mounted coaxial, lacks stock, sights, bipod, has solenoid electric trigger, longer heavier barrel. PKS: Lightweight tripod-mounted infantry weapon PKMS: Lightweight tripod-mounted variant of the PKS PKB (PKBM): Pintle-mounted on APCs, SP guns, BRDM, BTRs, has butterfly trigger rather than solenoid, double space grips, and front and rear sights</p> <p>AMMUNITION</p> <p>Name: INA Caliber and Length: 7.62x54-mm rimmed Type: Ball Max Range (PKM/PKT) (m): 3,800/4,000 Practical Range (PKM/PKT) (m): Day: 1,000/2,000 Night: 300/INA Armor Penetration @ 0° obliquity @ 500 range (mm): 8 Muzzle Velocity (PKM/PKT) (m/s): 825/855</p>	

NOTES

The 7.62-mm general-purpose machinegun (PKM) is a gas-operated, belt-fed, sustained-fire weapon. The basic PKM is bipod-mounted but can also fit in vehicle firing ports. It is constructed partly of stamped metal and partly of forged steel. Compared to the US M-60, the PK-series machineguns are easier to handle during firing, easier to care for, and lighter. The 7.62x54R is a more powerful cartridge than the US with a slightly shorter effective range.

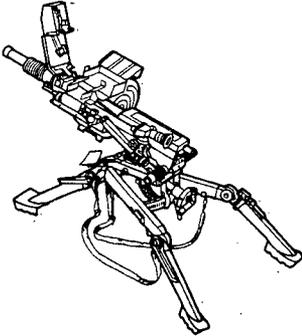
Russian 12.7-mm Heavy Machinegun NSV/NSV-T

	<p>Ammunition Types</p> <p>12.7-mm cartridge API (B-32) API-T (BZT-44) HEI</p>	<p>Typical Combat Load:</p> <p>300</p>
<p>SYSTEM</p> <p>Alternative Designations: NSVS (tripod-stand mounted), Utyos Date of Introduction: Early 1970s Proliferation: Widespread</p> <p>Description: Weight (kg): Total System (w/6T7): 43 Empty: 25 Loaded: INA Tripod (6T7 tripod): 16 Length (mm): Overall: 1,560 On 6T7 Tripod: 1,900 Width (on 6T7 tripod) (mm): 860 Height (on 6T7 tripod) (mm): 380 Barrel Life (rds): 5,000 Barrel Change Time (sec): 5 Barrel Weight (kg): 9.2 Mount Type: 6T7 (infantry) tripod or 6U6 (w/seat) universal tripod Mounted On: (see VARIANTS) Traverse (°): 360 Elevation (°): -5 to +75 Rate of Fire (rd/min): Cyclic: 680-800 Practical: 100 Fire Mode: Automatic; short bursts (four to six) or long bursts (10 to 15) or continuously Operation: Gas Feed: Left or right from metal link belt from 50-rd boxes</p>	<p>SIGHTS</p> <p>Name: INA Type: Metallic sights, (tangent leaf rear and folding front post) Sight Range (m): 2,000 Name: 10P50 Optical Type: Day optical sight Magnification: 3-6x Name: 1PN52-1 Type: Night sight Magnification: 5.3x Name: 10P80 (used w/ 6U6 mount) Type: AA collimating sight (aircraft speed to 300 km/h) Name: 10P81 (used w/ 6U6 mount) Type: Ground target sight Name: K10-T (on NSVT for T-72/T-80) Type: Reflex AA sight</p> <p>VARIANTS</p> <p>NSVT: Tank-mounted, (see NOTES)</p> <p>AMMUNITION</p> <p>Name: B-32 Caliber and Length: 12.7x108-mm Type: Armor Piercing Incendiary Max Range (ground) (m): 7,850 Effective Range (m): AA: 1,000 Ground: 2,000 Armor: 800 Night (w/1PN52-1): 1,000 Armor Penetration @ 0° obliquity @ 500/1,000m range (mm): 20/13.2 Muzzle Velocity (m/s): 860</p>	

NOTES

A tripod-mount (6T7) version is available for infantry use in a ground role. However, the NSVT appears more commonly mounted on the turrets of tanks as an anti-aircraft machinegun. On the T-72 and the T-80, it has a rotating mount and can be fired from within the tank. The tank commander employs the K10-T reflex sight to engage aircraft. On the T-72/T-80 mount he engages ground targets with metallic sights on the gun itself. The T-64 tank mounts a modified version with a fixed mount on the commander's cupola. It fires by means of an electrical solenoid when the tank is buttoned up. An optic serves this purpose. Instead of the normal 50-round ammunition belt container, the NSVT on the T-64 may use a larger belt container holding 200 rounds.

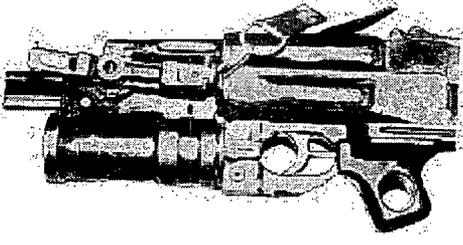
Russian 30-mm Automatic Grenade Launcher AGS-17

	<p>Ammunition Types</p> <p>30-mm grenade Frag-HE</p>	<p>Typical Combat Load (Dismounted)</p> <p>87</p>
<p>SYSTEM</p> <p>Alternative Designations: Plamya (Flame) Date of Introduction: 1974 Proliferation: At least 12 countries</p> <p>Description: Crew: 3 (see NOTES) Weight (kg): Empty (without magazine): 30.71 Loaded (with magazine): 45.05 Launcher: 17.86 Sight: .99 Tripod: 11.86 Magazine (loaded): 14.34 Length (m): 1.28 Height (m): INA Width (m): INA Tripod Name: SAG-17 Mounts: Tripod, vehicle, or helicopter Traverse (°): 30 total Elevation (°): +7 to +87 Service Life of Barrel (rds): 6,000 Barrel Change Time: Quick disconnect Rate of Fire (rd/min): Practical: 60-100 Cyclic: 100-400 Adjustable with a thumb safety. May be fired single shot or in short (≤ 5 rds) or long (6-10 rds) bursts. Operation: Blowback Feed: Drum magazine containing 29 round belt. Fire Mode: Selective, automatic and semi-automatic Loader Type: Manual</p>	<p>SIGHTS</p> <p>Name: PAG-17 Type: Illuminated day optical sight Sighting Range (m): 1,700 Magnification: 2.7x Location: Left rear of launcher Night Sights Available: Yes</p> <p>VARIANTS</p> <p>AG-17: Vehicle mounted. AG-17A: Helicopter mounted, electric trigger, rate of fire increased to 420-500 rd/min, 300 rd belt. TKB-722K AGL: Lighter version and possibly the follow-on to the AGS-17, shoots the same ammunition as the AGS-17</p> <p>AMMUNITION</p> <p>Name: VOG-17A, VOG-17M (self-destruct) Caliber/length: 30x132.8-mm Type: Frag-HE Range (m) Direct Fire Range (m): 700 Effective (m): 1,200 Min Range (m): 50 Max Indirect Range (m): 1,730 Armor Penetration: Lightly armored vehicles. Accuracy @ 400 m: Distance: 4.3 m Deflection: .2 m Casualty Radius (m): 15 (90% at 7 m) Complete Round Weight (grams): 350 Grenade Weight (grams): 280 Warhead Explosive Weight (grams): 36 Muzzle Velocity (m/s): 185 Fuze Type: Impact, activates after 25 spins.</p>	

NOTES

The AGS-17 provides the infantry with an area suppressive capability. One AGL can create a damage zone 15 meters wide. The fire from an AGL platoon covers a sector approximately 90 m across. Although primarily intended for use against personnel, it has a limited capability to engage lightly armored vehicles. The crew consists of a gunner and two riflemen-assistant gunners, and may have an additional ammunition bearer. For ground transport the AGS-17 breaks down into four parts: launcher, sight, tripod, and magazine. When dismounted the gunner carries the sight and launcher, the first assistant carries the tripod and a magazine, and the second assistant carries two additional magazines. It is very accurate in the semiautomatic mode and is quite effective in area coverage in the automatic mode. The 50-meter increments in the range table atop the receiver indicate accuracy against point targets. The AGS-17 is normally organized in a platoon consisting of 6 launchers, carried in pairs in three armored vehicles (they can also be carried in trucks, or by individuals). The AGS-17 is capable of mounting night vision sights.

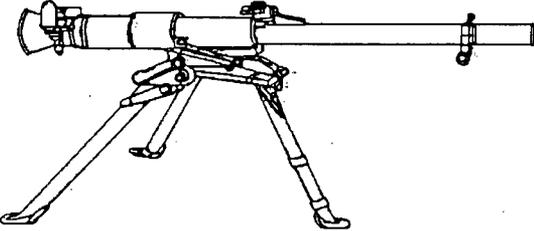
Russian 40-mm Under-Barrel Grenade Launcher GP-30

	<p>Ammunition Types</p> <p>40-mm grenade Frag-HE (impact) Frag-HE (bounding) Smoke</p>	<p>Typical Combat Load</p> <p>10</p>
<p>SYSTEM</p> <p>Alternative Designations: BG-15 Mukha; GP-25 Koster, GP-30 Obuvka Date of Introduction: 1980 Proliferation: Widespread</p> <p>Description: Weight (kg): Loaded: 1.79 Empty: 1.5 Length (mm): Overall: 323 Barrel: 205 Rate of Fire (rd/min): 4-5 Operation: N/A Feed: Muzzle-loaded Fire Mode: Single-shot Accuracy @ 400 m: Distance: 6.7 m Deflection: 3 m Components: Barrel (w/ mounting bracket and sight), trigger assembly</p> <p>SIGHTS</p> <p>Name: N/A Type: Front post and rear open U-notched Location: Left side of mounting bracket Sighting Range (m): Graduated out to 400</p> <p>VARIANTS</p> <p>BG-15, GP-25: (see NOTES)</p>	<p>AMMUNITION</p> <p>Name: VOG-25 Caliber/length: 40x102-mm Type: Frag-HE with impact fuze Weight (kg): Round: .250 Exposive: .048 Range (m): Maximum: 400 Minimum: 10-40 (arms itself) Casualty Radius (m): 6; (90% @ 10) Self-destruct Time (sec): 14-19 Muzzle Velocity (m/s): 76</p> <p>Name: VOG-25P Caliber/length: 40x122-mm Type: Bounding Frag-HE, explodes .5 to 1.5 m from impact Weight (kg): Round: .278 Exposive: .037 Range (m): Maximum: 400 Minimum: 10 - 40 (arms itself) Casualty Radius (m): 6; 90% @ 10 Self-destruct Time (sec): 14 - 19 Muzzle Velocity (m/s): 75</p> <p>Name: GRD-40 Caliber/length: 40x150-mm Type: Smoke Effective Against: Visual and infrared Weight (g): 260 Smoke Screening Range (m): 50, 100, 200 Smoke Screen Dispersion (m): 1 sec..... 10x10x10 2 sec..... 20x20x20 3 sec..... 25x25x25 Smoke Screen Duration @ wind speed of 3-5 m/s: At least 60 sec Muzzle Velocity (m/s): 70-75</p>	

NOTES

The GP-30 Obuvka is a widely proliferated, muzzle-loaded, single-shot, detachable, under-barrel grenade launcher. The BG-15, GP-25 and the GP-30 are all basically the same weapon. Variants can be mounted on all models of Kalashnikov assault rifles. The rifleman can fire the launcher only when the complete weapon is attached to the assault rifle.

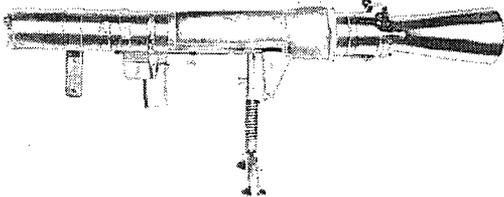
Russian 73-mm Recoilless Gun SPG-9

	<p>Ammunition Types</p> <p>73-mm recoilless gun RA HEAT RA HE</p>	<p>Typical Combat Load</p> <p>INA</p>
<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: 1970 Proliferation: Widespread</p> <p>Description: Crew: 3 Caliber (mm): 73 Weight (kg): Firing Position: 47.5 Travel Position: 47.5 Tripod: 12 Length (travel) (m): 2.11 Width (travel) (m): .99 Height (travel) (m): .80 Rifling: None Breech Mechanism Type: Interrupted screw Feed: Breech load Traverse (°): 30 total Elevation (°): -3 to +7 Rate of Fire (rd/min): 6 Emplacement/displacement time (min): 1 Fire From Inside Building: No</p>	<p>SIGHTS</p> <p>Name: PGO-9 Type: Optical and iron Magnification: Optical 4x, 10° field of view Location: Left side Sighting Range (m): 1,300 Night Sights Available: IR and passive night, PGN-9</p> <p>VARIANTS</p> <p>SPG-9D: Airborne version with detachable wheels</p> <p>AMMUNITION</p> <p>Range (m): Maximum Effective: HEAT: 1,000 HE: 1,300 Minimum: INA Armor Penetration (mm) @ 1,000 m: 400 (HEAT any range) Casualty Radius (m): INA Length (mm): 1,000 Complete Round Weight (kg): Rocket-Assisted HEAT: 3.5 Rocket-Assisted HE: 4 Muzzle Velocity (m/s): 435 Max Velocity w/rocket assist (m/s): 700</p>	

NOTES

The SPG-9 is a recoilless, smooth-bore, single-shot antitank weapon that fires both antiarmor and antipersonnel ammunition. Several generations of night vision equipment are available for the SPG-9. It is manportable, but a truck or APC normally carries it. It must be dismounted and placed on its tripod for firing.

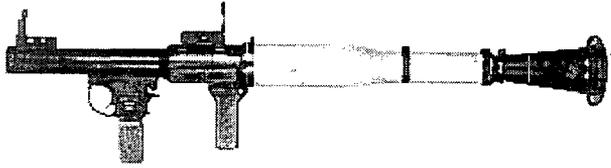
Swedish 84-mm Recoilless Rifle Carl Gustaf M2

	<p>Ammunition Types</p> <p>84-mm round HEAT (tandem) HEDP HEAT HE Smoke Illumination</p>	<p>Typical Combat Load</p> <p>INA</p>
<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: INA Proliferation: At least 20 countries Description: Crew: 1 or 2 (see NOTES) Caliber (mm): 84 Weight (kg): Mount: .8 M2: 14.2 M3: 8.5 Length (mm): 1,065 Rifling: 24 lands/progressive twist Breech Mechanism Type: Hinged Rate of Fire (rd/min): 6 Fire From Inside Building: INA</p> <p>SIGHTS</p> <p>Name: INA Type: Iron and telescoped Magnification: 3x Location: Left side Weight (kg): 1 Used With Range Finders: Yes, laser Night Sights Available: May be used with Generation III Image Intensification Systems.</p> <p>VARIANTS</p> <p>M3: Lightweight version of the M2</p> <p>AMMUNITION</p> <p>Name: FFV 751 Type: HEAT (tandem) Range (m): Effective: 500 Minimum: INA Moving: INA Penetration: Armor (mm): +500 Weight (kg): 4</p>	<p>Name: FFV 502 Type: HEDP (with dual mode fuze) Range (m): Effective (personnel in open): 1,000 Effective (stationary): 500 Moving: 300 Arming Range: 15-40 Penetration: Armor (mm): +150 Weight (kg): 3.3 Muzzle Velocity (m/s): 230</p> <p>Name: FFV 551 Type: HEAT Range (m): Effective: 700 Arming Range: 5-15 Penetration: Armor (mm): 400 Weight (kg): 3.2 Muzzle Velocity (m/s): 255</p> <p>Name: FFV 441B Type: HE Range (m): Effective (unprotected troops, soft-skinned vehicles): 1,100 Arming Range: 20-70 Casualty Radius (m): INA Weight (kg): 3.1 Muzzle Velocity(m/s): 240</p> <p>Name: FFV 469B Type: Smoke Range (m): Effective: Up to 1,300 Weight (kg): 3.1 Muzzle Velocity (m/s): 240</p> <p>Name: FFV 545 Type: Illumination Range (m): Practical: 300-2,100 Burning Time (sec): 30 Illuminated Area, dia: 400-500 Candle Power: 650,000 cd Weight (kg): 3.1 Muzzle Velocity (m/s): 260</p>	

NOTES

The 84-mm Carl Gustaf recoilless rifle is a one-man portable, direct-fire, single-shot, breech-loading weapon. Several versions of the Carl Gustaf are produced outside Sweden; however, the ammunition is interchangeable among the variants. While the weapon can be operated by one person it is better to have two—one to fire the gun, and the other to carry and load the ammunition. In addition to its antitank role, the weapon can be used as part of an illumination plan, to provide smoke, or for bunker busting.

Russian 40-mm Antitank Grenade Launcher RPG-7V

	Ammunition Types 40-mm grenade PG-7V PG-7VM PG-7VS PG-7VL PG-7VR TBG-7V OG-7V OG-7VM	Typical Combat Load 5
<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: 1962 Proliferation: At least 40 countries</p> <p>Description: Crew: 2 Caliber (launcher) (mm): 40 Weight (kg): Empty: 7.9 Loaded: Varies with grenade Length (mm): 950 Rate of Fire (rd/min): 6 Fire From Inside Building: No Grenade Components: Warhead, rocket motor, tail assembly</p> <p>SIGHTS</p> <p>Name: PGO-7 Type: Optical w/II Magnification: 2.7x, 13° field of view Location: Top of launcher/sight-left side Sighting Range (m): 500 Night Sights Available: Yes, NSP-3, NSP-2 (IR), NSPU, PGN-1 (II), IPN58 (II)</p> <p>VARIANTS RPG-7D, RPG-7DV1: Folding variants used by airborne troops</p> <p>AMMUNITION</p> <p>Name: PG-7V Caliber (mm): 85 Type: HEAT Range (m): Effective: 500 Minimum: INA Moving: 300 Penetration: Armor (mm): 330 Length (mm): INA Weight (kg): 2.2</p>	<p>Name: PG-7VM Caliber (mm): 70.5 Type: INA Range (m): Effective: 500 Minimum: INA Penetration: Armor (mm): 330 Muzzle Velocity (m/s): 140 Length (mm): 950 Weight (kg): 2</p> <p>Name: PG-7VS Caliber (mm): 72 Type: INA Range (m): Effective: 500 Minimum: INA Penetration: Armor (mm): INA Brick (m): + 1.5 Reinforced concrete (m): + 1 Casualty Radius (m): INA Muzzle Velocity (m/s): INA Length (mm): INA Weight (kg): 2</p> <p>Name: PG-7VL Caliber (mm): 93 Type: INA Range (m): Effective: 300 Minimum: INA Penetration: Armor (mm): 600 Brick (m): 1.7 Reinforced concrete (m): + 1.1 Muzzle Velocity (m/s): 112 Length (mm): 980 Weight (kg): 2.6</p>	

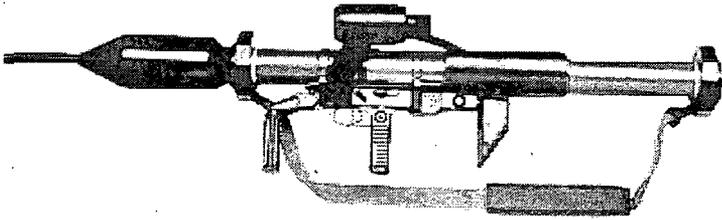
NOTES

The RPG-7V is a recoilless, shoulder-fired, muzzle-loaded, reloadable, antitank grenade launcher. It fires a variety of rocket-assisted grenades from a 40-mm smoothbore launcher tube. It is the standard squad antitank weapon in use by the OPFOR. The RPG-7V is light enough to be carried and fired by one person. However, an assistant grenadier normally deploys to the left of the gunner to protect him from small arms fire. The RPG-7V requires a well-trained gunner to estimate ranges and lead distances for moving targets. Crosswinds as low as 7 miles per hour can complicate the gunner's estimate and reduce first-round hit probability to 50% at ranges beyond 180 meters.

Russian Antitank Grenade Launcher RPG-7V continued

<p>Name: PG-7VR (uses RPG-7V1 launcher sights) Caliber (mm): 105 Type: Tandem Range (m): Effective: 200 Minimum: INA Sighting Range: INA Penetration: Armor (mm): +750 (all armor including reactive armor) Brick (m): 2 Reinforced concrete (m): +1.5 Muzzle Velocity (m/s): INA Length (mm): 1,306 Weight (kg): 4.5</p> <p>Name: TBG-7V (uses RPG-7V1 launcher sights) Caliber (mm): 105 Type: Thermobaric (similar to RPO-A warhead) Range (m): Effective: 200 Sighting Range: 800 Penetration: Armor (mm): INA Brick (m): +1.5 Reinforced concrete (m): + 1.5 Casualty Radius (m): INA Muzzle Velocity (m/s): INA Length (mm): INA Weight (kg): 4.5</p>	<p>Name: OG-7V Caliber (mm): 40 Type: Frag-HE Range (m): Effective: 950 Casualty Radius (m): INA Muzzle Velocity (m/s): 152 Length (mm): 569 Weight (kg): 1.7</p> <p>Name: OG-7VM Caliber (mm): 40 Type: Frag-HE Range (m): Effective: 1,000 Casualty Radius (m): INA Muzzle Velocity (m/s): 145 Length (mm): 595 Weight (kg): 1.7</p>
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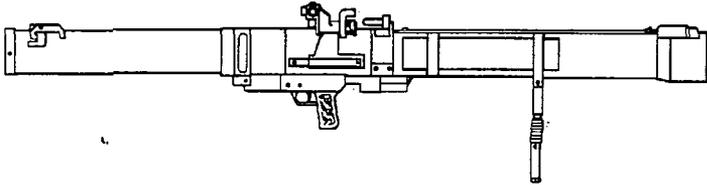
German 60-mm Antitank Grenade Launcher Panzerfaust-3

	<p style="text-align: center;">Ammunition Types</p> <p>60-mm grenade HEAT Multipurpose-FRAG BASTEG Illumination Smoke Practice</p>	<p style="text-align: center;">Typical Combat Load</p> <p style="text-align: center;">INA</p>
<p>SYSTEM</p> <p>Alternative Designations: Balliste, Pzf 3 Date of Introduction: 1990 Proliferation: At least eight countries.</p> <p>Description: Crew: 1 Caliber (mm): Launch Tube: 60 Warhead: 110 Weight (kg): 12 Length (mm): Firing Position: 1,200 Travel Position: 1,200 Rifling: None Breech Mechanism Type: N/A Rate of Fire (rd/min): 5 Fire From Inside Building: Yes</p> <p>SIGHTS</p> <p>Name: INA Type: Optical Magnification: INA Location: Left side Used With Range Finders: Yes Night Sights Available: Yes</p> <p>VARIANTS</p> <p>Panzerfaust 3-T 600: Simrad IS2000 laser gun sight with range of moving targets out to 600 m. Can be fitted with Simrad KN205F night sights.</p>	<p>AMMUNITION</p> <p>Name: INA Caliber (mm): 110 Type: HEAT Range (m): Effective (moving): 300 Effective (stationary): 500 Penetration: Armor (mm): + 700 Weight (kg): 3.8 Muzzle Velocity(m/s): 170 Flight Velocity(m/s): 250 Time of Flight to 300 m (sec): 1.3</p> <p>Name: BASTEG (Barricade and Street Encounter Grenade) Caliber (mm): 110 Type: Shaped-charge w/stand-off fuze Range (m): INA Penetration: Concrete (mm): INA Weight (kg): INA Muzzle Velocity(m/s): INA Flight Velocity(m/s): INA Time of Flight to 300 m (sec): INA</p> <p>OFF-ROUTE MINE SYSTEM</p> <p>Target Speed range (km/h): 30-60 Effective Range (m): 150 Operational Time (days): 40 Acquisition: Targets detected by acoustic sensor which activates the infra-red sensor. Sensors: IR Sensor: Passive, two-color IR Optics: Double parabolic, off-axis Acoustic: Capacitative microphone.</p>	

NOTES

The Panzerfaust 3 is a compact, lightweight, shoulder-fired, unguided antitank weapon. It consists of a disposable cartridge with a 110-mm warhead and reusable firing and sighting device. The Panzerfaust can be adapted to serve as an off-route mine.

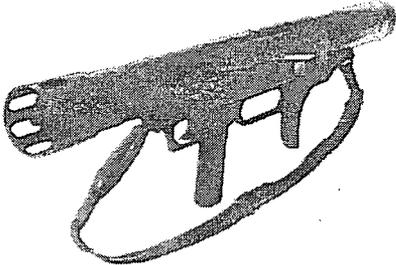
Russian 105-mm Antitank Grenade Launcher RPG-29

	<p>Ammunition Types</p> <p>105-mm grenade HEAT (tandem)</p>	<p>Typical Combat Load</p> <p>INA</p>
<p>SYSTEM</p> <p>Alternative Designations: Vampir Date of Introduction: Late 1980s Proliferation: Former Soviet Union</p> <p>Description: Crew: 2 Caliber (tube) (mm): 105 Weight (kg): 11.5 Length (mm): 1,000 Life of Tube/barrel: 300 Rate of Fire (rd/min): INA Fire From Inside Building: INA Maximum Target Speed (km/h): INA Emplacement/displacement time (min): (see NOTES)</p> <p>SIGHTS</p> <p>Name: INA Type: Iron, optical, and night Magnification: INA Location: Left side Sighting Range (m): 450 Night Sights Available: Yes, INA</p>	<p>VARIANTS (see NOTES)</p> <p>AMMUNITION Name: PG-29V Caliber (warhead): 105 Type: HEAT (tandem) Range (m): Effective: 500 Minimum: INA Penetration (m): Armor: +750, (650 behind ERA) Concrete and brick: +1.5 Casualty Radius (m): INA Length (mm): INA Complete Round Weight (kg): 6.7 Muzzle Velocity (m/s): 280</p>	

NOTES

For ease of transportation the RPG-29 can be broken down into two parts which one soldier can carry. It can be made ready to fire within a few seconds. A folding bipod is provided to assist aiming during prone firing. An unnamed variant has a tripod mount and guidance and control system. The guidance and control system of the mounted variant includes an optical sight, laser rangefinder and ballistic data computer for firing on moving targets. This increases the effective range of the mounted system to 800 m against a stationary target with a hit probability of 80%.

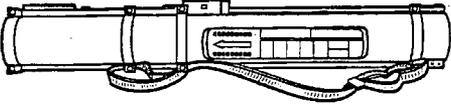
German 67-mm Disposable Antitank Grenade Launcher Armbrust _____

	<p style="text-align: center;">Ammunition Type</p> <p>67-mm grenade HEAT</p>	<p style="text-align: center;">Typical Combat Load</p> <p style="text-align: center;">INA</p>
<p>SYSTEM</p> <p>Alternative Designations: Crossbow Date of Introduction: INA Proliferation: At least seven countries</p> <p>Description: Crew: 1 Caliber (mm): 67 Weight (kg): 6.3 Length (mm): 850 Rifling: None Breech Mechanism Type: N/A Rate of Fire (rd/min): N/A (disposable) Fire From Inside Building: Yes (see NOTES)</p> <p>SIGHTS</p> <p>Name: N/A Type: Reflex Magnification: None Location: Left side Sighting Range (m): INA Night Sights Available: INA</p>	<p>VARIANTS (INA)</p> <p>AMMUNITION</p> <p>Name: INA Type: HEAT Range (m): Maximum: 1,500 Effective AT: 300 Flight Time (sec) @ 300 m: 1.5 Penetration: Armor (mm): 300 Reinforced Concrete (m): INA Muzzle Velocity(m/s): 210</p>	

NOTES

The Armbrust is a preloaded, disposable, shoulder-fired antitank weapon. It has a low signature and low IR detectability and can be safely fired from small enclosed rooms. The muzzle does not emit smoke or blast and no flash can be seen from the rear. Only .8 m clearance is required between the rear of the weapon and the wall. It is quieter than a pistol shot. The entire weapon is considered a round of ammunition and the launcher is thrown away once the weapon is fired. Manufactured by Singapore.

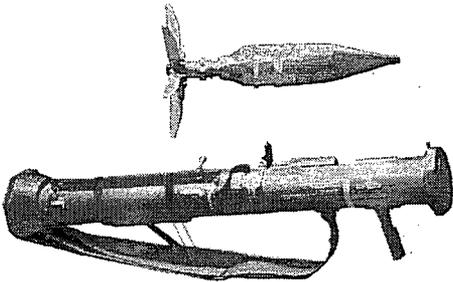
Russian 72-mm Disposable Antitank Grenade Launcher RPG-22

	<p style="text-align: center;">Ammunition Types</p> <p>72-mm grenade HEAT</p>	<p style="text-align: center;">Typical Combat Load</p> <p style="text-align: center;">INA</p>
<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: 1985 Proliferation: At least three countries</p> <p>Description: Crew: 1 Caliber (mm): 72 Weight (kg): 2.8 Length (mm): Firing Position: 850 Travel Position: 750 Rifling: None Breech Mechanism Type: N/A Rate of Fire (rd/min): N/A (disposable) Fire From Inside Building: No, backblast out to 30 m behind the weapon.</p> <p>SIGHTS</p> <p>Name: INA Type: Iron, calibrated for 50, 150, 200 m Magnification: None Location: Top of launcher Sighting Range (m): 250 Night Sights Available: No</p>	<p>VARIANTS (None)</p> <p>AMMUNITION (see NOTES)</p> <p>Name: INA Caliber (mm): 72 Type: HEAT Range (m): Effective: 250 Arming Range: INA Penetration: Armor (mm): 390 Brick (m): 1.2 Reinforced Concrete (m): 1 Muzzle Velocity(m/s): Initial: 133 Maximum: 300 Length (mm): 618 Weight (kg): 1.48</p>	

NOTES

The RPG-22 is a lightweight, shoulder-fired, preloaded, disposable antiarmor weapon intended for firing one round, after which the tube is discarded. It is basically a scaled-up version of the RPG-18 (similar to the US LAW) and has no dedicated grenadier; however, all soldiers train to use the squad-level disposable weapon.

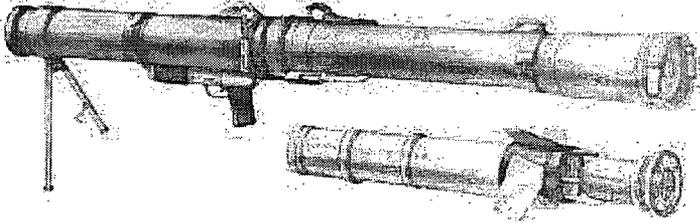
Swedish 84-mm Disposable Light Antitank Weapon AT4

	<p>Ammunition Types</p> <p>84-mm round HEDP HEAT</p>	<p>Typical Combat Load</p> <p>INA</p>
<p>SYSTEM</p> <p>Alternative Designations: US M136, Bofors AT 4, FFV AT4 Date of Introduction: INA Proliferation: At least seven countries</p> <p>Description: Crew: 1 Caliber (mm): 84 Weight (kg): 6 Length (mm): Firing Position: 1,000 Travel Position: 1,000 Rate of Fire (rd/min): N/A (disposable) Fire From Inside Building: See AT4 CS</p> <p>SIGHTS</p> <p>Name: INA Type: Popup, preset to 200 m Location: Top left Night Sights Available: Yes, INA</p> <p>VARIANTS (see NOTES)</p> <p>LMAW: Light Multipurpose Assault Weapon, uses HEDP AT4 CS: Confined space AT4 HP: High penetration</p> <p>AMMUNITION</p> <p>Name: AT4 HEAT Caliber (mm): 84 Type: HEAT Range (m): Effective: 300 Arming Range: INA Penetration: Armor (mm): 420 Weight (kg): 6.7 Muzzle Velocity(m/s): 285</p>	<p>Name: LMAW (see VARIANTS) Caliber (mm): 84 Type: HEDP, modified Carl Gustaf HEPD FFV 502 (with dual mode fuze) Range (m): Effective: 300 Arming Range: INA Penetration: Armor (mm): 150 Concrete (m): INA Casualty Radius (m): INA Muzzle Velocity (m/s): 235</p> <p>Name: AT4 CS (confined space) can fire from confined spaces as small as 22.5 m³ Caliber (mm): 84 Type: HEAT or HEDP (LMAW) warheads Range (m): Effective: INA Arming Range: INA Penetration: Armor (mm): INA Weight (kg): INA Muzzle Velocity(m/s): INA</p> <p>Name: AT4 HP (high penetration) Caliber (mm): 84 Type: HEAT Range (m): Effective: INA Arming Range: INA Penetration: Armor (mm): 600 Weight (kg): Less than 7 Muzzle Velocity(m/s): 290</p>	

NOTES

The AT4 is a lightweight, preloaded, disposable antiarmor weapon intended for firing one round, after which the tube is discarded. All AT4 systems share the same launcher but may contain different preloaded munitions. The variant selected depends on the intended use. The AT4's average recoil is comparable to the M16 rifle.

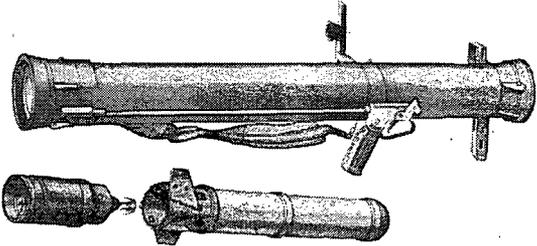
Russian Infantry Rocket Flame Weapon RPO

	<p style="text-align: center;">Ammunition Types</p> <p>Rocket Rocket-propelled encapsulated napalm projectile.</p>	<p style="text-align: center;">Typical Combat Load</p> <p style="text-align: center;">2</p>
<p>SYSTEM Alternative Designations: Rys (Lynx) Date of Introduction: Late 1970s Proliferation: FSU</p> <p>Description: Crew: 1 Weight (kg): Empty: 3.5 Pack (launcher and two rounds): 22 Length (ready to fire) (m): 1.44 Rate of Fire (rockets/min): 1 Reaction Time-Travel to Fire (sec): 60 Fire From Inside Building: INA Tube Life: 100 rounds Launcher Components: Firing tube, firing mechanism, mechanical sights, collapsing bipod and sling.</p> <p>PERFORMANCE</p> <p>Range (m): Effective: 190 Maximum: 400 Minimum: INA Accuracy: INA Muzzle Velocity (m/s): INA</p>	<p>SIGHTS</p> <p>Name: N/A Type: Open metal, front and rear Location: Left side, rear is on-line with rear of grip Magnification: None Night Sights Available: INA</p> <p>VARIANTS (None)</p> <p>AMMUNITION</p> <p>Name: RPO Type: Incendiary Warhead Incendiary Fill (liters): 4 Weight of Incendiary in Warhead (kg): 4 Type of Incendiary: Pyrogel Burn Temperature (°C): 800-1,000 Caliber (mm): 122 Casualty Radius: Fire envelope 10-40 m deep in the direction of the shot with a spray width of 3-4 m. Components: Container, warhead canister, propulsion unit</p>	

NOTES

The RPO is a combat-tested, shoulder-fired reusable weapon that fires a rocket-propelled encapsulated napalm warhead. It was designed to replace the LPO-50. The RPO is carried in two parts that must be connected to fire. Squeezing the trigger ignites the rocket with an electric spark. Part of the propellant gas enters the container and pushes the canister, kindling the igniter which in turn, ignites the incendiary mixture. The napalm in the RPO ignites at the initial stage of the flight and upon impact burning pieces are scattered all over the target. Although still in use by the OPFOR Flamethrower Bn (Encapsulated) at Corps or Army level (and other armies), the RPO has generally been replaced by the Infantry Rocket Flame Weapon RPO-A Series (RPO-A/D/Z).

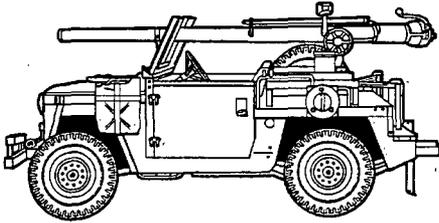
Russian Infantry Rocket Flame Weapon RPO-A Series (RPO-A/Z/D)

	<p>Ammunition Types</p> <p>Rocket RPO-A: Thermobaric-flammable mixture RPO-Z: Incendiary RPO-D: Smoke</p>	<p>Typical Combat Load</p> <p>2</p>
<p>SYSTEM</p> <p>Alternative Designations: Shmel (Bumblebee) Date of Introduction: 1984 Proliferation: Widespread</p> <p>Description: Crew: 1 Caliber (mm): 93 Number of Weapons in a Package: 2 Weight of Package (kg): 12 Total weapon (1) weight (kg): 11 Length (mm): 920 Rate of Fire (rockets/min): 2 Reaction Time-Travel to Fire (sec): 30 Fire From Inside Building: Yes. It can be fired in enclosures of 60 m³ or greater or with a barrier behind the weapon. Components: Container, ejection motor, warhead.</p> <p>PERFORMANCE</p> <p>Range (m): Direct Fire: 200 With Optical Sight: 850 Effective: 600 Minimum: 20 Indirect Fire: 1,000 Accuracy @ 200 m: .5 m² Muzzle Velocity (m/s): 125</p>	<p>SIGHTS</p> <p>Name: OPO-1 Type: Optical calibrated to 600 m Location: Left, next to grip Magnification: None Night Sights Available: INA</p> <p>VARIANTS (None)</p> <p>AMMUNITION</p> <p>Name: RPO-A Type: Thermobaric Casualty Radius (m): 50 (personnel in open) Lightly armored materiel kill probability at 400 m: 0.7 Burn Temperature (°C): 800+ Warhead Explosive Type: Trotyl equivalent (kg) -2 Warhead Mixture Weight (kg): 2.1</p> <p>Name: RPO-Z Type: Incendiary Warhead Mixture Weight (kg): 2.5</p> <p>Name: RPO-D Warhead Weight (kg): 2.3 Smoke-Incendiary Type: Based on red phosphorous. Smokescreen: Time of Formation (min): 2 Length (m): 55 to 90 Depth (m): INA Height (m): INA Duration (min): 3 to 5 Effective Against: Visual and infrared</p>	

NOTES

Designed as a follow-on to the RPO, the RPO-A, -Z, and -D are one-shot, disposable, shoulder-fired, combat tested (Afghanistan, Tajikistan, Chechnya), flame weapons. They are reliable and can be ready to fire within 30 seconds. Any soldier, infantryman, or paratrooper can use this close-combat weapon with minimal instruction. The RPO-A comprises three basic components: container, ejection motor, and case which is filled, depending on its purpose, with thermobaric (enhanced blast explosive), smoke or incendiary rockets. At any range the blast effects of the thermobaric munitions are much more serious than the thermal effects. The RPO-A is known as the infantryman's pocket artillery because the demolition effect corresponds to the 122-mm HE artillery, and 120-mm mortar projectile. The RPO series of flame weapons also serves as an extremely effective counter-sniper weapon. The armor- and mechanized -based OPFOR usually issues one RPO-A per BMP (mechanized infantry squad). They are also found in the Flamethrower Bn (Encapsulated) at Corps or Army level. One squad per infantry platoon has a RPO-A in the infantry-based OPFOR. The RPO-A series of flame weapons are issued more along the lines of ammunition rather than a weapon, therefore the BOI may vary.

United States 106-mm Recoilless Rifle M40

	<p>Ammunition Types</p> <p>106-mm recoilless gun HEAT HEAT-T HEP-T APERS-T HEAP</p>	<p>Typical Combat Load</p> <p>INA</p>
<p>SYSTEM</p> <p>Alternative Designations: (see VARIANTS) Date of Introduction: 1953 Proliferation: At least 50 countries</p> <p>Description: Crew: 2 Caliber (mm): 106 Weight (kg): With Spotting Rifle: 130 Gun Only: 113 Length (m): Total: 3.40 Barrel: 2.85 Width (on M79 mount) (m): Legs Spread: 1.524 Legs Closed: .8 Height (on M79 mount) (m): 1.3 Bore: Rifled 36 grooves, rh Breech Type: Interrupted thread Recoil System: Vented breech Feed: Manual Traverse (°): 360 Elevation (°) (M79 Mount): -17/+65 Rate of Fire (rd/min): 5 Spotting Rifle: .50 cal M8C Emplacement/displacement time (min): INA Fire From Inside Building: No Complete Round Weight (kg): 13 Muzzle Velocity (m/s): 570</p> <p>SIGHTS</p> <p>Name: INA Type: Optical Name: Bofors modernization package Type: Simrad LP101 laser sight in place of the ranging gun Magnification: INA Location: INA Name: Bofors modernization package Type: Computerized LASer Sight (CLASS) Magnification: INA Location: INA Night Sights Available: Yes, INA</p>	<p>VARIANTS</p> <p>M79 Mount: Tripod, ground, or vehicle M50 Ontos: Six-barrel mount on small tracked vehicle PAK-66: Austrian M40 on two-wheel carriage</p> <p>AMMUNITION</p> <p>Name: M344A1 Type: HEAT Range (m): Maximum Effective: 1,350 Maximum Range: 2,745 Armor Penetration (mm): INA Complete Round Weight (kg): 16.8 Muzzle Velocity (m/s): 503</p> <p>Name: 3/A-HEAT-T (Bofors upgrade) Type: HEAT-Tracer Range (m): Maximum Effective: 2,000 Armor Penetration (mm): 700 + Complete Round Weight (kg): 14.5 Muzzle Velocity (m/s): 570</p> <p>Name: M346A1 Type: HEP-T (HE plastic-tracer) Range (m): Maximum: 6,870 Complete Round Weight (kg): 16.95 Muzzle Velocity (m/s): 498</p> <p>Name: M581 Type: APERS-T (antipersonnel-tracer) (flechette) Fill (.5 g ea): 10,000 flechettes Range (m): Maximum Effective: 300 Complete Round Weight (kg): 18.73 Muzzle Velocity (m/s): 438</p> <p>Name: HEAP M-DN Type: HE antipersonnel (steel pellets) Fill: 1,000 steel pellets Range (m): Maximum Effective: 1,500 Lethal Radius: 40 Complete Round Weight (kg): 16.4 Muzzle Velocity (m/s): 560</p>	

NOTES

The US M40 or M40A1 recoilless rifle is an antitank weapon. It uses a .50 cal spotting rifle mounted along the axis of the barrel to determine proper elevation for the 106-mm barrel. Upgraded systems may have the Simrad laser sight in lieu of the ranging (spotting) gun.

Chapter 2 Infantry Vehicles

Infantry vehicles can vary from general transport assets such as trucks, to specially designed *light armored fighting vehicles (LAFVs)*. The intensity of combat on the modern battlefield requires infantry vehicles that are mobile, survivable, and lethal. Many ground forces have programs underway to field infantry LAFVs for modern requirements. Because of budgetary constraints, many ground forces continue using infantry vehicles which we might consider obsolete, but which are well suited for their environment and military role. A number of forces have aggressive upgrade programs for older systems. The U.S. Army, in its next conflict, is likely to encounter infantry forces with a mix of older and newer infantry vehicles.

CLASSIFICATION

Infantry LAFVs are generally classed as *armored personnel carriers (APCs)* or *infantry fighting vehicles (IFVs)*. The lighter, less protected and less lethal system is the APC. It is intended to carry soldiers to the close combat zone, then dismount them for their commitment to the fight. An IFV is designed to fight with soldiers onboard, to carry the soldiers forward without dismounting them if possible, and to support them with direct fires if they do dismount. The plethora of upgrade options available is permitting both APCs and IFVs to become more mobile, survivable, and lethal. Thus we see APCs with IFV survivability or IFV lethality, or with both—which transforms them into IFVs. We also see IFVs with vulnerabilities which ill-suit them for their mission requirement. This chapter highlights key infantry vehicles, with an emphasis on their capabilities in mobility, survivability and lethality. Please note that on the modern battlefield, lack of a capability (swim, night sights, etc.) is in fact a vulnerability.

TRENDS

This chapter highlights infantry LAFV features in terms of mobility, survivability, and lethality. Armies have been looking at ways to balance the need for increased protection with limitations that additional armor brings, such as the need to be amphibious. One solution is to accept a lack of swim capability for a segment of up-armored IFVs, coupled with a distribution of (less armored) amphibious vehicles within the force. Other armies are looking at limited addition of applique armor or active protection systems. Several companies have developed light explosive reactive armor (ERA), which can be used on LAFVs. However, this is a less likely upgrade, because exploding armor fragments are a hazard to dismounted soldiers.

In the past, higher combat power and cost of tanks justified the wide disparity in firepower between tanks and IFVs. However, modern IFVs, when fully manned and equipped, may have equal or higher combat power and similar cost. Therefore, lethality improvements previously afforded to tanks are being added to selected IFVs. A wide variety of lethality upgrades are available for LAFVs. These include larger main weapons and antitank guided missile (ATGM) launchers, and improved fire control systems (FCS), especially night sights. The simplest but sometimes most costly upgrade is improved ammunition.

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Improved secondary armaments for aerial targets permit the main weapon to focus more on heavy targets. Thus, several countries are adding remote day sights and night sights and improved ammunition for machineguns (MGs). Others are adding automatic grenade launchers to supplement MG fires.

The aerial threat to AFVs has prompted ground forces to address that threat. One response is proliferation of air defense assets, such as shoulder-fired SAMs. A more direct response which is difficult to counter, is cost-effective, and has long-term benefits for force effectiveness, is to better equip the vehicles for counterair fires. Some infantry vehicles have been fitted with high-angle-of-fire turrets (e.g., BTR-80) and antiaircraft sights (BMP-3). Improved fire control technology has led to more exotic ammunition solutions. The BMP-3 gun-launched ATGM has a higher velocity for use against helicopters. Another new development is ballistic computer-based electronically-fuzed frag-HE rounds, including forward- and side-firing rounds, which can defeat rotary-wing aircraft and ground-based antiarmor positions at stand-off range.

Infantry vehicles offer the most economical armored vehicle chassis for development of combat support and service support vehicles, including air defense vehicles, artillery, C⁴, reconnaissance, etc. Noted variants offer a link to other systems described in the WEG.

This chapter provides a representative sampling of infantry vehicles in use today. The selection is not comprehensive, rather reflects APCs and IFVs currently available to the OPFOR. Within this chapter, other types of infantry vehicles are also noted. These include airborne vehicles and multipurpose transporters. Other armored transport vehicles available to infantry units are armored trucks (e.g., former Soviet BTR-152), amphibious assault vehicles (such as U.S. LVTP7), jeep-type vehicles (e.g., HMMWV), and fast-attack vehicles (based on so-called dune buggy designs). Examples of alternative vehicles will be added in later issues of the WEG.

TECHNICAL NOTES

The following notes apply to infantry LAFVs, and to combat vehicles (in other chapters) that are used for reconnaissance, tank/assault, antitank, air defense, and artillery roles. Weapon, fire control, and munition-related narrative applies to towed and ground weapon systems.

On each equipment sheet, the top of the page provides an illustration (line drawing or photo of the system) and a summary of weapons and munitions. Note that a Typical Combat Load, when available, may be estimated. In actuality, ammunition load depends on specific country holdings, on time frame, and on scenario tactical considerations.

System and Variants sections provide basic data to assist in understanding current system status and proliferation, as well as possible upgrade options. Under Description, to assure comparability on vehicle dimensions, gun tube length is not included in those dimensions.

In the area, Automotive Performance, the figure *max off-road* denotes speed on dirt roads. The figure *average cross-country* is used for true off-road speed; for selected systems, it was measured on an approved course. Although some systems have specified radios, for many OPFOR countries, radios will be replaced to link with their military radio nets.

Protection figures for use in simulation applications must be measured by certifying agencies in accordance with specific Army standards. Figures on equipment sheets include published data provided for general information use, and may not coincide with vulnerability data developed by approved agencies. Protection options are available for upgrading systems. The wide variety of supplemental protection packages include active and passive armor, active protection systems and countermeasure systems. Although upgrades are being advertised and are technically possible, that does not mean that they are tactically sound, or that the application fits the OPFOR to be portrayed. Other options are generally available for installation; but, because their applicability has not been noted for specific systems, they were not included. Only a few countermeasure parameters were included. However, specific protection upgrades and systems are noted for selected OPFOR systems.

System lethality is determined by a variety of interrelated functions and considerations in the process of bringing destruction upon enemy forces and equipment. Lethality is addressed on the equipment sheets under the headings of Armament, Fire Control, Sights, and Main Armament Ammunition. Lethal fires can be delivered by *direct fire*, in which weapon systems acquire and observe their targets, or by *indirect fire*, in which weapons use remote acquisition assets to direct their fires. Note that direct-fire systems such as tanks can receive remote acquisition reports and engage targets by indirect fire; and indirect fire systems (such as artillery) can employ direct-fire sights to fire in the direct-fire mode. For the WEG, high-angle fires are not interpreted as indirect fires as long as the firing weapon uses its own sights to acquire and aim.

Factors affecting lethality, which are considered in the WEG, include: rates of fire, various ranges, accuracy and errors, acquisition/fire control capabilities, lethality effects, ammunition, and ability to engage targets on the move. Any of these technical factors, and other more subtle ones, may affect lethality in combat. Note also that various rates of fire are used, with adjusting factors, such as movement status and type of target. Generally automatic weapon use life dictates that, for more than a 3-4 second interval, the number of rounds expended will not exceed the *practical* rate of fire. However, maximum rate is critical against fast-closing targets, such as flying aircraft.

Range is not a fixed figure for most systems. It can be directly affected by four technical factors: gun/launcher configuration, mount (how it is fixed to the system), acquisition capability, and specific munition ballistics. Range is also related to less tangible factors, such as movement status (moving versus stationary, and movement speed), target type, elevation angle (such as for air defense weapons), visibility conditions, and terrain. Each weapon can have different ranges listed by ammunition type and model, where munitions are broken out. Generally, the range of direct-fire frag-HE rounds is greater than munitions designed for point targets, because the effects area is much greater than those of shaped-charge or kinetic-energy rounds. With fragmentation and blast effects, a near miss may be good enough to inflict severe damage. With these considerations, the WEG provides a figure called *maximum aimed range*. This range indicates the farthest range for system-on-system aimed direct fire.

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The maximum aimed range is based on a combination of tactics, techniques and procedures (TTPs), and on parameters of the technical factors noted above: gun/launcher, mount, acquisition system, and ammunition ballistics. This direct-fire range significantly exceeds the weapon's *maximum effective range*. The maximum effective range/night denotes the effective range for a round, given available night acquisition capabilities. The TTPs also call for a "salvo range" for armored fighting vehicles, which exceeds other ranges and requires one or more volleys of a platoon against a single point target. These figures are less tangible, are based on TTP, and are not included in the WEG.

Probability of hit data is included for instructional purposes, not for use in simulations and models. Accuracy for weapons, munitions, and acquisition systems decreases with range. Antitank guided missiles are an exception; they usually have a singular probability of hit for all ranges, based on technical precision capability. Limitations, vulnerabilities, and countermeasures can affect actual performance. Several of these factors are noted on equipment pages.

Lethality performance given a hit can be measured in terms of radius of effects for fragmentation/blast effects against soft targets, and penetration distance (through steel) against hard targets. The fragmentation and blast effects of a frag-HE round mean that it is less lethal against hard targets, such as heavily armored vehicles. Another consideration is the level of destruction required. For many possible adversary forces, the critical requirement against armored vehicles is not a 100% or catastrophic kill. A mobility kill or firepower kill may be sufficient to render a system combat-ineffective, and may be counted in lethality data. The OPFOR can employ a mix of lethal and nonlethal methods. Fires of degrading (versus destructive) munitions such as smoke, mines, and radio frequency jammers can be used to suppress units and support the effort. Consult other manuals in the FM 100-60 series and other approved publications for guidance on these tactics, techniques, and procedures.

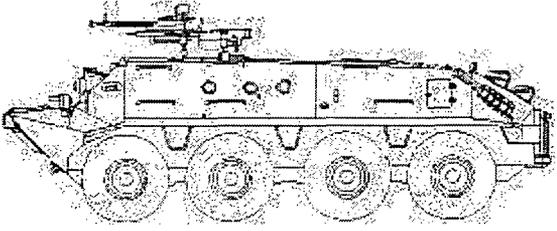
Questions and comments on data listed in this chapter should be addressed to:

Mr. Tom Redman

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e-mail address: redmant@leav-emh1.army.mil

Russian Armored Personnel Carrier BTR-60PA

	<p>Weapons & Ammunition Types</p> <p>12.7-mm DShK MG APDS, API, API-T, HE-T, HEI, I-T</p> <p>2 x 7.62-mm PKT MG Lt Ball, Ball-T, API, API-T</p>	<p>Typical Combat Load</p> <p>500 250 250</p> <p>3,000</p>
<p>SYSTEM: Alternative Designations: BTR-60-PK Date of Introduction: 1963 Proliferation: At least 30 countries (including variants) Description: Crew: 2 Troop Capacity: 12 Combat Weight (mt): 10.1 Chassis Length Overall (m): 7.22 Height Overall (m): 2.06 Width Overall (m): 2.82 Ground Pressure (kg/cm²): INA Drive Formula: 8 x 8</p> <p>Automotive Performance: Engine Type: 2 x 180-hp Gasoline Cruising Range (km): 500 Speed (km/h): Max Road: 80 Max Off-Road: 60 Average Cross-Country: INA Max Swim: 10 Fording Depths (m): Amphibious</p> <p>Radio: INA</p> <p>Protection: Armor, Turret Front (mm): 7-9mm hull front (no turret) Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Active Protective System: N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A NBC Protection System: Collective Smoke Equipment: N/A</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 12.7-mm (12.7 x 108) heavy MG, DShK Rate of Fire (rd/min): 80-100 (practical) Loader Type: Belt feed Ready/Stowed Rounds: INA Elevation (°): -10/+80 Fire on Move: Yes</p> <p>Auxiliary Weapons: Caliber, Type, Name: 2 x 7.62-mm machinegun PKT Mount Type: Vehicle top Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,000 Night: N/A</p>	<p>Fire on Move: Yes Rate of Fire (rd/min): 250 practical / 650 cyclic, in 2-10 rd bursts</p> <p>ATGM Launcher: N/A Firing Ports: 3 on each side</p> <p>FIRE CONTROL FCS Name: N/A Main Gun Stabilization: N/A Rangefinder: N/A Infrared Searchlight: N/A Sights w/Magnification: Gunner: Day: K10-T Field of View (°): INA Acquisition Range (m): 1,500 (est) Night: N/A Commander Fire Main Gun: No</p> <p>VARIANTS A variety of armament variants for the vehicle were used, including single 7.62-mm PKT MG, or 12.7-mm MG, or no MG.</p> <p>Artillery command and reconnaissance vehicles. ACRV 1V18 is a command and observation vehicle (COP). ACRV 1V19 is a fire direction center (FDC).</p> <p>BTR-60PB: The most widely fielded variant has a one-man turret, a 14.5-mm KPV-T MG, a coaxial 7.62-mm MG and day/night sights.</p> <p>BTR-60PBK: Company commander variant with 3 additional radios</p> <p>BTR-60 PU: Armored command vehicle (ACV) variant with a 10-m mast radio antenna and front-to-rear rail antenna for mobile use</p> <p>BTR-60 PU-12/ -12M: Air defense associated ACV and its upgrade</p> <p>BTR-60 R-975: Forward air controller turreted variant.</p> <p>MTP-2: Armored recovery vehicle</p> <p>R-145BM: ACV with R-111, R-123, and R-130M radios and the distinctive Clothesline antenna</p>	

Russian Armored Personnel Carrier BTR-60PA continued

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<p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 12.7-mm, APDS Chinese, Type 54 Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,500 vehicles Night: N/A Tactical AA Range: 1,600 Armor Penetration (mm): INA</p> <p>12.7-mm, API/API-T Type 54 Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,500 unarmored ground / 800 armored Night: N/A Tactical AA Range: 1,000 Armor Penetration (mm): INA</p>	<p>Other Ammunition Types: Incendiary-T, HE-T Type MDZ, HEI Type ZP, Russian Duplex, Russian Duplex-T</p>
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NOTES

This vehicle is a roofed variant of the BTR-60P open-hatch armored carrier. It is widely fielded in original and modified form. The APC has a top-mounted 12.7-mm MG forward of rectangular gunner's hatch. Where an additional two 7.62-mm MGs are mounted, they are right and left of the hatch. Because of space restriction, no more than one or two gunners can fit in the opening.

A notable vulnerability is that passengers have to exit the vehicle through top hatches, which makes them vulnerable to fires. Also, gunners must be at least shoulder high out of the vehicle to operate the weapons.

Russian Armored Personnel Carrier BTR-80

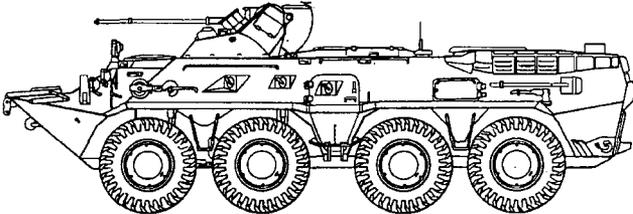
		<p>Weapons & Ammunition Types</p> <p>14.5-mm turret MG API, API-T</p> <p>7.62-mm coax PKT MG Light ball, Ball-T, API, API-T, I-T</p>	<p>Typical Combat Load</p> <p>500</p> <p>2,000</p>
<p>SYSTEM Alternative Designations: GAZ-5903 Date of Introduction: 1984 Proliferation: At least 22 countries Description: Crew: 2 Troop Capacity: 8 Combat Weight (mt): 13.6 Chassis Length Overall (m): 7.55 Height Overall (m): 2.41 Width Overall (m): 2.95 Ground Pressure (kg/cm²): INA Drive Formula: 8 x 8</p> <p>Automotive Performance: Engine Type: 260-hp Diesel Cruising Range (km): 600 Speed (km/h): Max Road: 85 Max Off-Road: 60 Average Cross-Country: 20 Max Swim: 10 Fording Depths (m): Amphibious</p> <p>Radio: R-173.</p> <p>Protection: Armor, Turret Front (mm): Against 12.7mm Applique Armor (mm): Available Explosive Reactive Armor (mm): N/A Active Protective System: N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A NBC Protection System: Collective Smoke Equipment: 6 x 81-mm smoke grenade launchers</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 14.5-mm (14.5 x 114) heavy MG, KPVT Rate of Fire (rd/min): 150 practical Loader Type: Belt-fed Ready/Stowed Rounds: 50/450 Elevation (°): -4/+60 Fire on Move: Yes</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm machinegun, PKT Mount Type: Coax Maximum Aimed Range (m): 1,500</p>	<p>Max Effective Range (m): Day: 1,000 Night: N/A Fire on Move: Yes Rate of Fire (rd/min): 250 practical/650 cyclic, 2-10 round bursts ATGM Launcher: N/A Firing Ports: 3 on each side</p> <p>FIRE CONTROL FCS Name: N/A Main Gun Stabilization: N/A Rangefinder: N/A Infrared Searchlight: OU-3GA2M Sights w/Magnification: Gunner: Day: 1P3-6, 1.2x/4x Field of View (°): 49/14 Acquisition Range (m): 2,000 Night: N/A Commander Fire Main Gun: No</p> <p>VARIANTS BTR-80A: IFV with a stabilized turret containing a 30-mm 2A42 (BMP-2) automatic gun, coax 7.62-mm MG, and TNP-3 day/night sights. This vehicle is in prototype and offered for export. The drop-in turret package is also offered for export. A BTR-80S variant includes the turret/fire control, but with 14.5-mm versus 30-mm gun.</p> <p>BTR-80K: Command variant w/ added R-173, R-173P, and R-159 (portable) radios, R-174 intercom, navigation aids, and an 11-m mast</p> <p>1V152: Artillery battalion command vehicle 2S23: 120-mm self-propelled combination gun (howitzer/mortar) BREM-K: Armored recovery vehicle RKhM-4: NBC reconnaissance vehicle UNSh: Standardized expanded chassis for current variants, including Kushetka-B ACRV and BMM vehicle series.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 14.5-mm API-T Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 2,000 Night: INA Tactical AA Range: 1,500-2,000 Armor Penetration (mm): 20 at 1,000 m/ 30 at 500 m</p> <p>Other Ammunition Types: API, I-T</p>		

NOTES

BTR-80 is superior to BTR-60/70 with a larger chassis, high-angle-of-fire turret, and single more powerful diesel engine (vs gasoline). Options include the Kliver turret with a 30-mm gun, 7.62-mm coax MG, thermal sights, superior day sights, and (four) Kornet ATGM launchers.

Russian Armored Personnel Carrier BTR-80A

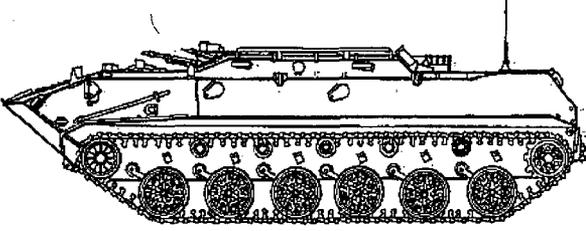
Worldwide Equipment Guide

	Weapons & Ammunition Types 30-mm automatic gun HEI-T, Frag-HE-T AP-T, APDS-T, APFSDS-T 7.62-mm coax MG	Typical Combat Load 300 2,000
<p>SYSTEM Alternative Designations: GAZ-59034 Date of Introduction: 1994 Proliferation: At least 3 countries Description: Crew: 2 Troop Capacity: 8 Combat Weight (mt): 14.6 Chassis Length Overall (m): 7.65 Height Overall (m): 2.80 Width Overall (m): 2.90 Ground Pressure (kg/cm²): INA Drive Formula: 8 x 8</p> <p>Automotive Performance: Engine Type: 260-hp Diesel Cruising Range (km): 800 Speed (km/h): Max Road: 90 Max Off-Road: INA Average Cross-Country: INA Max Swim: 10 Fording Depths (m): Amphibious</p> <p>Radio: R-163-50U VHF, R-163-UP receiver, R-174 intercom</p> <p>Protection: Armor, Turret Front (mm): Can defeat 12.7-mm Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Mineclearing Equipment: No Self-Entrenching Blade: N/A Active Protective System: N/A NBC Protection System: Collective Smoke Equipment: 6 x 81-mm smoke grenade launchers</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 30-mm automatic gun, 2A72 Rate of Fire (rd/min): 200-330 variable cyclic in bursts Loader Type: Dual-belt feed Ready/Stowed Rounds: 300/0 Elevation (°): -5 to +70 Fire on Move: Yes</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm machinegun PKT Mount Type: Coax Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,000 Night: 800+</p>	<p>Fire on Move: Yes Rate of Fire (rd/min): 250 practical/650 cyclic, 2-10 round bursts</p> <p>ATGM Launcher: N/A Firing Ports: 4 right side, 3 left side</p> <p>FIRE CONTROL FCS Name: N/A Main Gun Stabilization: 2-plane Rangefinder: INA Infrared Searchlight: OU-5 Sights w/Magnification: Gunner: Day: 1P3-9, 1.2x/4x Field of View (°): 49/14 (est) Acquisition Range (m): 4,000 Night: TPN3-42 11/IR Field of View (°): INA Acquisition Range (m): 800</p> <p>Commander Fire Main Gun: No</p> <p>VARIANTS BTR-80S: APC has the same turret with 14.5-mm vs 30-mm gun.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 30-mm APDS-T Maximum Aimed Range (m): INA Max Effective Range (m): Day: 2,000 Night: INA Tactical AA Range: 2,500 Armor Penetration (mm): 25 (RHA) at 1,500 m</p> <p>30-mm APFSDS-T, M929 Maximum Aimed Range (m): INA Max Effective Range (m): Day: 2,000+ Night: INA Tactical AA Range: 2,500 Armor penetration (mm): 55 (RHA) at 1,000 m/45 at 2,000 m</p> <p>30-mm Frag-HE Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: 4,000 Night: INA Tactical AA Range: 2,500 Armor Penetration (mm): INA</p> <p>Other Ammunition Types: 30-mm AP-T, HEI-T</p>	

NOTES

The drop-in gun/turret package (Modular Weapon System) is offered for export, to upgrade a wide variety of vehicles to BTR-80A standard. BTR-80A can mount K1-126 bullet-resistant tires.

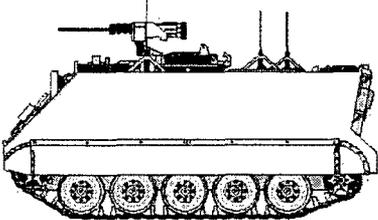
Russian Airborne Armored Personnel Carrier BTR-D

	<p>Weapons & Ammunition Types</p> <p>2x 7.62-mm hatch MG Lt Ball, Ball-T, API, API-T, Incendiary</p>	<p>Typical Combat Load</p> <p>2,000</p>
<p>SYSTEM Alternative Designations: BMD M1979 Date of Introduction: 1974 Proliferation: At least 1 country Description: Crew: 1 Troop Capacity: 12 passengers Combat Weight (mt): 6.7 Chassis Length Overall (m): 5.88 Height Overall (m): 1.67 Width Overall (m): 2.63 Ground Pressure (kg/cm²): 0.5</p> <p>Automotive Performance: Engine Type: 240-hp Diesel Cruising Range (km): 500 Speed (km/h): Max Road: 61 Max Off-Road: 35 Average Cross-Country: INA Max Swim: 10 Fording Depth (m): Amphibious</p> <p>Radio: R-123</p> <p>Protection: Armor, Turret Front (mm): "Antibullet" (7.62-mm) Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A Active Protective System: No NBC Protection System: Yes Smoke Equipment: 2x2 forward firing smoke grenade launchers Vehicle engine exhaust smoke system (VEESS)</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 7.62-mm (7.62 x 54R) machinegun, PKT Rate of Fire (rd/min): 250 practical / 650 cyclic, in 2-10 round bursts Loader Type: Belt-fed Ready/Stowed Rounds: INA Elevation (°): INA Fire on Move: Yes</p> <p>Auxiliary Weapon: N/A</p>	<p>ATGM Launcher: N/A Firing Ports: 2 on each side, 1 in left rear door, permit two 5.45-mm RPK-74 light machineguns to be used.</p> <p>FIRE CONTROL FCS Name: N/A Main Gun Stabilization: N/A Rangefinder: N/A Infrared Searchlight: N/A Sights w/Magnification: Open, 1x Commander Fire Main Gun: No</p> <p>VARIANTS 1V118 Reostat/1V119 Spektr: Artillery command and observation posts for amphibious and airborne forces.</p> <p>2S9: 120-mm self-propelled combination gun, with a turreted breech-loaded mortar/howitzer system.</p> <p>BMD-KShM: Former Soviet regiment or division command and staff variant, with large Clothes-line antenna.</p> <p>BREM-D: Armored repair and recovery variant.</p> <p>BTR-RD/Robot: An ATGM variant (AT-4/-5) with 2 launchers, dismounted or mounted on pintles for vehicle launch.</p> <p>BTR-ZD: Air defense variant with porteed or towed ZU-23 twin 23-mm air defense gun. Vehicle also carries manpad SAM launchers.</p> <p>BTR-3D: Air defense variant with a rear-mounted ZU-23 gun.</p> <p>Sterkh (Malakit/Shmel): UAV transporter and launcher vehicle.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 7.62-mm API Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,000 m / 400-500 on the move Night: INA Tactical AA Range: INA Armor Penetration (mm): 8 (RHA) at 500 m</p> <p>Other Ammunition Types: 7.62-mm Light Ball, Ball-T, Heavy Ball, API, API-T, Incendiary</p>	

NOTES

BTR-D is a variant of the BMD-1, with an additional road wheel, with the turret removed, and with a raised hatch area. The vehicle can be parachute landed with airborne troops. The BTR-Ds in grenade launcher units will carry one AGS-17 30-mm AGL in the rear. Options include the Kliver turret with a 30-mm gun, 7.62-mm coax MG, thermal sights, superior day sights, and (four) Kornet ATGM launchers.

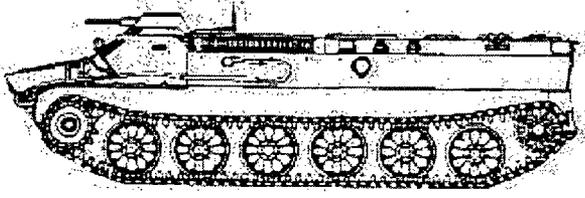
US Armored Personnel Carrier M113A1

	<p>Weapons & Ammunition Types</p> <p>.50 cal cupola MG Slap, API, API-T, Ball, Ball-T, Incendiary, I-T</p>	<p>Typical Combat Load</p> <p>2,000</p>
<p>SYSTEM Alternative Designations: INA Date of Introduction: 1964 Proliferation: At least 46 countries Description: Crew: 2 Troop Capacity: 11 passengers Combat Weight (mt): 11.20. Chassis Length Overall (m): 4.90 Height Overall (m): 1.80 Width Overall (m): 2.70 Ground Pressure (kg/cm²): .55</p> <p>Automotive Performance: Engine Type: 215-hp Diesel Cruising Range (km): 483 Speed (km/h): Max Road: 64 Max Off-Road: INA Average Cross-Country: INA Max Swim: 5.8 Fording Depths (m): Amphibious</p> <p>Radio: Various, including intercom</p> <p>Protection: Armor, Turret Front (mm): N/A—No turret Applique Armor (mm): Yes—anti-mine armor on bottom Explosive Reactive Armor (mm): Available Active Protective System: N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A NBC Protection System: N/A Smoke Equipment: N/A</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: .50 cal (12.7 x 99) heavy machinegun, M2HB Rate of Fire (rd/min): 450-550 cyclic Loader Type: Belt feed Ready/Stowed Rounds: 250/1750 Elevation (°): -20/+60 Fire on Move: Yes</p> <p>Auxiliary Weapon: N/A ATGM Launcher: N/A Firing Ports: None</p> <p>FIRE CONTROL FCS Name: N/A</p>	<p>Main Gun Stabilization: N/A Rangefinder: N/A Infrared Searchlight: N/A Sights w/Magnification: Gunner: Day: Open ladder sight, 1x Field of View (°): INA Acquisition Range (m): 2,000 Night: N/A Commander Fire Main Gun: No</p> <p>VARIANTS More than 100 variants have been produced in numerous countries, with 7.62-mm MGs, 40-mm automatic grenade launchers, 90-mm recoilless rifles, and turrets with 20-to-76-mm cannons. The following are US variants. Command variants are M577 and M114 (C&R). Self-propelled mortars are M125 (81-mm) and M106A2 (4.2-inch). The M901/ITV ATGM launcher vehicle is a common variant. The M163 SP air defense gun has a 20-mm Vulcan cannon; and M730 is a Chapparral AD missile launcher. Other variants include ambulances, recovery and engineer vehicles.</p> <p>M113A2: This multi-national variant features mobility improvements. One version is being developed with the Giat TS90 90-mm cannon. M113A3: Changes for this multi-national variant include a new power train and increased armor protection.</p> <p>AIFV: The multi-national IFV variant has M113A3 armor upgrades, a stabilized turret with 25-mm gun, and a 7.62-mm MG.</p> <p>VCC-1: Italian M113 copies are supplemented by this variant</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: .50 SLAP (sabot light armor penetrator) Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 2,000 Night: INA Armor Penetration (mm): INA</p> <p>.50 Cal Ball Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,000 Night: N/A Armor Penetration (mm): INA</p> <p>Other Ammunition Types: Ball-T, Incendiary, I-T, API, API-T</p>	

NOTES

The M113A1 is a variant of the gasoline-powered M113. Armors available include Rafael Enhanced Add-on Armor Kit (EAAK), Creusot-Marrel plate armor, and SNPE explosive reactive armor. Thermal and TV sights are also available.

Russian Light Armored Multi-purpose Vehicle MT-LB

	<p>Weapons & Ammunition Types</p> <p>7.62-mm Turret MG Lt Ball, Ball-T, API, API-T, Incendiary</p>	<p>Typical Combat Load</p> <p>2,000</p>
<p>SYSTEM Alternative Designations: MT-LB-T Date of Introduction: 1970, modernized in 1995 Proliferation: At least 9 countries Description: Crew: 2 Troop Capacity: 11 passengers Combat Weight (mt): 11.9 Chassis Length Overall (m): 6.35 Height Overall (m): 1.87 Width Overall (m): 2.85 Ground Pressure (kg/cm²): 0.46 standard track / 0.28 wide track</p> <p>Automotive Performance: Engine Type: 290-hp Diesel Cruising Range (km): 500 Speed (km/h): Max Road: 61.5/70 modernized Max Off-Road: 30/45 modernized Average Cross-Country: INA Max Swim: 3-4 Fording Depth (m): Amphibious</p> <p>Radio: R-123 or upgrade to -123M/-173</p> <p>Protection: Armor, Turret Front (mm): 7-14 Applique Armor (mm): N/A Explosive Reactive Armor (mm): INA Active Protective System: N/A Mineclearing Equipment: N/A Self-Entrenching Blade: Yes NBC Protection System: Collective Smoke Equipment: N/A</p> <p>ARMAMENT Main Armament(s): Caliber, Type, Name: 7.62-mm (7.62x 54R) machinegun, PKT Rate of Fire (rd/min): 250 practical / 650 cyclic, 2-10 round bursts Loader Type: Belt-feed Ready/Stowed Rounds: INA Elevation (°): -5/ +35 Fire on Move: Yes</p> <p>Auxiliary Weapon: N/A ATGM Launcher: N/A</p>	<p>Firing Ports: 1 on each side and 1 in each rear door.</p> <p>FIRE CONTROL FCS-Name: INA Main Gun Stabilization: N/A Rangefinder: N/A Infrared Searchlight: N/A Sights w/Magnification: Gunner: Day: PP-61AM, 2.6x Field of View (°): 23 Acquisition Range (m): 1,500 (est) Night: N/A Commander Fire Main Gun: No</p> <p>VARIANTS MT-LB Upgrade: 1995 upgrade includes improved steering and a new engine. 2S1: 122-mm self-propelled howitzer. 9P149/Shturm-S: ATGM launcher vehicle with AT-6 autoloader. MT-LB "blade": Dozer version with a blade attached to the vehicle. MT-LBu: Expanded variant for artillery command and reconnaissance vehicles (ACRVs) and other uses. MT-LBV: Arctic variant with .57m wide track for snow and improved flotation. MTP-LB: Technical support vehicle. MT-SON: Ground surveillance radar vehicle with Pork Trough/SNAR-2 radar. RKhM: Chemical reconnaissance vehicle. SA-13: Regimental surface-to-air missile launcher vehicle. SNAR-10: Ground surveillance radar vehicle with Big Fred radar.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 7.62-mm API, API-T Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,000/400-500 on the move Night: INA Tactical AA Range: INA Armor Penetration (mm): 8 (RHA) at 500 m</p> <p>Other Ammunition Types: Light Ball, Ball-T, Heavy Ball, Incendiary</p>	

NOTES

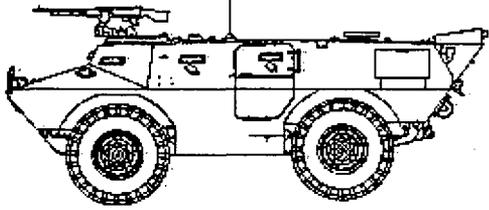
Russian AG-17 30-mm automatic grenade launcher modification is available for use on MT-LB.

Russian KBP offers a drop-in one-man turret, called Kliver, with a stabilized 2A72 30-mm gun, a 4 Kornet ATGM launcher, thermal sights, and improved fire control system.

US Armored Personnel Carrier V-150

	<p>Weapons & Ammunition Types</p>	<p>Typical Combat Load</p>
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Worldwide Equipment Guide

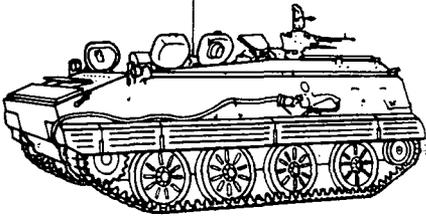
	<p>7.62-mm cupola MG Ball-T, Match API, API-T</p>	<p>3,200</p>
<p>SYSTEM Alternative Designations: Commando Date of Introduction: 1971 Proliferation: At least 20 countries Description: Crew: 3 Troop Capacity: 2 Combat Weight (mt): 9.89 Chassis Length Overall (m): 5.69 Height Overall (m): 1.98 Width Overall (m): 2.26 Ground Pressure (kg/cm²): INA Drive Formula: 4 x 4</p> <p>Automotive Performance: Engine Type: 202-hp Diesel Cruising Range (km): 643 Speed (km/h): Max Road: 89 Max Off-Road: INA Average Cross-Country: INA Max Swim: 5 Fording Depth (m): Amphibious</p> <p>Radio: INA</p> <p>Protection: Armor, Turret Front (mm): Against 7.62-mm ball Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A Active Protective System: N/A NBC Protection System: N/A Smoke Equipment: Optional</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 7.62-mm (7.62 x 51) MG, FN-MAG (example) Rate of Fire (rd/min): 650-1000 cyclic Loader Type: Belt feed, box magazines Ready/Stowed Rounds: INA Elevation (°): INA Fire on Move: Yes</p> <p>Auxiliary Weapon: N/A</p>	<p>ATGM Launcher: N/A Firing Ports: None</p> <p>FIRE CONTROL FCS Name: N/A Main Gun Stabilization: N/A Rangefinder: N/A Infrared Searchlight: N/A Sights w/Magnification: Gunner: Day: Open ladder sight Field of View (°): INA Acquisition Range (m): 2,000 Night: N/A Commander Fire Main Gun: No</p> <p>VARIANTS Armament options vary widely and include: a turret with 7.62-mm or 12.7-mm MG or turrets with 20-mm, 25-mm, 30-mm, 76-mm, or 90-mm gun. Another turret offers a 12.7-mm MG and 40-mm grenade launcher. An 81-mm self-propelled mortar launcher variant and a TOW ATGM launcher variant are available. Variants include a cargo carrier, police and security vehicles, an air defense variant with 20-mm Vulcan cannon.</p> <p>V-100: This earlier 4x4 APC has a gasoline engine.</p> <p>V-150S: This slightly larger 4x4 variant has improved drive train and the above variety of turret and gun options. A Commando command variant includes a raised compartment area with external-mount 7.62-mm MG. Taiwan has versions with an open-mount 12.7-mm MG and a 107-mm (4.2 inch) mortar.</p> <p>V-200: Variant sold to Singapore with 20-mm turret, 90-mm turret, air defense variant with RBS-70 surface-to-air missile and a recovery variant. Another variant has a 120-mm mortar.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 7.62-mm Ball, NATO Maximum Aimed Range (m): 2,000 (est) Max Effective Range (m): Day: 1,500 Night: INA Tactical AA Range: INA Armor Penetration (mm): INA</p> <p>Other Ammunition Types: Ball-T, API, API-T, Match</p>	

NOTES

The baseline V-150 is equipped with a variety of pintle-mounted 7.62-mm machineguns. Many MGs are installed by user countries from their inventories. The Belgian FN-MAG general purpose MG is a widely used MG that represents a common capability.

Chinese Armored Personnel Carrier YW-531A

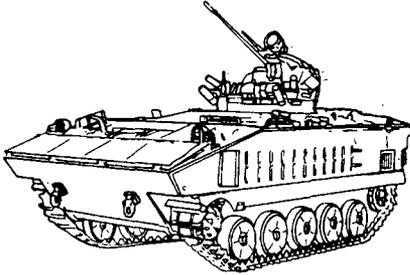
	Weapons & Ammunition Types	Typical Combat Load
	12.7-mm MG	1,120

	APDS, API, API-T, HE-T, HEI	500 620
<p>SYSTEM Alternative Designations: Type 63, North Korean M1967 Date of Introduction: Late 1960s Proliferation: At least 9 countries Description: Crew: 4 Troop Capacity: 10 passengers Combat Weight (mt): 12.60 Chassis Length Overall (m): 5.48 Height Overall (m): 2.85 Width Overall (m): 2.98 Ground Pressure (kg/cm²): 0.44</p> <p>Automotive Performance: Engine Type: 320-hp Diesel Cruising Range (km): 500 Speed (km/h): Max Road: 65 Max Off-Road: 46 Average Cross-Country: INA Max Swim: 6.0 Fording Depths (m): Amphibious</p> <p>Radio: INA</p> <p>Protection: Armor, Turret Front (mm): 14, front glacis Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A Active Protective System: NA NBC Protection System: N/A Smoke Equipment: N/A</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 12.7-mm (12.7 x 108), heavy MG, Type 54 Rate of Fire (rd/min): 80-100 practical/600 air targets in bursts Loader Type: Belt feed Ready/Stowed Rounds: INA Elevation (°): -4/+82 Fire on Move: Yes</p> <p>Auxiliary Weapon: N/A ATGM Launcher: N/A Firing Ports: 1 on each side, and 1 in the rear</p> <p>FIRE CONTROL FCS Name: N/A</p>	<p>Main Gun Stabilization: N/A Rangefinder: N/A Infrared Searchlight: N/A Sights w/Magnification: Gunner: Day: Open ladder sight, NFI Field of View (°): INA Acquisition Range (m): 2,000 Night: N/A Commander Fire Main Gun: No</p> <p>VARIANTS M1973: North Korean variant, also known as VTT-323, has a turret with twin 14.5-mm guns. Some versions have Susong-Po (AT-3/SAGGER variant) ATGM launcher and SA-7/16 manportable SAMs.</p> <p>Type 54-1: Self-propelled 122-mm open-mount howitzer. Type 70: Variant is a 130-mm (19-tube) multiple rocket launcher. Type YW-304: Self-propelled 82-mm mortar. Type YW-381: Self-propelled 120-mm mortar. YW-750: Ambulance with a similar box compartment YW-531C: This variant has a rectangular, three-sided open-topped shield around the gun, and better vision ports and ventilation. The C, D and E variants differ in intercom sets and firing ports.</p> <p>Type YW-701: Command post variant with a box compartment over rear half of vehicle, and 5 radios. Armament is a 7.62-mm MG.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 12.7-mm, APDS (Tungsten Core), Type 54 Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,500 vehicles / 1,600 aircraft Night: INA Tactical AA Range: 1,600 Armor Penetration (mm): INA</p> <p>12.7-mm, API, Type 54 Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,500 unarmored ground / 800 armored Night: INA Tactical AA Range: 1,000 Armor Penetration (mm): 21 (RHA) at 500 m, 13 at 1,000 m</p> <p>Other Ammunition Types: API-T, Russian Duplex, Russian Duplex-T, Incendiary-T, HE-T Type MDZ, HEI Type ZP</p>	

NOTES

Type 54 MG is a Chinese copy of former Soviet 12.7-mm DShKM.

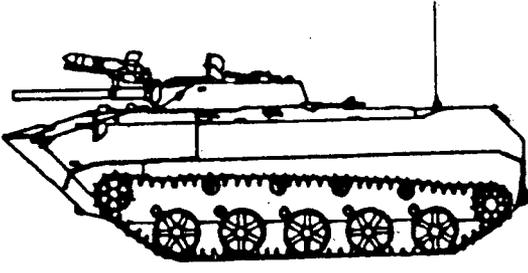
French Infantry Fighting Vehicle AMX-10P

	<p>Weapons & Ammunition Types</p> <p>20-mm Cannon APDS-T, API-T HEI, HEI-T</p> <p>7.62-mm coax MG Tracer, AP, API, Incendiary</p>	<p>Typical Combat Load</p> <p>760 (est) 260 500</p> <p>2,000</p>
<p>SYSTEM Alternative Designations: INA Date of Introduction: 1973 Proliferation: At least 3 countries Description: Crew: 3 Troop Capacity: 8 passengers Combat Weight (mt): 14.5 Length Overall (m): INA Height Overall (m): 2.57 Width Overall (m): 2.78 Ground Pressure (kg/cm²): 0.53</p> <p>Automotive Performance: Engine Type: 300-hp Diesel Cruising Range (km): 600 Speed (km/h): Max Road: 65 Max Off-Road: INA Average Cross-Country: INA Max Swim: 7 Fording Depths (m): Amphibious Mineclearing Equipment: N/A Self-Entrenching Blade: N/A</p> <p>Radio: INA</p> <p>Protection: Armor, Turret Front (mm): 12.7-mm frontal Applique Armor (mm): N/A Explosive Reactive Armor (mm): Available Active Protective System: N/A NBC Protection System: Yes Smoke Equipment: 4 smoke grenade launchers</p> <p>ARMAMENT Caliber, Type, Name: 20-mm automatic cannon M693 F1 Rate of Fire (rd/min): 740 Loader Type: Dual belt feed Ready/Stowed Rounds: INA Elevation (°): -8/+50 Fire on Move: INA</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62 x 51) MG, AAT 52 NF1 Mount Type: Coax Maximum Aimed Range (m): INA</p>	<p>Max Effective Range: Day: INA Night: INA Fire on Move: Yes Rate of Fire (rd/min): INA</p> <p>ATGM Launcher: N/A Firing Ports: None</p> <p>FIRE CONTROL FCS Name: INA Main Gun Stabilization: INA Rangefinder: INA Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: OB 40 Day/ night sight Field of View (°): INA, Acquisition Range (m): INA Night: OB 40 Day/ night sight Field of View (°): INA Acquisition Range (m): INA Commander Fire Main Gun: No</p> <p>VARIANTS AMX-10P: Variant with Milan or HOT ATGM launcher AMX-10P/Milan: ATGM launcher vehicle, with two launchers AMX/HOT: ATGM launcher vehicle (Toucan II turret, 4 launchers) AMX-10 TM: Mortar carrier towing 120-mm RT-61 mortar AMX-10 PAC 90: Fire support/AT variant with Giat 90-mm gun AMX-10P Marine: Improved swim variant w/ 12.7/25/90-mm gun AMX-10 PC: Command variant with varied command stations AMX-10 RC: Wheeled (6 x 6) fire support vehicle with 90-mm gun AMX-10 RAC: The same fire support chassis with 105-mm gun</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 20-mm (20x139) APDS-T Maximum Aimed Range (m): INA Max Effective Range (m): Day: 1,300 Night: INA Tactical AA Range: INA Armor Penetration (mm): INA</p> <p>Other Ammunition Types: API, API-T, HEI, HEI-T</p>	

NOTES

A French SNPE explosive reactive armor (ERA) kit and others are available for use on the AMX-10P. However, during dismounted troop movement, ERA would be a hazard. Thus, passive armor is more likely; and ERA application is doubtful.

Russian Airborne Fighting Vehicle BMD-1

	Weapons & Ammunition Types	Typical Combat Load
	73-mm gun HEAT HE	40 (est) 16 24
	AT-3/a/b/c/Imp ATGM HEAT HE	4 3 1
	7.62-mm coax MG 2x 7.62-mm bow MG	2,000 4,000

SYSTEM

Alternative Designations:

Date of Introduction: 1969

Proliferation: At least 1 country

Description:

Crew: 2

Troop Capacity: 5 passengers (+1)

Combat Weight (mt): 13.3

Chassis Length Overall (m): 6.74

Height Overall (m): 2.15

Width Overall (m): 2.94

Ground Pressure (kg/cm²): 0.57

Automotive Performance:

Engine Type: 240-hp Diesel

Cruising Range (km): 600

Speed (km/h):

Max Road: 65

Max Off-Road: 40-45

Average Cross-Country: INA

Max Swim: 7

Fording Depth (m): Amphibious

Radio: R-123M

Protection:

Armor, Turret Front (mm): 23 or Antibullet

Applique Armor (mm): See NOTES

Explosive Reactive Armor (mm): See NOTES

Active Protective System: N/A

Mineclearing Equipment: N/A

Self-Entrenching Blade: N/A

NBC Protection System: Collective

Smoke Equipment: VEES

ARMAMENT

Main Armament:

Caliber, Type, Name: 73-mm smoothbore gun, 2A28/Grom

Rate of Fire (rd/min): 7-8

Loader Type: Autoloader

Ready/Stowed Rounds: 40 / 0

Elevation (°): -4/ +33

Fire on Move: Yes, but only 10 km/h or less (est)

Auxiliary Weapons:

Caliber, Type, Name: 7.62-mm (7.62x 54R) machinegun, PKT

Mount Type: Coax

Maximum Aimed Range (m): 1,300

Max Effective Range (m):

Day: 1,000/400-500 on the move

Night: 800

Fire on Move: Yes

Rate of Fire (rd/min): 250 practical / 650 cyclic, 2-10 round bursts

Caliber, Type, Name: 7.62-mm machinegun, PKT

Mount Type: Bow (ball-mounted)

Maximum Aimed Range (m): 1,000

Max Effective Range (m):

Day: 1,000/ 400-500 on the move

Night: N/A

Fire on Move: Yes

Rate of Fire (rd/min): 250 practical / 650 cyclic, 2-10 round bursts

ATGM Launcher:

Name: 9P111

Launch Method: Rail-launched

Guidance: MCLOS

Command Link: Wire

Launcher Dismountable: Yes

Firing Ports: 1 on each side, 1 in left rear door

FIRE CONTROL

FCS Name: INA

Main Gun Stabilization: N/A

Rangefinder: Stadiametric

Infrared Searchlight: Yes

Sights w/Magnification:

Gunner:

Day: 1PN22M1, 8x

Field of View (°): 15

Acquisition Range (m):

Night: 1PN22M1, 6.7x

Field of View (°): 6

Acquisition Range (m): 800-1,000, based on light

Commander Fire Main Gun: No

VARIANTS

BMD-1K: Command IFV (FSU), with added R-126 and R-107.

BMD-1M: Variant with improved ventilation and road wheels.

BMD-1P: Widely fielded IFV with AT-4/5 replacing AT-3.

BMD-1PK: Company commander variant (FSU) of BMD-1P.

BMD-2: Widely fielded variant with a 30-mm automatic gun and with AT-3 ATGM launcher replaced by AT-4/5 ATGM launcher.

BTR-D: Stretched (6-road wheel) armored multipurpose transporter-variant, with two 7.62-mm MGs but no turret. This chassis has been used for a variety of other airborne vehicles.

Russian Airborne Fighting Vehicle BMD-1 continued

Worldwide Equipment Guide

<p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 73-mm HEAT-FS, PG-9- Maximum Aimed Range (m): 1,300 Max Effective Range (m): Day: 800, but 600 or less on the move Night: 800 Tactical AA Range: INA Armor Penetration (mm): 335 (RHA)</p> <p>73-mm HEAT-FS, NFI Maximum Aimed Range (m): 1,300 Max Effective Range (m): Day: 1,000, but 600 or less on the move Night: 800-1,000 Tactical AA Range: INA Armor Penetration (mm): >400 (RHA)</p> <p>73-mm HE, OG-9 Maximum Aimed Range (m): 1,300, 600 or less on the move Max Effective Range (m): Day: 1,300, but 600 or less on the move Night: 800-1,000 Tactical AA Range: INA Armor penetration (mm): INA</p> <p>73-mm HE, OG-9M1 Maximum Aimed Range (m): 4,500 Max Effective Range (m): Day: 1,300, but 600 or less on the move Night: 800-1,000 Tactical AA Range: INA Armor Penetration (mm): INA</p> <p>Other Ammunition Types: OG-9M</p>	<p>Antitank Guided Missiles: Name: AT-3, -3A, -B Warhead Type: Tandem HEAT Armor Penetration (mm): 410 RHA Range (m): 3,000</p> <p>Name: AT-3C Warhead Type: Tandem HEAT Armor Penetration (mm): 520 RHA Range (m): 3,000</p> <p>Name: AT-3C Imp/ Polk (Slovenian) Warhead Type: Precursor with HEAT Armor Penetration (mm): 580 RHA Range (m): 3,000</p> <p>Name: Malyutka-2 (Russian) Warhead Type: Tandem HEAT Armor Penetration (mm): 800 RHA Range (m): 3,000</p> <p>Name: Malyutka HE (Russian) Warhead Type: Frag-HE Armor Penetration (mm): N/A Range (m): 3,000</p>
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NOTES

Vehicle can be parachute landed with airborne troops onboard. Height can be lowered.

Russian KBP offers a drop-in one-man turret, called Kliver, with a stabilized 2A72 30-mm gun, a 4-Kornet ATGM launcher, thermal sights, and improved fire control system. The Russian Volgograd Tractor Plant offers the B30 turret (a drop-in one-man turret with 2A42 30-mm gun, 7.62-mm coax MG, and a 9P135M launcher for AT-4/-5 ATGM). A Russian AG-17 30-mm automatic grenade launcher is available for BMD-1.

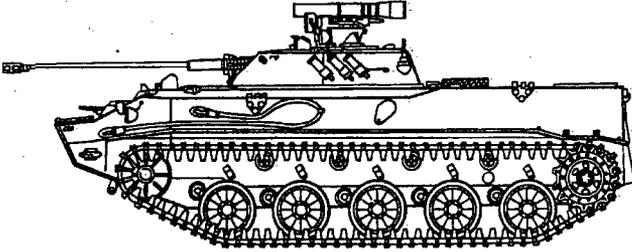
Other options are spall liners, air conditioning, and a more powerful engine. A French SNPE explosive reactive armor (ERA) kit and others are available for use on the BMD-1. However, during dismounted troop movement, ERA would be a hazard. Thus, passive armor is more likely; and ERA application is doubtful. For amphibious use, additional armor application is unlikely.

The Slovenian TS-M ATGM thermal night sight has a detection range of 4,500m and a recognition range of 2,000m.

The AT-3 HE-Blast ATGM is used for killing personnel and destroying bunkers and other fortifications.

The AT-3C Polk features a nose probe, an improved motor for increased velocity, lower smoke noise signature and a SACLOS launcher with improved sights.

Russian Airborne Fighting Vehicle BMD-3

	<p>Weapons & Ammunition Types</p> <p>30-mm automatic gun HEI-T, Frag-HE AP-T, APDS-T, APFSDS</p> <p>ATGM launcher 7.62-mm coax MG 30-mm grenade launcher 5.45-mm light MG</p>	<p>Typical Combat Load</p> <p>860 340/240 160/120</p> <p>6 2,000 551 2,325</p>
	<p>SYSTEM Alternative Designations: N/A Date of Introduction: 1992 Proliferation: At least 1 country Description: Crew: 3 Troop Capacity: passengers: 4 (+3) Combat Weight (mt): 12.9 Length Overall (m): 6.00 Height Overall (m): 2.25 Width Overall (m): 3.13 Ground Pressure (kg/cm²): 0.32 (wide track) / .48 (standard track)</p> <p>Automotive Performance: Engine Type: 450-hp Diesel Cruising Range (km): 500 Speed (km/h): Max Road: 70 Max Off-Road: 45 Average Cross-Country: INA Max Swim: 10 Fording Depth (m): Amphibious</p> <p>Radio: R-173</p> <p>Protection: Armor, Turret Front (mm): "Antibullet" (7.62) Applique Armor (mm): N/A Explosive Reactive Armor (mm): Available Active Protective System: N/A Mineclearing Equipment: KMT-8 plow or -10 roller Self-Entrenching Blade: N/A NBC Protection System: Collective Smoke Equipment: Smoke grenade launchers, 3 x each side of turret Vehicle engine exhaust smoke system (VEESS)</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 30-mm automatic gun, 2A42 Rate of Fire (rd/min): 550 cyclic in bursts/ 200-300 practical Loader Type: Dual-belt feed Ready/Stowed Rounds: 500/ 360 Elevation (°): -5 to +74 Fire on Move: Yes</p> <p>Auxiliary Weapons: Caliber, Type, Name: 30-mm automatic grenade launcher, AG-17 Mount Type: Bow left side Maximum Aimed Range (m): 1,700</p> <p>Max Effective Range (m): Day: 1,200 Night: N/A Fire on Move: Yes Rate of Fire (rd/min): 60-100 practical in short (≤ 5 rds) or long (6-10 rd) bursts.</p> <p>Caliber, Type, Name: 7.62-mm (7.62 x 54R) machinegun, PKT Mount Type: Turret coax Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,000 Night: 1,000 Fire on Move: Yes Rate of Fire (rd/min): 250 practical / 650 cyclic, 2-10 round bursts</p> <p>Caliber, Type, Name: 5.45-mm light machinegun, RPK-74 Mount Type: Bow right side Maximum Aimed Range (m): 1,000 Max Effective Range (m): Day: 800 Night: INA Fire on Move: Yes Rate of Fire (rd/min): 150 automatic/ 50 semiautomatic</p> <p>ATGM Launcher: Name: 9P135 Launch Method: Tube-launched Guidance: SACLOS Command Link: Wire Launcher Dismountable: Yes</p> <p>FIRE CONTROL FCS Name: INA Main Gun Stabilization: 2-plane Rangefinder: Laser Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: BPK-2-42 Field of View (°): 8 Acquisition Range (m): INA Night: BPK-2-42 II/IR Field of View (°): INA Acquisition Range (m): INA Commander Fire Main Gun: No</p> <p>VARIANTS None</p>	

Russian Airborne Fighting Vehicle BMD-3 continued

Worldwide Equipment Guide

<p>MAIN ARMAMENT AMMUNITION- Caliber, Type, Name: 30-mm AP-T Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 1,500 Night: INA Tactical AA Range: 4,000 Armor Penetration (mm): 18 (RHA) at 1,500m</p> <p>30-mm APDS Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 2,000 Night: INA Tactical AA Range: 4,000 Armor Penetration (mm): 25 (RHA) at 1,500m</p> <p>30-mm APFSDS-T M929 Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 2,000+ Night: INA Tactical AA Range: 4,000 Armor penetration (mm): 55 (RHA) at 1,000m, 45 at 2,000m</p>	<p>30-mm Frag-HE Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: 4,000 Night: INA Tactical AA Range: 4,000 Armor Penetration (mm): INA</p> <p>Other Ammunition Types: 30-mm HEI-T</p> <p>Antitank Guided Missiles: Name: AT-5B/Konkurs-M Warhead Type: Tandem shaped charge (HEAT) Armor Penetration (mm): 925 (RHA) Range (m): 4,000</p> <p>Name: AT-5/Spandrel Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 650 (RHA) Range (m): 4,000</p>
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NOTES

BMD-3 has variable height control.

Automatic grenade launcher has 290 ready rounds and 261 in the rack. The ATGM launcher has 3 ready rounds (one on the launcher), and two stowed.

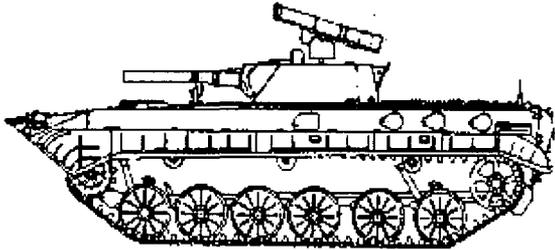
A French SNPE explosive reactive armor (ERA) kit and others are available for use on the BMD-3. However, during dismounted troop movement, ERA would be a hazard. Thus, passive armor is more likely and ERA application is doubtful. For amphibious use, additional armor application is unlikely. Other options are spall liners, air conditioning, and a more powerful engine.

The Russian SANOET-1 thermal gunner's sight is available. Thermal sights are available for the ATGM launcher. The Russian Trakt/IPN65 thermal imaging ATGM night sight is optional. Acquisition range is 2,500 m (NFI). For the ATGM launcher in dismount configuration, the Russian Mulat/IPN86 lightweight thermal ATGM night sight has 3,600 m detection range and 2,000 m identification range.

French-German Flame-V adapter kit permits the BMD-3 to launch Milan, Milan-2 and Milan-3 ATGMs.

Russian KBP offers a drop-in one-man turret, called Kliver, with a stabilized 2A72 30-mm gun, a 4 Kornet ATGM launcher, thermal sights, a coaxial 7.62-mm MG and improved fire control system.

Russian Infantry Fighting Vehicle BMP-1P

	<p>Weapons & Ammunition Types</p> <p>73-mm gun HEAT-FS HE</p> <p>ATGM AT-4/-4B/-5/-5B</p> <p>7.62-mm coax MG</p>	<p>Typical Combat Load</p> <p>40 (est) 16 24</p> <p>4</p> <p>2,000</p>
<p>SYSTEM Alternative Designations: BWP-1 (Poland), see NOTES Date of Introduction: 1974 Proliferation: At least 7 countries Description: Crew: 3 Troop Capacity: 6 passengers Combat Weight (mt): 13.3 Chassis Length Overall (m): 6.74 Height Overall (m): 2.15 Width Overall (m): 2.94 Ground Pressure (kg/cm²): 0.57</p> <p>Automotive Performance: Engine Type: 300-hp Diesel Cruising Range (km): 600 Speed (km/h): Max Road: 65 Max Off-Road: 40-45 Average Cross-Country: INA Max Swim: 7 Fording Depth (m): Amphibious</p> <p>Radio: R-123, or R-173</p> <p>Protection: Armor, Turret Front (mm): 19-23 Applique Armor (mm): N/A Explosive Reactive Armor (mm): Available Active Protective System: N/A Mineclearing Equipment: KMT-8 plow available Self-Entrenching Blade: N/A NBC Protection System: Collective Smoke Equipment: Six 81-mm smoke grenade launchers, VEES</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 73-mm smoothbore gun 2A28/Grom Rate of Fire (rd/min): 7-8 Loader Type: Autoloader Ready/Stowed Rounds: 40 / 0 Elevation (°): -4/+33 Fire on Move: Yes, but only 10 km/h or less (est)</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 54R) machinegun, PKT Mount Type: Coax Maximum Aimed Range (m): 1,300 Max Effective Range (m): Day: 1,000 / 400-500 on the move Night: 800 Fire on Move: No Rate of Fire (rd/min): 250 practical / 650 cyclic, 2-10 round bursts</p>	<p>ATGM Launcher: Name: 9P135M2 Launch Method: Tube-launched Guidance: SACLOS Command Link: Wire Launcher Dismountable: Yes</p> <p>Firing Ports: 4 on each side, 1 in left rear door</p> <p>FIRE CONTROL FCS Name: 1PN22M1 Main Gun Stabilization: N/A Rangefinder: Stadiametric Infrared Searchlight: OU-3GK Sights w/Magnification: Gunner: Day: 1PN22M1, 8 x Field of View (°): 15 Acquisition Range (m): 1,300 Night: 1PN22M1, 6.7x Field of View (°): 6 Acquisition Range (m): 800-1,000 based on light Commander Fire Main Gun: No</p> <p>VARIANTS BMP-1PG: This recently offered Russian upgrade is similar to BMP-1P with an added AG-17 30-mm automatic grenade launcher and other options, including thermal sights.</p> <p>BMP-1PK: Command variant, with addition of R-126 and R-107 transceiver. A small telescoping antenna is mounted on right rear. Firing ports and telescopes on right side are blocked off.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 73-mm HEAT-FS, PG-9 Maximum Aimed Range (m): 1,300 Max Effective Range (m): Day: 800, but 600 or less on the move in 2-4 round bursts Night: 800-1,000 Tactical AA Range: INA Armor Penetration (mm): 335 (RHA)</p> <p>73-mm HEAT-FS, NFI Maximum Aimed Range (m): 1,300 Max Effective Range (m): Day: 1,000/ 600 or less on the move Night: 800-1,000 Tactical AA Range: INA Armor Penetration (mm): >400 (RHA)</p>	

Russian Infantry Fighting Vehicle BMP-1P continued

Worldwide Equipment Guide

<p>73-mm HE, OG-9M1 Maximum Aimed Range (m): 4,500 Max Effective Range (m): Day: 1,300/ 600-1,000 on the move Night: 800-1,000 Tactical AA Range: INA Armor penetration (mm): INA</p> <p>Other Ammunition Types: OG-9, OG-9M</p> <p>Antitank Guided Missiles: Name: AT-5/SPANDREL Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 650 (RHA) Range (m): 4,000</p>	<p>Name: AT-5B/Konkurs-M Warhead Type: Tandem shaped charge (HEAT) Armor Penetration (mm): 925 (RHA) Range (m): 4,000</p> <p>Name: AT-4/SPIGOT Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 480 (RHA) Range (m): 2,000</p> <p>Name: AT-4B/Factoria Warhead Type: Tandem Shaped charge (HEAT) Armor Penetration (mm): 550 (RHA) Range (m): 2,500</p>
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NOTES

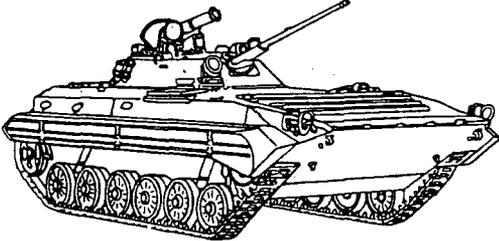
The prototype IFV, known as BMP, was not fielded. Initial BMP production variant, BMP-A, was halted with insignificant numbers. The baseline production IFV, BMP-1, has an AT-3/SAGGER antitank guided missile. The BMP-1P upgrade is widely fielded, with an AT-4/-5 ATGM launcher replacing the AT-3 launcher. The vehicle also added smoke grenade launchers. This variant should generally be portrayed where OPFOR calls for the BMP-1. For applications where a robust and modernized OPFOR is expected, use AT-5B ATGM. The AT-4/-4B ATGMs are less likely to be employed on this vehicle.

Other options are spall liners, air conditioning, and a more powerful engine. A French SNPE explosive reactive armor (ERA) kit and others are available for use on the BMD-1. However, during dismounted troop movement, ERA would be a hazard. Thus, passive armor is more likely; and ERA application is doubtful. Additional armor application may jeopardize amphibious capability.

Russian AG-17 30-mm automatic grenade launcher modification is available for use on BMP-1P. Russian KBP offers a drop-in one man turret, called Kliver, with a stabilized 2A72 30-mm gun, a 4 Kornet ATGM launcher, thermal sights, and improved fire control system.

The Russian Alis thermal gunner's sight is available. The Slovenian TS-F ATGM thermal night sight has a detection range of 4,500 m and a recognition range of 2,000 m.

Russian Infantry Fighting Vehicle BMP-2

	<p>Weapons & Ammunition Types</p> <p>30-mm automatic gun HEI-T, Frag-HE AP-T, APDS-T, APFSDS-T</p> <p>ATGM AT-5/-5B/-4/-4B</p> <p>7.62-mm coax MG</p>	<p>Typical Combat Load</p> <p>500</p> <p>340</p> <p>160</p> <p>5</p> <p>2,000</p>
	<p>SYSTEM Alternative Designations: Yozh (Russia), Sarath (India) Date of Introduction: 1980 Proliferation: At least 20 countries Description: Crew: 3 Troop Capacity: 7 passengers Combat Weight (mt): 14.3 Chassis Length Overall (m): 6.72 Height Overall (m): 2.45 Width Overall (m): 3.15 Ground Pressure (kg/cm²): 0.63</p> <p>Automotive Performance: Engine Type: 300-hp Diesel Cruising Range (km): 600 Speed (km/h): Max Road: 65 Max Off-Road: 45 Average Cross-Country: 35 Max Swim: 7 Fording Depth (m): Amphibious</p> <p>Radio: R-123M transceiver or R-173</p> <p>Protection: Armor, Turret Front (mm): 23-33 Applique Armor (mm): On BMP-2D Explosive Reactive Armor (mm): Available, see NOTES Active Protective System: N/A Mineclearing Equipment: KMT-8 mine plow available Self-Entrenching Blade: N/A NBC Protection System: Collective Smoke Equipment: 6 smoke grenade launchers, VEES</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 30-mm automatic gun, 2A42 Rate of Fire (rd/min): 550 cyclic in bursts/ 200-300 practical Loader Type: Dual-belt feed Ready/Stowed Rounds: 500/0 Elevation (°): -5 to +74 Fire on Move: Yes</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 54R) machinegun, PKT Mount Type: Turret coax Maximum Aimed Range (m): 2,000</p> <p>Max Effective Range (m): Day: 1,000 Night: INA Fire on Move: Yes Rate of Fire (rd/min): 250 practical/650 cyclic, 2-10 round bursts</p> <p>ATGM Launcher: Name: 9P135M1/M3 Launch Method: Tube-launched Guidance: SACLOS Command Link: Wire Launcher Dismountable: Yes</p> <p>Firing Port: 4 on left side, 3 on right side 1 in left rear door</p> <p>FIRE CONTROL FCS Name: BPK-1-42 or BPK-2-42 Main Gun Stabilization: 2-plane Rangefinder: Laser Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: BPK-1-42 or BPK-2-42 Field of View (°): 8 Acquisition Range (m): 2,500-4,000 (est) Night: BPK-1-42 or BPK-2-42 II/IR Field of View (°): INA Acquisition Range (m): INA Commander Fire Main Gun: No</p> <p>VARIANTS BMP-2D: Variant with add-on plate armor, but which cannot swim BMP-2E: Variant with 6-mm steel plates added and track skirts BMP-2K: Command variant with additional radio</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 30-mm AP-T Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 1,500 Night: INA Tactical AA Range: 4,000 Armor Penetration (mm): 18 (RHA, 60°) at 1,500 m</p>	

Russian Infantry Fighting Vehicle BMP-2 continued

Worldwide Equipment Guide

<p>30-mm APDS Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 2,000 Night: INA Tactical AA Range: 4,000 Armor Penetration (mm): 25 (RHA) at 1,500m</p> <p>30-mm APFSDS-T M929 Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 2,000+ Night: INA Tactical AA Range: 4,000 Armor penetration (mm): 55 (RHA) at 1,000m/45 at 2,000m</p> <p>30-mm Frag-HE Maximum Aimed Range (m): 4,000/ 2,500 point target Max Effective Range (m): Day: 4,000 Night: INA Tactical AA Range: 4,000 Armor Penetration (mm): INA</p> <p>Other Ammunition Types: 30-mm HEI-T</p>	<p>Antitank Guided Missiles: Name: AT-5/SPANDREL Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 650 (RHA) Range (m): 4,000</p> <p>Name: AT-5B/Konkurs-M Warhead Type: Tandem shaped charge (HEAT) Armor Penetration (mm): 925 (RHA) Range (m): 4,000</p> <p>Name: AT-4/SPIGOT Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 480 (RHA) Range (m): 2,000</p> <p>Name: AT-4B/Factoria Warhead Type: Tandem shaped charge (HEAT) Armor Penetration (mm): 550 (RHA) Range (m): 2,500</p>
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NOTES

A French SNPE explosive reactive armor (ERA) kit and others are available for use on the BMP-2. However, during dismounted troop movement, ERA would be a hazard. Thus, passive armor is more likely and ERA application is doubtful. For amphibious use, additional armor application is unlikely. Other options are spall liners, air conditioning, and a more powerful engine.

Russian AG-17 30-mm automatic grenade launcher modification is offered for BMP-2.

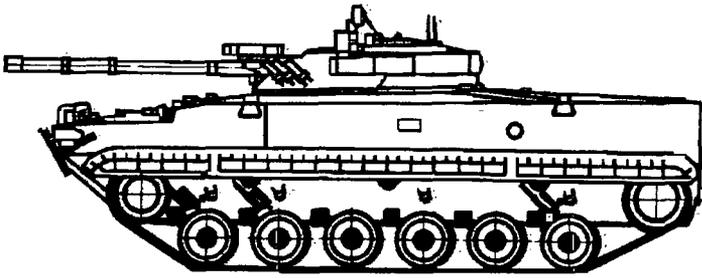
Russian KBP offers a drop-in one-man turret, called Kliver, with a stabilized 2A72 30-mm gun, a 4 Kornet ATGM launcher, thermal sights, a coaxial 7.62-mm MG and improved fire control system.

ATGM load consists of one ready on the launcher and four stowed. They are readily accessible, but require hand loading from an open hatch. The AT-5 and AT-5B are more likely than AT-4 and -4B.

French-German Flame-V adaptor kit permits the BMP-2 system to launch Milan, Milan-2, and Milan-3 ATGMs.

Thermal sights are available. The Russian SANOET-1 thermal gunner's sight is available. The Russian Trakt/1PN65 thermal imaging (TI) ATGM night sight is optional. Acquisition range is 2,500 m (NFI). For the launcher in dismount configuration, the Slovenian TS-F ATGM night sight is available and has a detection range of 4,500 m and recognition range of 2,000 m. The Russian Mulat/1PN86 lightweight TI ATGM thermal sight has 3,600 m detection range and 2,000 m identification range.

Russian Infantry Fighting Vehicle BMP-3

	<table border="1"> <thead> <tr> <th>Weapons & Ammunition Types</th> <th>Typical Combat Load</th> </tr> </thead> <tbody> <tr> <td>100-mm rifled gun</td> <td>40</td> </tr> <tr> <td>Frag-HE</td> <td>40</td> </tr> <tr> <td>AT-10/Imp ATGM</td> <td>8</td> </tr> <tr> <td>30-mm automatic gun</td> <td>500</td> </tr> <tr> <td>HEI-T, Frag-HE</td> <td>340</td> </tr> <tr> <td>AP-T, APDS-T or APFSDS-T</td> <td>160</td> </tr> <tr> <td>7.62-mm coax MG</td> <td>2,000</td> </tr> <tr> <td>2 x 7.62-mm bow MG</td> <td>4,000</td> </tr> </tbody> </table>	Weapons & Ammunition Types	Typical Combat Load	100-mm rifled gun	40	Frag-HE	40	AT-10/Imp ATGM	8	30-mm automatic gun	500	HEI-T, Frag-HE	340	AP-T, APDS-T or APFSDS-T	160	7.62-mm coax MG	2,000	2 x 7.62-mm bow MG	4,000
	Weapons & Ammunition Types	Typical Combat Load																	
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<p>SYSTEM Alternative Designations: Soviet ICV M1990/1 Date of Introduction: 1990 Proliferation: At least 7 countries Description: Crew: 3 Troop Capacity: 7 passengers Combat Weight (mt): 18.70 Chassis Length Overall (m): 6.73 Height Overall (m): 2.45 Width Overall (m): 3.15 Ground Pressure (kg/cm²): 0.62</p> <p>Automotive Performance: Engine Type: 500-hp Diesel Cruising Range (km): 600 Speed (km/h): Max Road: 70 Max Off-Road: 45 Average Cross-Country: 35 Max Swim: 10 Forcing Depth (m): Amphibious</p> <p>Radio: R-173, R-173P</p> <p>Protection: Armor, Turret Front (mm): 30-35 front glacis Applique Armor (mm): Yes on turret Explosive Reactive Armor (mm): Available, see NOTES Active Protective System: N/A Mineclearing Equipment: KMT-8 plow available Self-Entrenching Blade: Yes NBC Protection System: Collective Smoke Equipment: 6 smoke grenade launchers, VEES</p> <p>ARMAMENT Main Armaments: Caliber, Type, Name: 100-mm rifled gun 2A70 Rate of Fire (rd/min): 8-10 Loader Type: Autoloader gun rounds; manual for gun and ATGMs Ready/Stowed Rounds: 22/18 for rounds, 3/5 for ATGMs Elevation (°): -5 to +60 Fire on Move: Yes</p> <p>Caliber, Type, Name: 30-mm automatic gun 2A72 Rate of Fire: 350 rd/min (cyclic) in bursts Loader Type: Dual-belt feed Ready/Stowed Rounds: 500/0</p>	<p>Elevation (°): -5 to +60 Fire on Move: Yes</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 54R) machinegun, PKT Mount Type: Turret coax Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,000 Night: INA Fire on Move: Yes Rate of Fire (rd/min): 250 practical / 650 cyclic, in 2-10 round bursts</p> <p>Caliber, Type, Name: 7.62-mm (7.62x 54R) machinegun, PKT Mount Type: Bow left and right Maximum Aimed Range (m): 1,000 Max Effective Range (m): Day: 1,000/400-500 on the move Night: N/A Fire on Move: Yes Rate of Fire (rd/min): 250 practical / 650 cyclic, in 2-10 round bursts</p> <p>ATGM Launcher: Name: 2A70 100-mm gun Launch Method: Gun-launched Guidance: SACLOS, laser-beam rider Command Link: Encoded infrared laser-beam Launcher Dismountable: No</p> <p>Firing Ports: 2 on each side, 1 in left rear door</p> <p>FIRE CONTROL FCS Name: 1K13-2 Main Gun Stabilization: 2-plane Rangefinder: Laser Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: 1K13-2, 8x ; IP3-10 antiaircraft, 2.6x; PPD-1 stand-by Field of View (°): INA Acquisition Range (m): 5,200 Night: 1K13-2 II night channel, 5.5x Field of View (°): INA Acquisition Range (m): INA Commander Fire Main Gun: Yes</p>																		

Russian Infantry Fighting Vehicle BMP-3 continued

Worldwide Equipment Guide

<p>VARIANTS</p> <p>BMP-3F: Amphibious Armored Combat Vehicle developed for Naval Infantry.</p> <p>BMP-3 M1995: ATGM launcher vehicle, with Kornet (AT-14) launcher and autoloader, and thermal sights.</p> <p>9P157: ATGM launcher vehicle, with Krizantema (AT-15) ATGM autoloader, MMW and thermal fire control system.</p> <p>BMP-3K: Command variant, with electronic round fuze system for 100-mm gun. Bow MGs are removed. Added radios are R-159, R-143 and R-174.</p> <p>BREhM-L: Armored recovery vehicle (ARV).</p> <p>BRM-3K: Combat recon vehicle with radar and 30-mm gun.</p> <p>BMP-3: UAE upgrade improvements including Namut Thermal Night sight.</p> <p>MAIN ARMAMENT AMMUNITION</p> <p>Caliber, Type, Name: 100-mm HE 3UOF17 Maximum Aimed Range (m): 5,000 Max Effective Range (m): Day: 4,000 Night: INA Tactical AA Range: 4,000 Armor Penetration (mm): 25 (RHA)</p> <p>Caliber, Type, Name: 100-mm HE-Shapnel (HEF/MOD.96) Focused-fragmentation, electronically-fuzed Maximum Aimed Range (m): 5,200 Max Effective Range (m): Day: 5,200 Night: INA Tactical AA Range: 4,000 Armor Penetration (mm): INA</p> <p>30-mm APFSDS-T M929 Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 2,000+ Night: INA Tactical AA Range: 4,000 Armor penetration (mm): 55 (RHA) at 1,000 m, 45 at 2,000 m</p>	<p>30-mm Frag-HE Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: 4,000 Night: INA Tactical AA Range: 4,000 Armor Penetration (mm): INA</p> <p>30-mm AP-T Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 1,500 Night: INA Tactical AA Range: 4,000 Armor Penetration (mm): 18 (RHA, 60°) at 1,500 m</p> <p>30-mm APDS Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 2,000 Night: INA Tactical AA Range: 4,000 Armor Penetration (mm): 25 (RHA) at 1,500 m</p> <p>Other Ammunition Types: 100-mm HE-I, 30-mm HEI-T</p> <p>Antitank Guided Missiles Name: AT-10/Basnya Warhead Type: Shaped charge Command Link: Encoded laser-beam Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 650 (RHA) Range (m): 4,000</p> <p>Name: AT-10 Improved Warhead Type: Tandem shaped charge Armor Penetration (mm): 700 (RHA) behind ERA Range (m): 4,000 Launcher Dismountable: No</p>
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A French SNPE ERA kit and others are available for use on the BMP-3. However, during dismounted troop movement ERA would be a hazard. Thus, passive armor is more likely and ERA application is doubtful. Other options are spall liners and air conditioning.

Russian AG-17 30-mm automatic grenade launcher modification is available for use on BMP-3.

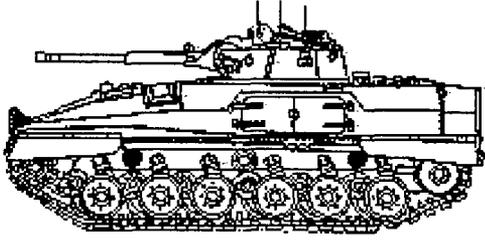
Russian KBP offers a drop-in one-man turret called Kliver, with a stabilized 2A72 30-mm gun, a 4 Kornet ATGM launcher, thermal sights, and improved fire control system.

The Namut thermal gunner's sight is available for use on BMP-3. This uses the French Athos thermal camera. Namut sight has 3x and 10x channels. Night acquisition range: 2,600 m (NFI)

Stowed rounds and ATGMs can be passed from the passenger compartment to the gunner for hand loading. This includes ATGMs.

The "HEF" (or "HE-Shrapnel") round can be employed in indirect fire mode with air burst to 7,000 m.

British Infantry Fighting Vehicle Warrior

	<p>Weapons & Ammunition Types</p> <p>30-mm auto gun HEI-T APDS-T, APSE-T</p> <p>7.62-mm coax MG Ball, Ball-T</p>	<p>Typical Combat Load</p> <p>228</p> <p>2,200</p>
<p>SYSTEM Alternative Designations: FV 511, MCV-80 Date of Introduction: 1988 Proliferation: At least two countries Description: Crew: 3 Troop Capacity: 7 passengers Combat Weight (mt): 24.00 Chassis Length Overall (m): 6.34 Height Overall (m): 2.79 Width Overall (m): 3.03 Ground Pressure (kg/cm²): 0.65</p> <p>Automotive Performance: Engine Type: 550-hp Diesel Cruising Range (km): 660 Speed (km/h): Max Road: 75 Max Off-Road: 60 Cross-Country: 48 Max Swim: N/A Fording Depth (m): 1.3 Unprepared</p> <p>Radio: INA</p> <p>Protection: Armor, Turret Front (mm): Against 14.5-mm gun Applique Armor (mm): Available (see VARIANTS) Explosive Reactive Armor (mm): N/A Active Protective System: N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A NBC Protection System: Yes Smoke Equipment: Smoke grenade launchers (4 each side of turret)</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 30-mm automatic cannon, RARDEN L21A1 Rate of Fire (rd/min): 80-90 cyclic Loader Type: Feed tray, clip-fed (3-round clips) Ready/Stowed Rounds: 228/0 Elevation (°): -10/+45 Fire on Move: INA</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm chain gun, L94A1 Mount Type: Turret coax Maximum Aimed Range (m): INA Max Effective Range: INA</p>	<p>Fire on Move: Yes Rate of Fire (rd/min): 520-570</p> <p>ATGM Launcher: N/A Firing Ports: None</p> <p>FIRE CONTROL FCS Name: INA Main Gun Stabilization: N/A Rangefinder: INA Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: INA Field of View (°): INA Acquisition Range (m): INA Night: SPAV L2A1 II sight Field of View (°): INA Acquisition Range (m): INA Commander Fire Main Gun: No</p> <p>VARIANTS Command variant is outfitted with radios, mapboards, other staff support equipment, and Vickers Defence Turret.</p> <p>Desert Warrior: Variant with the 2-man turret from LAV-25, with a US M242 Bushmaster 25-mm automatic cannon, coaxial MG and 1-2 ATGM launchers. Other modifications are additional passive armor and three periscopes for improved vision. Sold to Kuwait.</p> <p>Desert Storm Variant: Changes included passive armor added to hull sides and a pintle mount for a Milan-2 ATGM launcher.</p> <p>Mechanized Artillery Observation Vehicle (MAOV): It resembles an IFV, but is fitted with a dummy cannon, improved artillery reconnaissance and automation systems, and land navigation. Options include an Osprey 8-power optical and thermal sight with Nd:YAG laser designator for the observer.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 30-mm APDS-T, L14 Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: 1,100 Night: INA Armor Penetration (mm): INA</p> <p>Other Ammunition Types: 30-mm APSE-T (AP Secondary Effects-T L5, HEI-T L13)</p>	

NOTES

Variants available but not in production include engineer, recovery, mortar vehicles, armored fighting vehicles with 90-mm and 105-mm guns, an APC with 7.62-mm chain gun, ATGM launcher vehicles for Milan, HOT and Trigat, and a low-profile chassis for a reduced signature IFV.

Chapter 3 Reconnaissance Vehicles

The modern battlefield is becoming increasingly mobile and lethal. The challenge for reconnaissance systems is to acquire the enemy, transmit intelligence, and survive for the next mission. Therefore, ground forces use specialized reconnaissance vehicles. Most will employ a mix of systems, including tanks and infantry fighting vehicles, dismounted reconnaissance patrols, aerial reconnaissance, and reconnaissance vehicles. The spectrum of reconnaissance vehicles currently ranges from older systems ill-suited for modern requirements, to survivable, mobile, and lethal systems, equipped with complex sensor arrays and communications suites.

A number of forces fielded *combat reconnaissance vehicles* (CRVs) designed for operations at or beyond the FLOT, not to initiate combat but to survive if engaged. They may operate in combat reconnaissance patrols with heavily armed vehicles such as tanks and IFVs. Many offer sensors no better than those on other armored vehicles, and use optics for a variety of combat support missions, such as fire support. Examples of these are the British Saladin Armored Car and the Austrian Pandur armored reconnaissance Fire Support Vehicle. Main guns on these vehicles can range up to 105 mm (South African Rooikat). A growing trend is for CRVs with added sensors (such as the Russian BRM-3K). It is a versatile vehicle configured for maneuver reconnaissance with thermal sights and a 30-mm gun, but is also useful for setting up a stationary surveillance position with its Tall Mike radar. As a command (-K type) vehicle, it employs a mix of radios to transmit intelligence across several nets in a combined arms force.

A recent trend is the fielding of vehicles with sophisticated multi-sensor arrays specially designed to operate behind or near the FLOT and provide continuous data to combined arms forces. An example is the Czech Snezka, which will be featured in an update. Vehicles designed to support specific branches are included with those branches (such as PRP-3/4 for artillery).

A class of vehicles widely proliferated for light patrol duties is the armored scout car: With wheels rather than tracks, light armor, and guns generally of 7.62 - 20 mm, they offer low cost but are vulnerable to a wide variety of weapons. Examples include the British Ferret and Russian BRDM-2. A recent category of vehicle which US Army forces will encounter is lightly armored vehicles on truck or jeep-type chassis with very light armor for security, and patrol. Some are unarmed; whereas others employ sophisticated weapons stations and lethal firepower (up to 30-mm guns). Smaller 4x4 scout vehicles (such as French VBL) and ultra-light fast-attack vehicles have also been built for light patrol and rapid reconnaissance missions.

This chapter provides a representative sampling of reconnaissance vehicles in use today. The selection is not comprehensive, rather reflects systems currently available to the OPFOR.

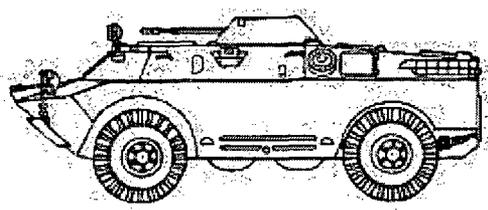
Questions and comments on data listed in this chapter should be addressed to:

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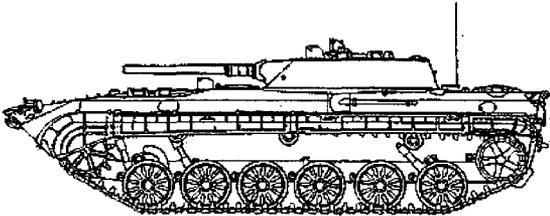
Russian Armored Scout Car BRDM-2

	<table border="1"> <thead> <tr> <th>Weapons & Ammunition Types</th> <th>Typical Combat Load</th> </tr> </thead> <tbody> <tr> <td>14.5-mm machinegun API, API-T, I-T HE-T</td> <td>500 160 340</td> </tr> <tr> <td>7.62-mm coax MG Heavy ball, I-T, Light ball, Ball-T, API-T</td> <td>2,000</td> </tr> </tbody> </table>	Weapons & Ammunition Types	Typical Combat Load	14.5-mm machinegun API, API-T, I-T HE-T	500 160 340	7.62-mm coax MG Heavy ball, I-T, Light ball, Ball-T, API-T	2,000	
Weapons & Ammunition Types	Typical Combat Load							
14.5-mm machinegun API, API-T, I-T HE-T	500 160 340							
7.62-mm coax MG Heavy ball, I-T, Light ball, Ball-T, API-T	2,000							
<p>SYSTEM Alternative Designations: GAZ 41-08 Date of Introduction: 1963 Proliferation: At least 45 countries Description: Crew: 4 Troop Capacity: 0 (for this configuration) Combat Weight (mt): 7.0 Chassis Length Overall (m): 5.75 Height Overall (m): 2.31 Width Overall (m): 2.75 Ground Pressure (kg/cm²): INA Drive Formula: 4 x 4 (+ 4 auxiliary wheels)</p> <p>Automotive Performance: Engine Type: 140-hp Gasoline Cruising Range (km): 750 Speed (km/h): Max Road: 95 Max Off-Road: INA Average Cross-Country: INA Max Swim: 10 Fording Depths (m): Amphibious</p> <p>Radio: R-123</p> <p>Protection: Armor, Turret Front (mm): 10 Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A Active Protective System: N/A NBC Protection System: Collective Smoke Equipment: N/A</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 14.5-mm Machinegun KPVT Rate of Fire (rd/min): 150 practical/600 cyclic Loader Type: Belt feed Ready/Stowed Rounds: 500/0 Elevation (°): -5 / +30 Fire on Move: Yes</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 54R) Machinegun PKT Mount Type: Coax Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,000m / 400-500 on the move Night: N/A</p>	<p>Fire on Move: Yes Rate of Fire (rd/min): 250 practical / 650 cyclic in 2-10 round bursts</p> <p>ATGM Launcher: N/A Firing Ports: INA</p> <p>FIRE CONTROL FCS Name: N/A Main Gun Stabilization: N/A Rangefinder: N/A Infrared Searchlight: INA Sights w/Magnification: Gunner: Day: PP-61AM Field of View (°): 23 Acquisition Range (m): 2,000 Night: N/A Field of View (°): INA Acquisition Range (m): INA</p> <p>Commander Fire Main Gun: No</p> <p>VARIANTS: Polish modernized variant has been offered in five versions, with upgrades such as: 12.7-mm MG, improved PKT MG mount, roof-mounted AT-4 ATGM, surveillance radar, improved fire control, etc.</p> <p>Antitank guided missile launcher vehicles: 9P122 variant with 6-rail AT-3 ATGM launcher 9P124 variant with 4-rail AT-2 MCLOS ATGM launcher 9P133 variant with 6-rail AT-3C SACLOS ATGM launcher 9P137 variant with 5-rail AT-5 ATGM launcher 9P148 variant with 5-rail AT-4 or AT-5 ATGM launcher.</p> <p>BRDM-2Rkh: NBC reconnaissance vehicle</p> <p>BRDM-2U: Command variant without a turret</p> <p>SA-9: SAM system transporter-erector-launcher vehicle</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 14.5-mm API-T Maximum Aimed Range (m): INA Max Effective Range (m): Day: 2,000 Night: INA Tactical AA Range: 1,400 Armor Penetration (mm): 20 at 1,000 m/30 at 500 m</p> <p>Other Ammunition Types: 14.5-mm API, I-T, HE-T Type MDZ</p>							

NOTES

Some BRDMs may include an AT-4 launcher and ATGMs for dismounted self-defense.

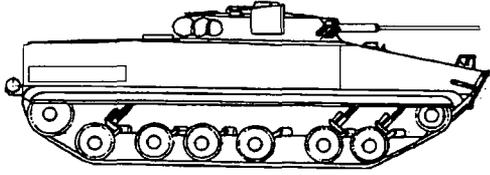
Russian Armored Reconnaissance Command Vehicle BRM-1K

	<p>Weapons & Ammunition Types</p> <p>73-mm gun HEAT HE</p> <p>7.62-mm coax MG</p>	<p>Typical Combat Load</p> <p>20 (est) 10 10</p> <p>2,000</p>
<p>SYSTEM Alternative Designations: BMP M1976/2 Date of Introduction: 1976 Proliferation: At least 3 countries Description: Crew: 4 (with addition of a navigator) Troop Capacity: 6 passengers Combat Weight (mt): 13.3 Chassis Length Overall (m): 6.74 Height Overall (m): 2.15 Width Overall (m): 2.94 Ground Pressure (kg/cm²): 0.57</p> <p>Automotive Performance: Engine Type: 300-hp diesel Cruising Range (km): 600 Speed (km/h): Max Road: 65 Max Off-Road: 40-45 Average Cross-Country: INA Max Swim: 7 Fording Depth (m): Amphibious Radio: R-173, R-130, 2x R-148 manportable, R-014D telegraph</p> <p>Protection: Armor, Turret Front (mm): 19-23 Applique Armor (mm): Available Explosive Reactive Armor (mm): Available Active Protective System: N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A NBC Protection System: Yes Smoke Equipment: VEES</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 73-mm smoothbore gun, 2A28/Grom Rate of Fire (rd/min): 7-8 Loader Type: Autoloader Ready/Stowed Rounds: 20 / 0 Elevation (°): -4/+33 Fire on Move: Yes, but only 10 km/h or less (est)</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 54R) machinegun PKT Mount Type: Coaxial Maximum Aimed Range (m): 1,300 Max Effective Range (m): Day: 1,000 / 400-500 on the move</p>	<p>Night: 800 Fire on Move: Yes Rate of Fire (rd/min): 250 practical / 650 cyclic, in 2-10 round bursts Firing Ports: 1 on each side, 1 in left rear door</p> <p>FIRE CONTROL FCS Name: INA Main Gun Stabilization: No Rangefinder: Laser Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: 1PN22M2, 8x Field of View (°): 15 (est) Acquisition Range (m): INA Night: 1PN22M2 II channel, 6x Field of View (°): 6 (est) Acquisition Range (m): 800-1,000, based on light</p> <p>VARIANTS BRM-1: Baseline armored reconnaissance vehicle (BMP M1976/1) without smoke grenade launchers, added comms (R-130, R-014D telegraph), and Tall Mike radar but with four more passengers.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 73-mm HEAT-FS, PG-9 Maximum Aimed Range (m): 1,300 Max Effective Range (m): Day: 800, 600 on the move Night: 800 Armor Penetration (mm): 335 (RHA)</p> <p>73-mm HEAT-FS, NFI Maximum Aimed Range (m): 1,300 Max Effective Range (m): Day: 1,000, 600 on the move Night: 800-1,000 Armor Penetration (mm): >400 (RHA)</p> <p>73-mm HE, OG-9 Maximum Aimed Range (m): 1,300 Max Effective Range (m): Day: 1,300, 1,000 on the move Night: 1,000 Armor penetration (mm): INA</p> <p>Other Ammunition Types: 73-mm HE, OG-9M</p>	

NOTES

Derived from BMP-1, the vehicle has a 2-man turret and additional sensors. Two manportable SAM launchers are included. BMP-1 options fit BRM-1 and -1K. SENSORS: 1PN22M2 sight, 1D8 laser rangefinder, and Tall-Mike battlefield surveillance radar. Radar characteristics: operating band I (9.0 GHz); detection ranges 30 km personnel, 12 km vehicles. The Russian Alis or Sanoet thermal gunner's sight can be installed. Passengers may dismount from BRM-1K and will dismount from BRM-1 to form an alternate reconnaissance post.

Russian Combat Reconnaissance Vehicle BRM-3K

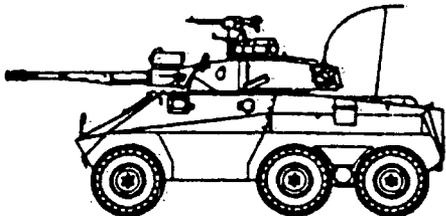
	Weapons & Ammunition Types	Typical Combat Load
<p>SYSTEM Alternative Designations: Lynx, Rys Date of Introduction: 1990 Proliferation: At least 1 country Description: Crew: 6 Combat Weight (mt): 19.6 Chassis Length Overall (m): 6.10 Height Overall (m): 2.65 Width Overall (m): 3.15 Ground Pressure (kg/cm²): 0.62</p> <p>Automotive Performance: Engine Type: 500-hp Diesel Cruising Range (km): 600 Speed (km/h): Max Road: 70 Max Off-Road: 45 Average Cross-Country: 35 Max Swim: 10 Fording Depths (m): Amphibious</p> <p>Radio: R-163-50U UHF, R-163-50K HF, R-163-10U (dismounts)</p> <p>Protection: Armor, Turret Front (mm): 30-35 mm (front glacis) Applique Armor (mm): Yes on turret Explosive Reactive Armor (mm): Available Mineclearing Equipment: N/A Self-Entrenching Blade: N/A Active Protective System: N/A NBC Protection System: Collective Smoke Equipment: 6 Smoke grenade launchers, VEES</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 30-mm automatic gun, 2A72 Rate of Fire: 350 rd/min (cyclic) in bursts Loader Type: Dual-belt feed Ready/Stowed Rounds: 500/0 Elevation (°): -5 to +60 Fire on Move: Yes</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm machinegun, PKT Mount Type: Turret coax Max Effective Range: Day: 2,000 m Night: 1,200-1,500 passive/2,000 active Fire on Move: Yes</p>	<p>30-mm auto gun: HE-I & Frag-HE-T APDS, APFSDS-T 7.62-mm coax MG</p> <p>500 340 160 2,000</p> <p>Rate of Fire (rd/min): 250 practical / 650 cyclic, in 2-10 round bursts</p> <p>Firing Ports: 1 on each side</p> <p>FIRE CONTROL FCS Name: BPK-2-42 Main Gun Stabilization: 2-plane, 2E52-1 Rangefinder: Laser Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: BPK-2-42 Field of View (°): 8 Acquisition Range (m): 4,000 (est) Night: 1PN61 II/IR sight Field of View (°): INA Acquisition Range (m): 1,200-1,500/3,000+ active Commander Fire Main Gun: INA</p> <p>VARIANTS N/A</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 30-mm APDS Maximum Aimed Range (m): 4,000 (est) Max Effective Range (m): Day: 2,500 Night: 1,200-1,500 passive/ 2,500 active Tactical AA Range: 4,000 Armor Penetration (mm): 25 (RHA) at 1,500 m</p> <p>30-mm APFSDS-T M929 Maximum Aimed Range (m): 4,000 (est) Max Effective Range (m): Day: 2,500+ Night: 1,200-1,500 passive/2,500+ active Tactical AA Range: 4,000 Armor penetration (mm): 55 (RHA) at 1,000 m, 45 at 2,000 m</p> <p>30-mm Frag-HE Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: 4,000 Night: 1,200-1,500 passive/ 3,000+ active Tactical AA Range: 4,000 Armor Penetration (mm): INA</p> <p>Other Ammunition Types: 30-mm HEI-T, AP-T</p>	

NOTES

BRM-3K is a variant of BMP-3 with a steel hull.

ONBOARD SENSORS: The 1PN71 thermal sight (3.7x/11.5x) has an acquisition range against tanks of 3.0 km. The 1D14 laser rangefinder (73x and 18x sights) has a day light only acquisition range of 10.0 km. The 1PN61 passive image intensifier night sight uses a laser illuminator. In the passive mode, the Generation II (7x) sight has a night acquisition range of 1.2-1.5 km. Using the active laser pulse illuminator, the acquisition range can be extended. Tall Mike Radar has an operating band I (9.0 GHz), and detection ranges: 3.0 km against personnel, 12.0 against moving vehicles.

Brazilian Armored Reconnaissance Vehicle EE-9

	Weapons & Ammunition Types	Typical Combat Load
	90-mm cannon- APFSDS-T HEAT-T, HESH HE-T 7.62-mm coax MG .50 cal AA MG	44 (est) 11 11 22 2,000 500

SYSTEM

Alternative Designations: Cascavel IV
Date of Introduction: 1977
Proliferation: At least 18 countries (all variants)
Description:
 Crew: 3
 Troop Capacity: None
 Combat Weight (mt): 13.4
 Chassis Length Overall (m): 5.19
 Height Overall (m): 2.36
 Width Overall (m): 2.66
 Drive Formula: 6 x 6

Automotive Performance:

Engine Type: 212-hp Diesel
 Cruising Range (km): 880
 Speed (km/h): Max Road: 100
 Max Off-Road: INA
 Average Cross-Country: INA
 Max Swim: N/A
 Fording Depth (m): 1.0 unprepared

Radio: INA

Protection:

Armor, Turret Front (mm): 16
 Applique Armor (mm): N/A
 Explosive Reactive Armor (mm): N/A
 Active Protective System: N/A
 Mineclearing Equipment: N/A
 Self-Entrenching Blade: N/A
 NBC Protection System: N/A
 Smoke Equipment: 6 smoke grenade launchers

ARMAMENT

Main Armament:

Caliber, Type, Name: 90-mm gun, Engesa EC-90 (Cockerill-type)
 Rate of Fire (rd/min): INA
 Loader Type: Manual
 Ready/Stowed Rounds: 24/ 20
 Elevation (°): -8/+15
 Fire on Move: INA

Auxiliary Weapons:

Caliber, Type, Name: 7.62-mm MG, INA
 Mount Type: Coax
 Maximum Aimed Range (m): 2,000
 Max Effective Range (m):
 Day: INA
 Night: INA
 Fire on Move: Yes
 Rate of Fire (rd/min): INA

Caliber, Type, Name: .50 Cal M2 HB MG
 Mount Type: Cupola
 Maximum Aimed Range (m): 2,000
 Max Effective Range (m):
 Day: 2,000
 Night: INA
 Fire on Move: Yes
 Rate of Fire (rd/min): INA

ATGM Launcher: N/A
Firing Ports: N/A

FIRE CONTROL

FCS Name: INA
Main Gun Stabilization: N/A
Rangefinder: LV3 laser rangefinder
Infrared Searchlight: N/A
Sights w/Magnification:
 Gunner:

Day: SS-123, 10x
 Field of View (°): INA
 Acquisition Range (m): INA
 Night: SS-122 II channel, 5.6x
 Field of View (°): INA
 Acquisition Range (m): INA

Commander Fire Main Gun: No

VARIANTS

Cascavel I: Original vehicle had a US M36 37-mm gun turret.
Cascavel II: Variant with a French 90-mm gun from AML-90.
Cascavel III: Uses the 90-mm Cockerill gun and new transmission.
Cascavel IV: Has a new engine and transmission, improved day and night optics with laser rangefinder, and a .50 cal antiaircraft MG.

MAIN ARMAMENT AMMUNITION

Caliber, Type, Name:
 90-mm APFSDS-T, Engequimica-produced
 Maximum Aimed Range (m): INA
 Max Effective Range (m):
 Day: 2,000+
 Night: INA
 Armor Penetration (mm): INA

90-mm HE-T, Engequimica-produced
 Maximum Aimed Range (m): INA
 Max Effective Range (m):
 Day: 2,200
 Night: INA
 Armor Penetration (mm): INA

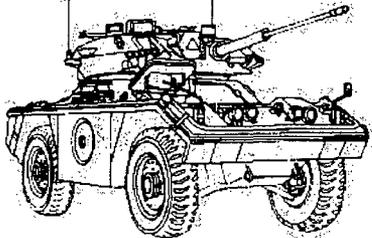
Other Ammunition Types: HEAT-T, HESH-T, Smoke, Cannister

NOTES

Other ammunition maximum effective ranges are (m): HEAT-T - 1,500, HESH-T - 800.

British Armored Reconnaissance Vehicle Fox

	Weapons & Ammunition	Typical
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	<p style="text-align: center;">Types</p> <p>30-mm auto-cannon HEI-T, APDS-T, APSE-T</p> <p>7.62-mm coax MG</p>	<p style="text-align: center;">Combat Load</p> <p style="text-align: right;">99 (est) 66 33</p> <p style="text-align: right;">2,600</p>
	<p>SYSTEM Alternative Designations: FV721 Date of Introduction: 1973 Proliferation: At least 3 countries</p> <p>Description: Crew: 3 Troop Capacity: 0 Combat Weight (mt): 6.12 Chassis Length Overall (m): 4.17 Height Overall (m): 2.20 Width Overall (m): 2.13 Ground Pressure (kg/cm²): INA Drive Formula: 4 x 4</p> <p>Automotive Performance: Engine Type: 190-hp Gasoline Cruising Range (km): 434 Speed (km/h): Max Road: 104 Max Off-Road: INA Average Cross-Country: INA Max Swim: 5.23 Forcing Depth (m): 1.0 Unprepared</p> <p>Radio: INA</p> <p>Protection: Armor, Turret Front (mm): Resistant to heavy MG (NFI) Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Active Protective System: N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A NBC Protection System: N/A Smoke Equipment: 2 x 4-barrel smoke grenade launchers</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 30-mm auto-cannon, Rarden L21 Rate of Fire (rd/min): 80-90 cyclic (1-6 round bursts) Loader Type: Feed tray, manual clip-fed (3-round clips) Ready/Stowed Rounds: INA Elevation (°): -14/+40 Fire on Move: INA</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm machinegun L7A2</p> <p>Mount Type: Coax Maximum Aimed Range (m): INA Max Effective Range (m): INA Fire on Move: Yes Rate of Fire (rd/min): INA</p> <p>ATGM Launcher: N/A Firing Ports: None</p> <p>FIRE CONTROL FCS Name: INA Main Gun Stabilization: N/A Rangefinder: N/A Infrared Searchlight: N/A Sights w/Magnification: Gunner: Day: SPAV L2A1, 5.8/1.6 x Field of View (°): 8/28 Acquisition Range (m): INA Night: L2A1, II sight Field of View (°): INA Acquisition Range (m): INA</p> <p>Commander Fire Main Gun: No</p> <p>VARIANTS None of the variants have been fielded.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 30-mm APDS-T, L14A2 Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,000 Night: INA Tactical AA Range: INA Armor Penetration (mm): 40 (RHA, 45°) at 1,500 meters</p> <p>Caliber, Type, Name: 30-mm HE-T, L13A1 Maximum Aimed Range (m): 2,000 Max Effective Range (m): INA Tactical AA Range: INA Armor Penetration (mm): N/A</p> <p>Other Ammunition Types: APSE-T (AP Secondary Effects-T L5A2). The gun can fire the KCB (Oerlikon) family of munitions.</p>	

NOTES

These vehicles have been phased out of British service.

Chapter 4 Tanks/Assault Vehicles

The lethality and variety of weapons available to armored, mechanized, and infantry forces for the close fight require a continued and expanded use of heavily armored fighting vehicles (AFVs). This chapter provides a representative sampling of AFVs in use today and designed for combat assault. The selection is not comprehensive, rather reflects a mix of systems currently available for the OPFOR and likely to be encountered in varying levels of conflict. The selection is also used to highlight trends within this field of weapons.

Vehicles used for combat assault in this Guide are divided into two categories—*main battle tanks* and *light tanks/assault vehicles*. Tanks are tracked, heavily armored vehicles with guns of generally 75 mm or more. Among modern trends in AFVs are: increased variety of systems worldwide, and a wider application of these systems for varied roles and missions on the battlefield. As a result, technology sharing and proliferation of upgrade packages have blurred lines among vehicles used for assault, antiarmor, combat reconnaissance and fire support missions. Another trend is increased weight for all types of armored vehicles. With heavier armor protection packages, higher-output engines and larger weapons, a significant proportion of medium tanks have grown into the heavy tank weight category. Therefore, the term *main battle tank* is more relevant than previous weight categories.

There are still *light tanks* on the battlefield, although increased armor and gun size on light armored fighting vehicles such as infantry fighting vehicles and armored reconnaissance vehicles have blurred lines of distinction. A number of AFVs, such as the British Scorpion and French AMX-13 can be characterized as reconnaissance vehicles, tank destroyers, fire support vehicles, or assault vehicles; but they have tracks, armor protection, and guns of 60 mm or greater. Thus, they can also be used for light tank missions. The term *assault vehicle* currently represents a narrow category of older vehicles used by (former) Soviet forces - medium-armored vehicles with medium-heavy guns and no turrets. None of these vehicles were selected for this initial publication. Some representative systems will be included in the next iteration. With blurring of lines among roles and missions for heavier LAFVs and light tanks, the term *assault vehicle* will likely broaden to reflect a variety of modern programs for light - medium armored vehicles with medium to heavy guns, for use in the assault role.

Two notable trends for vehicles in this chapter are a reflection of increasing systems costs and declines or leveling of military budgets - development of variants off of established systems, and use of equipment/packages to extend the use life of systems and enhance their effectiveness. As a result, seemingly old and out-of-date tanks, some of which pre-date World War II, can be a threat to modern armored and mechanized forces. The WEG highlights a variety of upgrades as well as limitations for selected tanks. Systems-related trends can be divided among mobility, survivability, and lethality, as noted on the data sheets.

To improve mobility and compensate for weight increases, many forces have replaced older engines with more powerful diesel engines. Swim capability is limited to a few light tanks.

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Within the area of survivability, the most obvious consideration is increasing armor protection levels. A prominent trend is the application of additional armor, such as plate armor or panels on turrets, side-skirts over tracks, and addition of explosive reactive armor (ERA). Additional protection measures include use of entrenching blades for self-emplacement, mine-clearing plows and rollers, nuclear, biological and chemical (NBC) protection, vehicle smoke emission systems, and smoke grenade launchers. To complement these systems are sensors such as mine detectors, laser warning receivers, and radar warning receivers. A trend receiving increasing attention is the use of active measures: electro-optical countermeasures, such as infrared jammers, and active protection systems (also known as defensive aides suites) designed to intercept incoming projectiles and destroy them prior to impact.

The area of lethality has seen a variety of upgrades, including: gun replacement, improved stabilization and fire control systems, additional weapons such as antitank guided missile systems, and improved ammunition. Critical parameters include fire on the move capability, which can be linked to stabilization, rate of fire, integrated sights, acquisition ranges, and weapon range. Note, because weapon range is really a function of sights, gun precision, the type of mount, and specific round ballistics, the WEG will incorporate those factors in the round data, as maximum aimed range. That figure conforms to the OPFOR tactics and accounts for technical capabilities (see Glossary). Maximum effective range is also included (see Glossary).

The WEG notes a variety of new ammunition natures, such as electronically fuzed tank rounds for use against helicopters, and OPFOR availability of western-style HEAT-multipurpose rounds, which can be used as both antitank and antipersonnel rounds, for greater flexibility and lethality. For some systems, the ammunition mix could be determined or estimated. For others, that data was not available. Within each category, the specific round mix will depend on tactical considerations, comparative lethality and the intended targets. A general rule for OPFOR is that tanks will have approximately 50% antitank rounds and 50% rounds for use against soft targets. Because of the relative increase in protection against HEAT rounds vs kinetic energy rounds, mix estimates reflect a bias toward KE rounds. The term *stowed rounds* does not mean rounds which are not in the tank's autoloader. Rounds in ready reach are ready rounds. Stowed rounds are those which are in compartments away from the gunner's or loader's positions, requiring a slower than normal rate of fire (see Glossary). In calculating tank rounds, the figure does not include the tactical possibility of adding an additional round in the breach.

Secondary arms continue to play an important role for OPFOR tanks, because their use permits the main gun to focus fires more on heavy and area targets. Tankers will fire main guns at hovering or slow-flying aircraft; however, the more likely weapon is the antiaircraft machinegun. Similarly, OPFOR tanks will fire main guns at personnel and other soft targets as required; but the more efficient weapon for targets at close range is the coaxial machinegun.

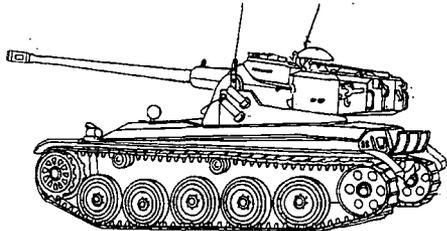
Questions and comments on data listed in this chapter should be addressed to:

Mr. Tom Redman

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e-mail address: redmant@leav-emh1.army.mil

French Light Tank AMX-13

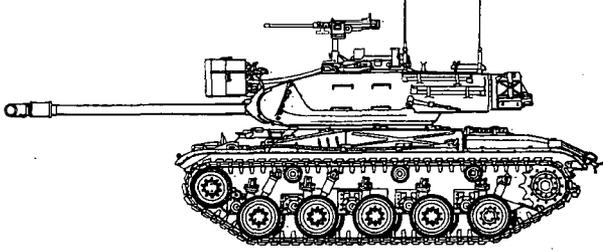
 <p style="text-align: center;">AMX-13 Model 51/75 mm Gun</p>	<p>Weapons & Ammunition Types</p> <p>90-mm rifled gun APFSDS-T HEAT HE Cannister</p> <p>7.62-mm coax MG</p>	<p>Typical Combat Load</p> <p>34</p> <p>3,600</p>
<p>SYSTEM Alternative Designations: AMX-13/90 Date of Introduction: 1966 Proliferation: At least 15 countries Description: Crew: 3 Combat Weight (mt): 15.0 Chassis Length Overall (m): 4.88 Height Overall (m): 2.28 Width Overall (m): 2.51 Ground Pressure (kg/cm²): 0.74</p> <p>Automotive Performance: Engine Type: 250-hp Gasoline Cruising Range (km): 350 Speed (km/h): Max Road: 60 Max Off-Road: INA Average Cross-Country: INA Max Swim: N/A Fording Depths (m): 0.6 unprepared, 2.1 with snorkel</p> <p>Radio: TR-VP118 and intercom</p> <p>Protection: Armor, Turret Front (mm): 25 at 45° impact angle Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Active Protective System: N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A NBC Protection System: N/A Smoke Equipment: 2 smoke grenade launchers each side of turret</p> <p>ARMAMENT Main Armaments: Caliber, Type, Name: 90-mm rifled gun CN-90-F3 Rate of Fire (rd/min): INA Loader Type: Autoloader and manual Ready/Stowed Rounds: 10 in autoloader, 11/13 in hull Elevation (°): -5.5/+12.5 Fire on Move: N/A</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x51) MG, AA52 Mount Type: Turret coax Maximum Aimed Range (m): INA Max Effective Range (m): Day: INA</p>	<p>Night: INA Fire on Move: Yes Rate of Fire (rd/min): INA</p> <p>FIRE CONTROL FCS Name: INA Main Gun Stabilization: N/A Rangefinder: N/A Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: L862, 7.5x and 8x Field of View (°): INA Acquisition Range (m): INA Night: OB-11-A, 5x Field of View (°): INA Acquisition Range (m): 800-1,000 Commander Fire Main Gun: No</p> <p>VARIANTS AMX-13 Model 51: Original tank destroyer/recon vehicle, Model 51, w/75-mm gun. Many variants and upgrades have diesel engines and a 7.62-mm AA MG. Two versions were fitted with 2 x SS-11 or 3 x HOT ATGM launchers AMX-13/90: This is the variant portrayed on this data sheet. AMX-13/105: Variant with a GIAT 105G1 105-mm gun. AMX-13 CD Model 55: Armored recovery variant. AMX-13 DCA: Air defense variant with twin 30-mm guns. AMX-13 with LAR: Multiple Rocket Launcher System. AMX 105-mm Mk 61: Self-propelled howitzer variant. AMX F3: 155-mm self-propelled gun. AMX-VCI: Variant used as an APC.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 90-mm APFSDS-T, NFI Maximum Aimed Range (m): INA Max Effective Range (m): Day: 2,000 Night: 800-1,000 Armor Penetration (mm): INA</p> <p>90-mm HEAT, NFI Maximum Aimed Range (m): INA Max Effective Range (m): Day: 1,000 Night: N/A Armor Penetration (mm): 160 (RHA) at 60° impact angle</p> <p>Other Ammunition Types: HE, Cannister, Smoke</p>	

NOTES

Israeli EL-OP thermal sights are available for use on the tank.

US Light Tank M41A3

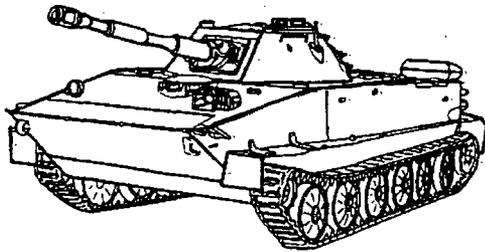
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	Weapons & Ammunition Types	Typical Combat Load
	76-mm rifled gun M32 APDS-T/APFSDS-T HEAT -T Frag-HE Cannister 7.62-mm coax MG 12.7-mm AA MG.	65 20 20 20 5 5,000 2,175
<p>SYSTEM Alternative Designations: Walker Tank, Walker Bulldog Date of Introduction: 1951 Proliferation: At least 18 countries Description: Crew: 4 Combat Weight (mt): 23.5 Chassis Length Overall (m): 5.82 Height Overall (m): 2.73 Width Overall (m): 3.20 Ground Pressure (kg/cm²): 0.72</p> <p>Automotive Performance: Engine Type: 500-hp Gasoline Cruising Range (km): 161 Speed (km/h): Max Road: 72 Max Off-Road: 48 Average Cross-Country: 40 Max Swim: N/A Fording Depths (m): 1.0 Unprepared, 2.4 prepared</p> <p>Radio: INA</p> <p>Protection: Armor, Turret Front (mm): 38 Applique Armor (mm): Available Explosive Reactive Armor (mm): N/A Active Protective System: N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A NBC Protection System: N/A Smoke Equipment: N/A</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 76-mm rifled gun M32 Rate of Fire (rd/min): INA Loader Type: Manual Ready/Stowed Rounds: INA Elevation (°): -9.75/ +19.75 Fire on Move: No</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x51) MG, M9194E1 Mount Type: Turret coax Maximum Aimed Range (m):</p>	<p>Max Effective Range (m): Day: INA Night: N/A Fire on Move: Yes Rate of Fire: INA</p> <p>Caliber, Type, Name: .50 (12.7 x 99) AA machinegun, M2HB Mount Type: Cupola AA mount Maximum Aimed Range (m): INA Max Effective Range (m): Day: 2,000 Night: INA Fire on Move: Yes Rate of Fire (rd/min): 450-550</p> <p>FIRE CONTROL FCS Name: INA Main Gun Stabilization: N/A Rangefinder: N/A Infrared Searchlight: Available Sights w/Magnification: Gunner: Day: M97A1 and M20A1 Field of View (°): INA Acquisition Range (m): INA Night: Available Commander Fire Main Gun: No</p> <p>VARIANTS M41 DK-1: Danish variant with diesel engine and LRF-based fire control. Other upgrades are side skirts, thermal sights, NBC protection, smoke grenade launchers and 7.62-mm AA MG. Brazilian M41: Upgrades are similar to DK-1 except for AA MG and change to 90-mm gun using Cockerill Mk III ammunition. Uruguayan M41: M41A3 fitted with Cockerill Mk III gun. YUNG HU: Taiwanese upgrade with diesel engine. M42/Duster: Air defense gun system with twin 40-mm AA cannon.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 76-mm APFSDS-T, AAI M464 Maximum Aimed Range (m): INA Max Effective Range (m): INA Armor Penetration (mm): NATO triple heavy (57°) at 1000 m</p> <p>Other Ammunition Types: M33A1 and A2 APDS-T, M319 and M339 AP-T, M496 HEAT-T, HE, Smoke (WP), M363 cannister</p>	

NOTES

German Atlas offers the MOLF 1-plane stabilized laser rangefinder fire control system and retrofit kit. The FCS includes a thermal night sight. Israeli EL-OP offers a FCS for the system. Maximum range for the canister round is 155 meters.

Russian Amphibious Tank PT-76B

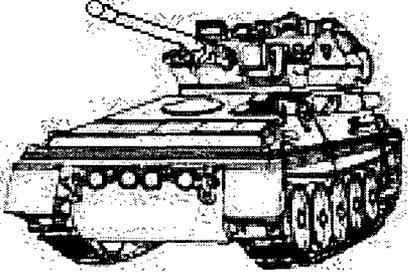
	<p>Weapons & Ammunition Types</p> <p>76-mm rifled gun D-56 HVAP, AP-T/API-T HEAT Frag-HE</p> <p>7.62-mm coax MG</p>	<p>Typical Combat Load</p> <p>40 10 10 20</p> <p>1,000</p>
	<p>SYSTEM Alternative Designations: INA Date of Introduction: 1952 Proliferation: At least 21 countries Description: Crew: 3 Combat Weight (mt): 14.0 Chassis Length Overall (m): 6.91 Height Overall (m): 2.26 Width Overall (m): 3.14 Ground Pressure (kg/cm²): 0.46</p> <p>Automotive Performance: Engine Type: 240-hp Diesel Cruising Range (km): 260 Speed (km/h): Max Road: 44 Max Off-Road: INA Average Cross-Country: 25 Max Swim: 10 Fording Depth (m): Amphibious</p> <p>Radio: R-123 Protection: Armor, Turret Front (mm): 20 Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Active Protective System: N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A NBC Protection System: N/A Smoke Equipment: VEES</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 76-mm rifled gun D-56B Rate of Fire (rd/min): 6-8 Loader Type: Manual Ready/Stowed Rounds: INA Elevation (°): -4/+30 Fire on Move: Yes</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x54R) machinegun PKT Mount Type: Coax Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,000/400-500 on the move Night: 600</p> <p>Fire on Move: Yes Rate of Fire (rd/min): 250 practical / 650 cyclic, 2-10 round bursts</p> <p>FIRE CONTROL FCS Name: INA Main Gun Stabilization: 2-plane Rangefinder: N/A Infrared Searchlight: Available Sights w/Magnification: Gunner: TShK-66 Day: Field of View (°): INA Acquisition Range (m): 4,000 Night: TVN-28 IR Available Field of View (°): INA Acquisition Range (m): 600 Commander Fire Main Gun: No</p> <p>VARIANTS Polish PT-76: Variant with a separate commander's hatch and 12.7-mm MG. Type 63: Chinese variant with a new turret, 85-mm gun, and 12.7-mm AA MG.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 76-mm HVAP-T, BM-354P Maximum Aimed Range (m): 1,060 Max Effective Range (m): Day: 650 Night: 600 Armor Penetration (mm): 127 at muzzle, 50 at 1,000 m</p> <p>76-mm HEAT, BK-350M Maximum Aimed Range (m): 1,000 Max Effective Range (m): Day: 650 Night: 600 Armor Penetration (mm): 280 to max range</p> <p>76-mm. Frag-HE, OF-350 Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: INA Night: 600 Armor Penetration (mm): INA</p> <p>Other Ammunition Types: 76-mm AP-T, BR-350 API-T</p>	

NOTES

Original PT-76 was produced in limited numbers with a non-stabilized main gun. Some PT-76s are augmented with 12.7-mm AA MGs. Israel offers an upgrade package with a 90-mm gun, LRF fire control and a 300-hp engine.

British Combat Reconnaissance Vehicle, Tracked Scorpion

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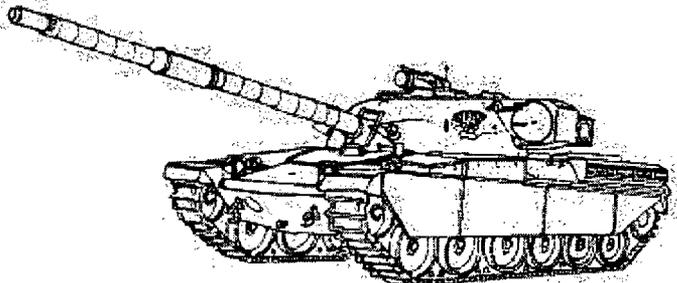
	<p>Weapons & Ammunition Types</p> <p>76-mm rifled gun HESH HE Cannister</p> <p>7.62-mm coax MG</p>	<p>Typical Combat Load</p> <p>40</p> <p>3,600</p>
<p>SYSTEM Alternative Designations: FV101 Date of Introduction: 1972 Proliferation: At least 18 countries Description: Crew: 3 Combat Weight (mt): 8.07 Chassis Length Overall (m): 4.79 Height Overall (m): 2.10 Width Overall (m): 2.24 Ground Pressure (kg/cm²): 0.36</p> <p>Automotive Performance: Engine Type: 190-hp Gasoline Cruising Range (km): 650 Speed (km/h): Max Road: 80 Max Off-Road: INA Average Cross-Country: INA Max Swim: 4/6 with propeller Fording Depth (m): 1.07, amphibious</p> <p>Radio: INA</p> <p>Protection: Armor, Turret Front (mm): Against 14.5-mm projectiles Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Active Protective System: N/A Mineclearing Equipment: N/A Self-Entrenching Blade: N/A NBC Protection System: Yes Smoke Equipment: 4 smoke grenade launchers each side of turret</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 76-mm rifled gun L23A1 Rate of Fire (rd/min): 6 Loader Type: INA Ready/Stowed Rounds: INA Elevation (°): -10/+35 Fire on Move: N/A</p>	<p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x51) MG, L8A1 Mount Type: Turret coax Maximum Aimed Range (m): INA Max Effective Range (m): INA Fire on Move: Yes Rate of Fire (rd/min): INA</p> <p>FIRE CONTROL FCS Name: INA Main Gun Stabilization: N/A Rangefinder: Laser rangefinder Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: Barr and Stroud Tank Laser Sight, 10x Field of View (°): INA Acquisition Range (m): 2,200 Night: GEC Sensors SS100, II, x5.8/1.6 Field of View (°): 8/28 Acquisition Range (m): INA Commander Fire Main Gun: No</p> <p>VARIANTS Scorpion 90: Variant with a 90-mm Cockerill Mk III gun.</p> <p>A number of vehicles use the same Alvis chassis. They include the Scimitar armored reconnaissance vehicle, Striker armored ATGM launcher vehicle, Spartan armored personnel carrier or Milan ATGM launcher, Stormer modernized APC, Samaritan armored ambulance, and Saber modernized reconnaissance vehicle.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 76-mm HESH, L29 Maximum Aimed Range (m): 2,200 Max Effective Range (m): INA Armor Penetration (mm): INA</p> <p>Other Ammunition Types: L24A1/2 HE (max effective range--indirect fire: 5,000 meters), L33A1 Cannister (max effective range: 100 meters), L32A5 Smoke (BE), L42 Illumination</p>	

NOTES

As a reflection of the vehicle's suitability for a variety of roles, in recent times it is referred to as an armored reconnaissance vehicle or combat vehicle reconnaissance (tracked)--CVR (T).

A British upgrade program includes a diesel engine, thermal sights, and secure communications. The Tank Laser Sight and Avimo LV10 Day/Night LRF sight can accept a thermal channel. Thermal sights are available for use on the tank.

British Main Battle Tank Chieftain Mk 5

	<table border="1"> <thead> <tr> <th>Weapons & Ammunition Types</th> <th>Typical Combat Load</th> </tr> </thead> <tbody> <tr> <td>120-mm rifled gun</td> <td>64</td> </tr> <tr> <td>APFSDS-T</td> <td>20</td> </tr> <tr> <td>HESH</td> <td>44</td> </tr> <tr> <td>7.62-mm MG</td> <td>6,200</td> </tr> <tr> <td>-Coaxial and Stowed</td> <td>6,000</td> </tr> <tr> <td>-Cupola AA MG</td> <td>200</td> </tr> </tbody> </table>	Weapons & Ammunition Types	Typical Combat Load	120-mm rifled gun	64	APFSDS-T	20	HESH	44	7.62-mm MG	6,200	-Coaxial and Stowed	6,000	-Cupola AA MG	200	
	Weapons & Ammunition Types	Typical Combat Load														
120-mm rifled gun	64															
APFSDS-T	20															
HESH	44															
7.62-mm MG	6,200															
-Coaxial and Stowed	6,000															
-Cupola AA MG	200															
<p>SYSTEM Alternative Designations: FV 4201 Date of Introduction: 1967 Original Chieftain Proliferation: At least 6 countries Description: Crew: 4 Combat Weight (mt): 55.00 Chassis Length Overall (m): 7.48 Height Overall (m): 2.90 Width Overall (m): 3.51 Ground Pressure (kg/cm²): 0.90</p> <p>Automotive Performance: Engine Type: 750-hp Diesel Cruising Range (km): 400-500 Speed (km/h): Max Road: 48 Max Off-Road: INA Average Cross-Country: 30 Max Swim: N/A Fording Depths (m): 1.1 Unprepared</p> <p>Radio: C42/Larkspur VHF</p> <p>Protection: Armor, Turret Front (mm): 300 (RHA) Applique Armor (mm): ROMOR applique on turret, side skirts Explosive Reactive Armor (mm): N/A Active Protective System: N/A Mineclearing Equipment: Plow variant, and AVLB/engineer variant Self-Entrenching Blade: No NBC Protection System: Yes Smoke Equipment: Smoke grenade launchers (6 each side of turret)</p> <p>ARMAMENT Main Armaments: Caliber, Type, Name: 120-mm rifled gun, L11A5 Rate of Fire (rd/min): 8-10 first minute/6 sustained Loader Type: Separate-loading manual Ready/Stowed Rounds: INA Elevation (°): -10 to +20 Fire on Move: Yes</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 51) Machine gun L8A1 Mount Type: Turret Coax Maximum Aimed Range (m): INA Max Effective Range (m): Day: 800 Night: INA Fire on Move: Yes Rate of Fire: INA</p>	<p>Caliber, Type, Name: 7.62-mm (7.62x 51) AA Machine gun L37A1 Mount Type: Cupola Maximum Aimed Range (m): INA Max Effective Range (m): Day: 800 Night: INA Fire on Move: Yes Rate of Fire (rd/min): INA</p> <p>ATGM Launcher: N/A</p> <p>FIRE CONTROL FCS Name: Improved Fire Control System (IFCS) Main Gun Stabilization: 2-plane Rangefinder: Laser, Nd-Yag Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: Barr and Stroud Tank Laser Sight (TLS), 8x Field of View (°): 10 Acquisition Range (m): 5,000 Night: 1R18 Thermal sight, 3x Field of View (°): INA Acquisition Range (m): INA</p> <p>Commander Fire Main Gun: INA</p> <p>VARIANTS Mk 5: Final production variant, with a new engine and NBC system, modified auxiliary weapons and sights. Mk 6-11 are upgrades to earlier models, with addition of IFCS. Mk 12 added ROMOR (aka: Stillbrew) spaced armor boxes. Mk 11 and Mk 12 have Thermal Observation and Gunnery Sight (TOGS).</p> <p>A variety of support vehicles were developed from the tank. They include recovery vehicles, AVLB, dozer, mineclearer, air defense and 155-mm SP artillery systems.</p> <p>Khalid/Shir 1: Jordanian variant which has chassis, turret and weaponry of the Chieftain, but which incorporates engine and running gear upgrades of Challenger I. The fire control has seen a number of improvements, including a new ballistic computer.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 120-mm APFSDS-T, L23A1 Maximum Aimed Range (m): 5,000 Max Effective Range (m): Day: 3,000 Night: INA Armor Penetration (mm): INA</p>															

British Main Battle Tank Chieftain Mk 5 continued _____

120-mm High-Explosive Squash-Head (HESH), L31 Maximum Aimed Range (m): 5,000 Max Effective Range (m): Day: 3,000 Night: INA Armor Penetration (mm): INA	Other Ammunition Types: L15 APDS, L34 WP Smoke
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NOTES

Early Chieftains and some later modified tanks mount the 50. Cal M2HB machinegun over the main gun as a ranging gun. Iran and Kuwait retained the .50 Cal MG.

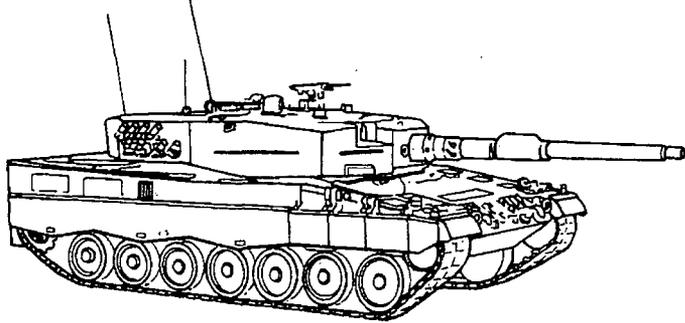
The HESH round is used for antitank chemical-energy (CE) antiarmor missions, and for HE effects against personnel and materiel.

The Iranians claim to employ a snorkel system on Chieftain, for fording to 5 meters depth.

A variety of fire control systems and thermal sights are available for Chieftain. At 324 Chieftains have been upgraded with the Barr and Stroud TOGS thermal sight system. The 1R26 thermal camera can be used with the 1R18 thermal night sight. It has wide (13.6°) and narrow (4.75°) fields of view, and is compatible with TOGS format. GEC Sensors offers a long list of sights including: Multisensors Platform, Tank Thermal Sensor, and SS100/110 thermal night sight. Marconi, Nanoquest, and Pilkington offer day and night sights for the Chieftain.

Charm Armament upgrade program, with the 120-mm L30 gun incorporated in Challenger 1, is available for Chieftain modification programs.

German Main Battle Tank Leopard 2

	<table border="1"> <thead> <tr> <th>Weapons & Ammunition Types</th> <th>Typical Combat Load</th> </tr> </thead> <tbody> <tr> <td>120-mm smoothbore gun APFSDS-T HEAT-MP-T</td> <td>42</td> </tr> <tr> <td>7.62-mm machineguns</td> <td>4750</td> </tr> <tr> <td>--Coaxial</td> <td>2000</td> </tr> <tr> <td>--Cupola MG/stowed</td> <td>2750</td> </tr> </tbody> </table>	Weapons & Ammunition Types	Typical Combat Load	120-mm smoothbore gun APFSDS-T HEAT-MP-T	42	7.62-mm machineguns	4750	--Coaxial	2000	--Cupola MG/stowed	2750	
Weapons & Ammunition Types	Typical Combat Load											
120-mm smoothbore gun APFSDS-T HEAT-MP-T	42											
7.62-mm machineguns	4750											
--Coaxial	2000											
--Cupola MG/stowed	2750											
<p>SYSTEM Alternative Designations: Swiss Pz 87, Swedish Strv 121 Date of Introduction: 1979 Proliferation: At least 7 countries Description: Crew: 4 Combat Weight (mt): 55.15 Chassis Length Overall (m): 7.69 Height Overall (m): 2.79 Width Overall (m): 3.70 Ground Pressure (kg/cm²): 0.83</p> <p>Automotive Performance: Engine Type: 1,500-hp Diesel Cruising Range (km): 550 Speed (km/h): Max Road: 72 Max Off-Road: 45 Average Cross-Country: 40 Max Swim: N/A Forcing Depths (m): 1.0 Unprepared, 4.0 with snorkel</p> <p>Radio: INA</p> <p>Protection: Armor, Turret Front (mm): 700 KE/1,000 against HEAT rounds Applique Armor (mm): Track skirt Explosive Reactive Armor (mm): N/A Active Protective System: Galix (See note Strv 122) Mineclearing Equipment: No Self-Entrenching Blade: No NBC Protection System: Yes Smoke Equipment: Smoke grenade launchers, 8 each side of turret</p> <p>ARMAMENT Main Armaments: Caliber, Type, Name: 120-mm smoothbore gun M256 Rate of Fire (rd/min): INA Loader Type: Manual Ready/Stowed Rounds: 15/27 Elevation (°): -9 to +20 Fire on Move: Yes</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 51) Machinegun MG3A1 Mount Type: Turret Coax Maximum Aimed Range(m): INA Max Effective Range (m): Day: INA Night: INA</p>	<p>Fire on Move: Yes Rate of Fire (rd/min): 1,200</p> <p>Caliber, Type, Name: 7.62-mm (7.62x 51) Machinegun MG3A1 Mount Type: Turret Cupola Maximum Aimed Range(m): INA Max Effective Range (m): Day: INA Night: INA Fire on Move: Yes Rate of Fire (rd/min): 1,200 ATGM Launcher: N/A</p> <p>FIRE CONTROL FCS Name: INA Main Gun Stabilization: WNA-H22, 2-plane Rangefinder: Laser neodymium Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: Krupp-Atlas EMES-15, 12x / FERO Z18 secondary, 8x Field of View (°): 5/10 Acquisition Range (m): INA Night: Zeiss thermal imager Field of View (°): INA Acquisition Range (m): INA Commander Fire Main Gun: Yes</p> <p>VARIANTS A variety of MBT variants from 2A1 to 2A4 denote minor changes, as well as FCS upgrades. Combat support variants include an armored recovery vehicle.</p> <p>Pz87: Swiss variant with indigenous machineguns, communications and FCS, and improved NBC equipment.</p> <p>Dutch Leopard 2: Uses indigenous equipment as noted above.</p> <p>Leopard 2A5/Leopard 2 (Improved): Recent upgrade with spaced armor added to turret front, and increased armor on hull and side skirts. Other improvements include improved stabilization, suspension, navigation, fire control, and hatch design.</p> <p>Strv 122: Swedish-licensed variant resembling 2A5 with an indigenous turret and other upgrades. The tank features French Galix active protection system and improved command and control. Sweden developed an HE-T round designed to range 2,000 meters or more for its Leopard-2 and Strv-122 tanks. With additional armor, Strv 122 will weigh 62 mt.</p>											

German Main Battle Tank Leopard 2 continued

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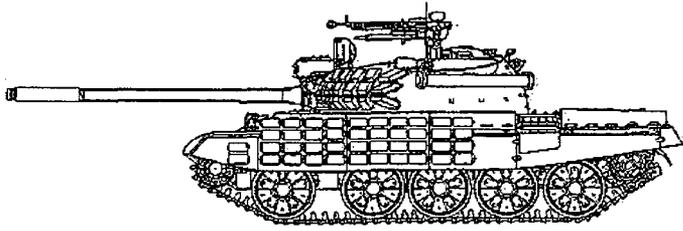
<p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 120-mm APFSDS-T, DM43 Maximum Aimed Range(m): 3,500 Max Effective Range (m): Day: INA Night: INA Armor Penetration (mm): 450 at 2,000 meters</p> <p>120-mm APFSDS-T, US Olin GD120 Maximum Aimed Range(m): 3,500 Max Effective Range (m): Day: 3,000 Night: INA Armor Penetration (mm): 520 at 2,000 meters</p>	<p>120-mm HEAT-MP-T, DM-12A1/US Olin M830 Maximum Aimed Range(m): INA Max Effective Range (m): Day: 2,500 Night: INA Armor Penetration (mm): INA</p> <p>Other Ammunition Types: US-produced M829, M829A1 APFSDS-T; US M830A1 HEAT-MP-T (MPAT), GE DM12A1 (US copy M830) HEAT-MP-T (MPAT)</p>
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NOTES

A variety of upgrade programs and options are available for the Leopard 2. These include the Atlas Elektronik Vehicle Integrated Command and Information System (IFIS), a digital command and information system.

A new longer gun barrel (L55 gun barrel, 1.30 meters longer) is available. It permits effective use of a new APFSDS-T round, DM53 (LKE II), with a longer rod penetrator, and which is under development. The German Army has decided not to buy the DM43 APFSDS-T round (aka: LKE I), rather to wait and upgrade to the DM53.

Russian Main Battle Tank T-55AMV

	<p>Weapons & Ammunition Types</p> <p>100-mm rifled gun APFSDS-T HEAT Frag-HE ATGM</p> <p>7.62-mm coax PKT MG 12.7-mm AA MG</p>	<p>Typical Combat Load</p> <p>(mix est) 43 14 3 21 5</p> <p>1,250 500</p>
<p>SYSTEM Alternative Designations: INA Date of Introduction: 1983 Proliferation: At least 3 countries Description: Crew: 4 Combat Weight (mt): 40.5 Chassis Length Overall (m): 6.20 Height Overall (m): 2.32 Width Overall (m): 3.60 Ground Pressure (kg/cm²): 0.89</p> <p>Automotive Performance: Engine Type: 620-690 hp Diesel Cruising Range (km): 390/600 with extra tanks Speed (km/h): Max Road: 50 Max Off-Road: 35 Average Cross-Country: 25 Max Swim: N/A Fording Depths (m): 1.4 Unprepared, 5.5 with snorkel</p> <p>Radio: R-173, R-173P, R-124 intercom</p> <p>Protection: Armor, Turret Front (mm): 200 (base T-55 armor) Applique Armor (mm): Rubber screens and box armor Explosive Reactive Armor (mm): 1st Gen raises to KE/700-900 against HEAT; 2nd Gen raises to 450-480 KE/700-900 HEAT Active Protective System: Russian Drozd APS available Mineclearing Equipment: Roller-plow set, and plows available Self-Entrenching Blade: No NBC Protection System: Yes Smoke Equipment: Smoke grenade launchers (4x 81-mm each side of turret), and 24 grenades. Vehicle engine exhaust smoke system</p> <p>ARMAMENT Main Armaments: Caliber, Type, Name: 100-mm rifled gun, D-10T2S Rate of Fire (rd/min): 5-7 Loader Type: Manual Ready/Stowed Rounds: INA Elevation (°): -5 to +18 Fire on Move: Yes (gun rounds only--ATGMs require a short halt)</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 54R) Machinegun PKT-T Mount Type: Turret coax Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 800</p>	<p>Night: 800 Fire on Move: Yes Rate of Fire (rd/min): 250 rpm practical, 800 cyclic, 2-10 rd bursts</p> <p>Caliber, Type, Name: 12.7-mm (12.7x108) AA MG DShKM Mount Type: Turret top Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,500 Night: N/A Fire on Move: Yes Rate of Fire (rd/min): 80-100 practical, 600 cyclic, 2-10 rd bursts</p> <p>ATGM Launcher : Name: D-10T2S gun Launch Method: Gun-launched Guidance: SACLOS, Infrared laser-beam rider Command Link: Encoded laser-beam Launcher Dismountable: No</p> <p>FIRE CONTROL FCS Name: Volna Main Gun Stabilization: M1 Tsiklon 2-plane Rangefinder: KDT-2 Laser Infrared Searchlight: L-4 Sights w/Magnification: Gunner: Day: TShSM-32PV, 3.5x and 7x Field of View (°): 18 and 8 Acquisition Range (m): 4,000 Night: 1K13 Field of View (°): INA Acquisition Range (m): 800-1,300, gun rounds only Commander Fire Main Gun: No</p> <p>VARIANTS More than a dozen countries have produced upgraded T-55 variants with similar capabilities in protection and lethality. Many countries have upgraded to a larger main gun.</p> <p>T-55AMV is derived from a line of variants of T-55 MBT. T-55A added an NBC protection system. T-55M added the Volna fire control system (with ATGM launcher), improved gun stabilization and sights, improved engine, new radio, and increased protection. That included side skirts, smoke grenade launchers, applique armor, and fire protection. T-55AM added bra armor, an armor band around the turret for 180° coverage. The -AMV upgrade means substitution of ERA for the bra armor. Variants ending with -I denote replacement of the engine w/V-46 engine from T-72 MBT. The Ukraine and Syria will upgrade to the T-55AMV standard.</p>	

Russian Main Battle Tank T-55AMV continued

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<p>T-55AM2B: Czech version of T-55AMV with Kladivo fire control. T-55AM2: Variant does not have ATGM capability or Volna FCS. T-55AM2P: Polish version of T-55AMV but with Merida FCS. T-55AMD: Variant with the Drozd APS instead of ERA. T-55AD Drozd: Variant with Drozd but not Volna FCS and ERA.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 100-mm BM-8 Russian Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 1,500 Night: 800-1,300 Armor Penetration (mm): 200 at 1,000 meters</p> <p>100-mm APFSDS-T, BM-25 Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: INA Night: 800-1,300 Armor Penetration (mm): INA</p> <p>100-mm APFSDS-T, BM-412M, Romanian Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 2,000+ (est) Night: 800-1,300 Armor Penetration (mm): 418 at 2,000 m, 380 at 3,000 m</p> <p>100-mm APFSDS-T, M1000, Belgian Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 2,500 (est) Night: 800-1,300 Armor Penetration (mm): NATO triple heavy target, 4,500 m</p>	<p>100-mm HEAT, BK-17 Maximum Aimed Range (m): 2,500 Max Effective Range (m): Day: 1,000 (est) Night: 800-1,000 (est) Armor Penetration (mm): 380</p> <p>100-mm Frag-HE, OF-32 Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: <2,500 Night: 800-1,300 Armor Penetration (mm): INA</p> <p>Other Ammunition Types: A variety of other rounds within the range noted above are available. They include the GIAT NR 322/ NR 352 APFSDS-T and Slovak JPrSv AP-T with ranges beyond 2,000 m.</p> <p>Antitank Guided Missiles: Name: AT-10/BASTION Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 650 (RHA) Range (m): 4,000 (day only, see NOTES)</p> <p>Name: AT-10 Improved Warhead Type: Tandem shaped charge Armor Penetration (mm): 700 (RHA) behind ERA Range (m): 4,000 (day only, see NOTES)</p>
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NOTES

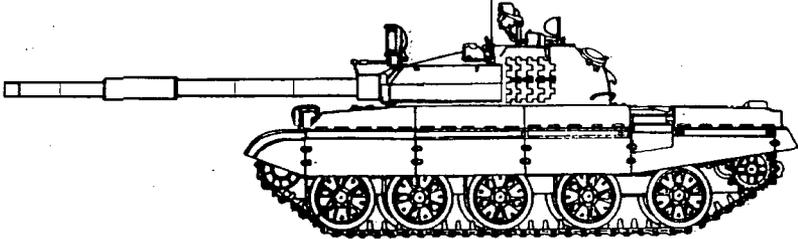
The 1K13 sight is both night sight and ATGM launcher sight; however, it cannot be used for both functions simultaneously.

T-55s with "bra armor", semi-circular add-on armor, have turret protection increased to 330 mm (KE) and 400-450 mm (CE). Other improvements available include a hull bottom reinforced against mines, better engines, rubber track pads, and a thermal sleeve for the gun.

Optional sights and fire control systems include the Israeli El-Op Red Tiger and Matador FCS, Swedish NobelTech T-series sight, and German Atlas MOLF. The Serbian SUV-T55A FCS, British Marconi Digital FCS, South African Tiger, and Belgian SABCA Titan offer upgraded function. One of the best is the Slovenian EFCS-3 integrated FCS.

A variety of thermal sights is available. They include the Russian/French ALIS and Namut-type sight from Peleng. There are thermal sights available for installation which permit night launch of ATGMs.

Russian Main Battle Tank T-62M

	Weapons & Ammunition Types	Typical Combat Load
	115-mm rifled gun APFSDS-T HEAT Frag-HE ATGM	(mix est) 40 12 3 20 5
	7.62-mm coax PKT MG	2,500

SYSTEM

Alternative Designations: INA
Date of Introduction: 1983
Proliferation: At least 1 country

Description:

Crew: 4
 Combat Weight (mt): 41.5
 Chassis Length Overall (m): 6.63
 Height Overall (m): 2.4
 Width Overall (m): 3.52
 Ground Pressure (kg/cm²): INA

Automotive Performance:

Engine Type: 620-hp Diesel
 Cruising Range (km): 450/650 with extra tanks
 Speed (km/h):
 Max Road: 45
 Max Off-Road: INA
 Average Cross-Country: INA
 Max Swim: N/A
 Fording Depths (m): 1.4 Unprepared, 5.5 with snorkel

Radio: R-173, R-173P, R-124 intercom

Protection:

Armor, Turret Front (mm): 230
 Applique Armor (mm): Bra armor (+100 on turret) and track skirts
 Explosive Reactive Armor (mm): Available, replaces bra armor
 Active Protective System: Russian Drozd APS will fit
 Mineclearing Equipment: Roller-plow set, and plows
 Self-Entrenching Blade: No
 NBC Protection System: Nuclear radiation only
 Smoke Equipment: Vehicle engine exhaust smoke system
 2 x 4 Smoke grenade launchers

ARMAMENT

Main Armaments:

Caliber, Type, Name: 115-mm smoothbore gun, 2A20/Sheksna
 Rate of Fire (rd/min): 3-5
 Loader Type: Manual
 Ready/Stowed Rounds: INA
 Elevation (°): -5 to +18
 Fire on Move: Yes (gun rounds only--ATGMs require a short halt)

Auxiliary Weapon:

Caliber, Type, Name: 7.62-mm (7.62x 54R) machinegun PKT
 Mount Type: Turret coax
 Maximum Aimed Range (m): 2,000
 Max Effective Range (m):
 Day: 800
 Night: 800

Fire on Move: Yes
 Rate of Fire (rd/min): 250 rpm practical, 800 cyclic, 2-10 rd bursts

ATGM Launcher:

Name: 2A20 gun
 Launch Method: Gun-launched
 Guidance: SACLOS, Infrared laser-beam rider
 Command Link: Encoded laser-beam
 Launcher Dismountable: No

FIRE CONTROL

FCS Name: Volna
Main Gun Stabilization: M1 Meteor 2-plane
Rangefinder: KTD-2 Laser
Infrared Searchlight: L-4
Sights w/Magnification:
 Gunner:

Day: TShSM-41U, 3.5x and 7x
 Field of View (°): 18 and 8
 Acquisition Range (m): 4,000
 Night: 1K13-1
 Field of View (°): INA
 Acquisition Range (m): 850-1,300, gun rounds only

Commander Fire Main Gun: No

VARIANTS

T-62M is one of a variety of T-62 variants. **T-62A:** added a 12.7-mm MG. **T-62M'** adds protection, FCS and ATGM capability. T-62 variants with a V-46 T-72-type engine add -1 to their designation.
T-62M1: Variant with Volna FCS but no missile launch capability.
T-62D: Variant with the Drozd APS vs ERA.
T-62MK: Command variant.
T-62MV: Version with ERA in place of the bra armor. The ERA includes Kontakt ERA and Kontakt-5 2nd-Generation ERA.

MAIN ARMAMENT AMMUNITION

Caliber, Type, Name:

115-mm APFSDS-T, BD/36-2
 Maximum Aimed Range (m): 3,000
 Max Effective Range (m):
 Day: 2,000+ (est)
 Night: 850-1,300
 Armor Penetration (mm): 520 (RHA, 71° angle) at 1,000 m

115-mm APFSDS-T, BM-6 Russian

Maximum Aimed Range(m): 3,000
 Max Effective Range (m):
 Day: 1,500
 Night: 850-1,300
 Armor Penetration (mm): 237 (RHA) at 1,000 m

Russian Main Battle Tank T-62M

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<p>115-mm HEAT, BK-4 Maximum Aimed Range (m): 1,500 (est) Max Effective Range (m): Day: 1,200 Night: 850-1,200 Armor Penetration (mm): 495 (RHA)</p> <p>115-mm Frag-HE-T, OF-27 Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: 1,500-2,000 Night: 850-1,300 Armor Penetration (mm): INA</p> <p>Other Ammunition Types: BM-3 APFSDS, BM-4 APFSDS, BK-4M HEAT, BK-15 HEAT, OF-11 Frag-HE, OF-18 Frag-HE</p>	<p>Antitank Guided Missiles Name: AT-10/Sheksna Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 650 Range (m): 4,000 (day only, see NOTES)</p> <p>Name: AT-10 Improved Warhead Type: Tandem shaped charge Armor Penetration (mm): 700 behind ERA Range (m): 4,000 (day only, see NOTES)</p>
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NOTES

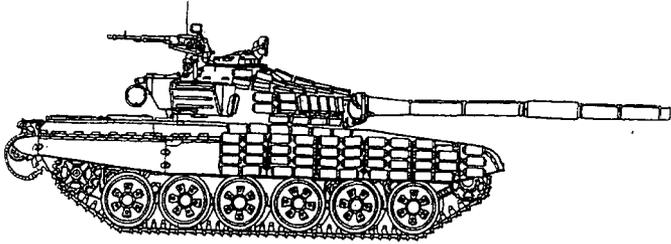
The 1K13 sight is both night sight and ATGM launcher sight; however, it cannot be used for both functions simultaneously.

Other improvements available include a hull bottom reinforced against mines, rubber track pads, and a thermal sleeve for the gun.

Optional sights and fire control systems include the Israeli El-Op Red Tiger and Matador FCS, Swedish NobelTech T-series sight, and German Atlas MOLF. The British Marconi Digital FCS, South African Tiger, and Belgian SABCA Titan offer upgraded function. One of the best is the Slovenian EFCS-3 integrated FCS.

A variety of thermal sights is available. They include the Russian Agava, French SAGEM-produced ALIS and Namut sight from Peleng. There are thermal sights available for installation which permit night launch of ATGMs.

Russian Main Battle Tank T-72B

 <p style="text-align: center;">T-72B w/Kontakt ERA</p>	<table border="1"> <thead> <tr> <th>Weapons & Ammunition Types</th> <th>Typical Combat Load</th> </tr> </thead> <tbody> <tr> <td>125-mm smoothbore gun</td> <td>45</td> </tr> <tr> <td>APFSDS-T</td> <td>(mix est) 15</td> </tr> <tr> <td>HEAT</td> <td>3</td> </tr> <tr> <td>Frag-HE</td> <td>21</td> </tr> <tr> <td>ATGM</td> <td>6</td> </tr> <tr> <td>7.62-mm coax MG</td> <td>2,000</td> </tr> <tr> <td>12.7-mm AA MG</td> <td>300</td> </tr> </tbody> </table>	Weapons & Ammunition Types	Typical Combat Load	125-mm smoothbore gun	45	APFSDS-T	(mix est) 15	HEAT	3	Frag-HE	21	ATGM	6	7.62-mm coax MG	2,000	12.7-mm AA MG	300
Weapons & Ammunition Types	Typical Combat Load																
125-mm smoothbore gun	45																
APFSDS-T	(mix est) 15																
HEAT	3																
Frag-HE	21																
ATGM	6																
7.62-mm coax MG	2,000																
12.7-mm AA MG	300																
<p>SYSTEM Alternative Designations: T-72S (export), SMT M1988 Date of Introduction: 1985 Proliferation: At least 2 countries Description: Crew: 3 Combat Weight (mt): 44.5 Chassis Length Overall (m): 6.91 Height Overall (m): 2.19 Width Overall (m): 3.58 Ground Pressure (kg/cm²): 0.90</p> <p>Automotive Performance: Engine Type: 840-hp Diesel Cruising Range (km): 500/ 900 with external tanks Speed (km/h): Max Road: 60 Max Off-Road: 45 Average Cross-Country: 35 Max Swim: N/A Fording Depths (m): 1.2 Unprepared/5.0 with snorkel Radio: R-173 and R-134</p> <p>Protection: Armor, Turret Front (mm): 520/950 against HEAT Applique Armor (mm): Side of hull over track skirt, turret top Explosive Reactive Armor (mm): Kontakt or Kontakt-5 ERA Active Protective System: Arena available Mineclearing Equipment: Roller-plow set, and plows available Self-Entrenching Blade: Yes NBC Protection System: Yes Smoke Equipment: Smoke grenade launchers (8x 81-mm left side of turret), and 32 grenades. Vehicle engine exhaust smoke system.</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 125-mm smoothbore gun 2A46M/ D-81TM Rate of Fire (rd/min): 4-6/2 in manual mode Loader Type: Autoloader (separate loading) and manual Ready/Stowed Rounds: 22/23 Elevation (°): -6 to +14 Fire on Move: Yes, up to 25 km/h. Depending on the road and distance to the target, most crews may halt before firing.</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 54R) Machinegun PKT Mount Type: Turret coax Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,000 Night: 800</p>	<p>Fire on Move: Yes Rate of Fire (rd/min): 250 practical, 600 cyclic in 2-10 round bursts</p> <p>Caliber, Type, Name: 12.7-mm (12.7x108) AA MG NSVT Mount Type: Turret top Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,500/1,000 antiaircraft Night: N/A Fire on Move: Yes Rate of Fire (rd/min): 200 practical, 600 cyclic in bursts</p> <p>ATGM Launcher: Name: 2A46M Launch Method: Gun-launched Guidance: SACLOS, Laser beam rider Command Link: Encoded infrared laser beam Launcher Dismountable: No</p> <p>FIRE CONTROL FCS Name: 1A40-1 Main Gun Stabilization: 2E42-2, 2-plane Rangefinder: TPD-K1M laser rangefinder Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: TPD-K1, 8 Field of View (°): 9 Acquisition Range (m): 3,000 with LRF, 5,000 without ATGM/Night: 1K13-495 5.6x (8x ATGM) Field of View (°): 6, 40 min (5 ATGM) Acquisition Range (m): INA Commander Fire Main Gun: No</p> <p>VARIANTS T-72BK: Commander's variant with additional radios</p> <p>T-72BM: Version with Kontakt-5 explosive reactive armor. This system is being fielded and is available for export.</p> <p>T-72S/Shilden: Russian export T-72A upgraded to be comparable to the T-72BM standard. Although similar to the T-72BM, it may have less turret front protection. The early T-72S tank has Kontakt ERA, as shown above.</p> <p>T-90: Successor to T-72BM. This tank has been tentatively approved for production and adoption as a standard tank, alongside the T-80U, for the Russian army. The T-90 uses the gun and 1G46 gunner sights from T-80U, a new engine, and thermal sights. Protective measures include Kontakt-5 ERA, laser warning receivers, and the SHTORA infrared ATGM jamming system.</p>																

Russian Main Battle Tank T-72B continued

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<p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 125-mm APFSDS-T, BM-42M Maximum Aimed Range (m): 3,000 Max Effective Range (m): Day: 2,000-3,000 Night: 850-1,300 Armor Penetration (mm): 590-630 at 2,000 meters</p> <p>125-mm Frag-HE-T, OF-26 Maximum Aimed Range (m): 5,000 Max Effective Range (m): Day: INA Night: 850-1,300 Armor Penetration (mm): INA</p> <p>125-mm HEAT-MP, BK-29M Maximum Aimed Range (m): 3,000 Max Effective Range (m): Day: INA Night: 850-1300 Armor Penetration (mm): 650-750</p>	<p>125-mm HEAT, BK-27 Maximum Aimed Range (m): 3,000. Max Effective Range (m): Day: INA Night: 850-1,300 Armor Penetration (mm): 700-800</p> <p>Other Ammunition Types: Giat 125G1 APFSDS-T, Russian BM-42 and BM-32 APFSDS-T. Note: The Russians may have a version of the BM-42M with a DU penetrator.</p> <p>Antitank Guided Missiles: Name: AT-11/SVIR Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 700 behind ERA/800 conventional Range (m): 4,000</p> <p>Name: AT-11B/INVAR Warhead Type: Tandem Shaped charge (HEAT) Armor Penetration (mm): 800 behind ERA /870 conventional Range (m): 4,000</p>
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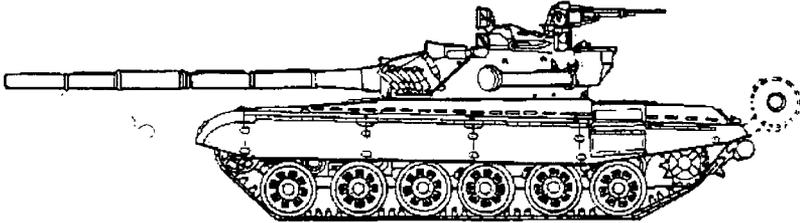
NOTES

The T-72B is the second main variant from the original Russian T-72 tank (after T-72A).

The 1K13-49 sight is both night sight and ATGM launch sight. However, it cannot be used for both functions simultaneously. A variety of thermal sights is available. They include the Russian Agava-2, French SAGEM-produced ALIS and Namut sight from Peleng. Thermal gunner night sights are available which permit night launch of ATGMs.

The more recent BK-27 HEAT round offers a triple-shaped charge warhead and increased penetration against conventional armors and ERA. The BK-29 round, with a hard penetrator in the nose is designed for use against reactive armor, and as an MP round has fragmentation effects. If the BK-29 HEAT-MP is used, it may substitute for Frag-HE (as with NATO countries) or complement Frag-HE. With three round natures (APFSDS-T, HEAT-MP, ATGMs) in the autoloader vs four, more antitank rounds would be available for the higher rate of fire.

Polish/Czechoslovakian Main Battle Tank T-72M1

	Weapons & Ammunition Types	Typical Combat Load
	125-mm smoothbore gun	44
	APFSDS-T	(mix est) 15
	HEAT	7
	Frag-HE	22
	7.62-mm coax MG	2,000
	12.7-mm AA MG	300

SYSTEM

Alternative Designations: Russian T-72A

Date of Introduction: 1975

Proliferation: At least 7 countries

Description:

Crew: 3

Combat Weight (mt): 41.5 (without ERA)

Chassis Length Overall (m): 6.91

Height Overall (m): 2.19

Width Overall (m): 3.59

Ground Pressure (kg/cm²): 0.90

Automotive Performance:

Engine Type: 780-hp Diesel

Cruising Range (km): 460/700 with extra tanks

Speed (km/h):

Max Road: 60

Max Off-Road: 45

Average Cross-Country: 35

Max Swim: N/A

Fording Depths (m): 1.2 Unprepared/5.0 with snorkel

Radio: R-173M

Protection:

Armor, Turret Front (mm): 500/560 against HEAT

Applique Armor (mm): Side of hull over track skirt, turret top

Explosive Reactive Armor (mm): 1st or 2nd Gen ERA available

Active Protective System: Arena or Drozd available

Mineclearing Equipment: Roller-plow set, and plows available

Self-Entrenching Blade: Yes

NBC Protection System: Yes

Smoke Equipment: Smoke grenade launchers (6x 81-mm each side of turret), and 24 grenades. Vehicle engine exhaust smoke system.

ARMAMENT

Main Armaments:

Caliber, Type, Name: 125-mm smoothbore gun 2A46M/ D-81TM

Rate of Fire (rd/min): 4-6/2 in manual mode

Loader Type: Autoloader (separate loading) and manual

Ready/Stowed Rounds: 22/22 (22 in carousel)

Elevation (°): -6 to +14

Fire on Move: Yes, up to 25 km/h. Depending on the road and distance to the target, most crews may halt before firing.

Auxiliary Weapon:

Caliber, Type, Name: 7.62-mm (7.62x 54R) Machinegun PKT

Mount Type: Turret coax

Maximum Aimed Range (m): 1,800

Max Effective Range (m):

Day: 1,000

Night: 800

Fire on Move: Yes

Rate of Fire (rd/min): 250 practical, 600 cyclic in 2-10 round bursts

Caliber, Type, Name: 12.7-mm (12.7x108) AA MG NSVT

Mount Type: Turret top

Maximum Aimed Range (m): 2,000

Max Effective Range (m):

Day: 1,500, 1,000 AA

Night: N/A

Fire on Move: Yes

Rate of Fire (rd/min): 200 practical, 600 cyclic in bursts

ATGM Launcher: N/A

FIRE CONTROL

FCS Name: INA

Main Gun Stabilization: 2E28M, 2-plane

Rangefinder: TPD-K1 laser rangefinder

Infrared Searchlight: Yes

Sights w/Magnification:

Gunner:

Day: TPD-K1 laser rangefinder sight, 8 x

Field of View (°): 9

Acquisition Range (m): 3,000 with LRF, 5000 without

Night: TPN-1-49, 5.5 x

Field of View (°): 6

Acquisition Range (m): 800

Commander Fire Main Gun: No

VARIANTS

T-72: Original Russian tank from which T-72 variants were derived.

T-72M: Original Polish and former-Czechoslovakian T-72-series tank from which Polish/Czechoslovakian T-72M1 was derived.

T-72M differs from T-72 in replacing the right-side coincident rangefinder with a centerline-mounted TPDK-1 LRF.

T-72A: The Russian variant differs from T-72 with the TPDK-1 LRF, added sideskirts, additional armor on the turret front and top, smoke grenade launchers, internal changes, and a slight weight increase. The Russian export version and Polish/Czechoslovakian counterparts are called **T-72M1**. Versions with Kontakt ERA are known as **T-72AV /T-72 M1V**. Please note that some countries have inventories of T-72, T-72M and T-72M1, with different versions of each variant. Also, many variants were upgraded or modified. Some T-72M1s do not have smoke grenade launchers or track skirts. Some T-72s/T-72Ms have smoke grenade launchers. More reliable discriminators are armor and rangefinder/FCS.

Polish/Czechoslovakian Main Battle Tank T-72M1 continued

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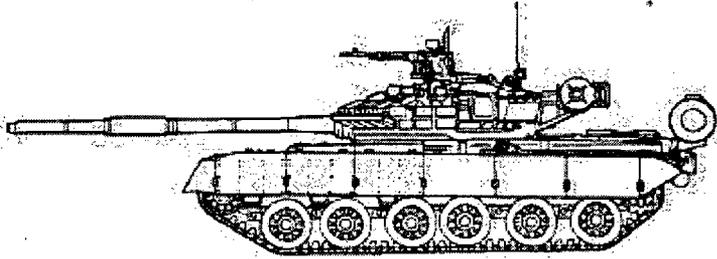
<p>T-72AK/7T-2M1K: Commander's variant with additional radios</p> <p>T-72AM/Banan: Ukrainian T-72A upgrade with ERA, a new engine, and additional smoke grenade launchers. The T-72AG upgrade has a 1200-hp engine, Shtora-1 ATGM jammer, and 1G46 (T-80U) FCS with thermal night sights.</p> <p>T-72M1M: T-72M1 variant upgraded to T-72B standard.</p> <p>T-72M2/Moderna. Slovakian T-72M upgrade with new engine and fire control, SFIM thermal sight, laser warning receiver, ERA, and 2 x 20-mm AA guns on turret</p> <p>T-72M4CZ: Czech variant with TURMS FCS with thermal sight, new engine, increased protection ERA, and 48t weight. T72M3CZ is a less radical upgrade-- for instance existing engine is modified.</p> <p>T-72MP: Ukrainian upgrade with a 1,000-hp engine, added armor, Shtora-1, and SAGEM FCS and thermal sights.</p> <p>T-72S/Shilden: Russian export T-72A upgraded to T-72B standard.</p> <p>M-84: Former Yugoslavian tank upgraded to T-72M1 standard, but with indigenous sights. With an upgraded engine, the tank is M-84A. A Croatian improved version of M-84 is M84A4/Sniper, with improved fire control and thermal night sights. A Slovenian upgrade uses the state-of-the-art and the well-marketed EFCS-3 FCS.</p> <p>PT-91/Twardy: Polish upgrade tank with ERA, laser warning receiver, smoke grenade launchers, and Tiger fire control system. Sights include a thermal gunner night sight.</p>	<p>MAIN ARMAMENT AMMUNITION</p> <p>Caliber, Type, Name: 125-mm APFSDS-T, BM-42M Maximum Aimed Range (m): 3,000 Max Effective Range (m): Day: 2,000-3,000 Night: 850-1,300 Armor Penetration (mm): 590-630 at 2,000 meters</p> <p>125-mm Frag-HE-T, OF-26 Maximum Aimed Range (m): 5,000 Max Effective Range (m): Day: INA Night: 850-1,300 Armor Penetration (mm): INA</p> <p>125-mm HEAT-MP, BK-29M Maximum Aimed Range (m): 3,000 Max Effective Range (m): Day: INA Night: 850-1300 Armor Penetration (mm): 650-750</p> <p>125-mm HEAT, BK-27 Maximum Aimed Range (m): 3,000 Max Effective Range (m): Day: INA Night: 850-1,300 Armor Penetration (mm): 700-800</p> <p>Other Ammunition Types: Giat 125G1 APFSDS-T, Russian BM-42 and BM-32 APFSDS-T. Note: The Russians may have a version of the BM-42M with a DU penetrator.</p>
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NOTES

A variety of thermal sights is available. They include the Russian Agava-2, French SAGEM-produced ALIS and Namut sight from Peleng.

The more recent BK-27 HEAT round offers a triple-shaped charge warhead and increased penetration against conventional armors and ERA. The BK-29 round, with a hard penetrator in the nose is designed for use against reactive armor, and as an MP round has fragmentation effects. If the BK-29 HEAT-MP is used, it may substitute for Frag-HE (as with NATO countries) or complement Frag-HE. With three round natures (APFSDS-T, HEAT-MP, ATGMs) in the autoloader vs four, more antitank rounds would be available for the higher rate of fire.

Russian Main Battle Tank T-80B

	<p>Weapons & Ammunition Types</p> <p>125-mm smoothbore gun APFSDS-T HEAT Frag-HE ATGM</p> <p>7.62-mm coax MG 12.7-mm NSVT AA MG</p>	<p>Typical Combat Load</p> <p>45 (mix est) 15 3 21 6</p> <p>1,250 500</p>
<p>SYSTEM Alternative Designations: See NOTES Date of Introduction: 1978 Proliferation: At least 1 country Description: Crew: 3 Combat Weight (mt): 44.5 Chassis Length Overall (m): 6.98 Height Overall (m): 2.22 Width Overall (m): 3.58 Ground Pressure (kg/cm²): 0.87</p> <p>Automotive Performance: Engine Type: 1,000-hp or 1,100-hp Gas turbine (multifuel), Cruising Range (km): 370/ 500 with extra tanks Speed (km/h): Max Road: 70 Max Off-Road: 48 Average Cross-Country: 40 Max Swim: N/A Fording Depths (m): 1.8 Unprepared, 5.0 w/snorkel, 12.0 with BROD-M system</p> <p>Radio: R-173, R-174 intercom</p> <p>Protection: Armor, Turret Front (mm): Defeat 120-mm rounds (triple layer) Applique Armor (mm): N/A Explosive Reactive Armor (mm): 1st Generation ERA available Active Protective System: Available Mineclearing Equipment: Mine rollers and plows available Self-Entrenching Blade: Yes NBC Protection System: Yes Smoke Equipment: Smoke grenade launchers (4x 81-mm each side of turret), and 24 grenades. Vehicle engine exhaust smoke system</p> <p>ARMAMENT Main Armaments: Caliber, Type, Name: 125-mm smoothbore gun 2A46-2 Rate of Fire (rd/min): 6-8 (lower in manual mode) Loader Type: KORZINA separate-loading autoloader and manual Ready/Stowed Rounds: 28 in carousel/17 rounds stowed but readily available for manual loading Elevation (°): -7 to +20 Fire on Move: Yes (30 km/h gun rounds/low speed or stop ATGMs)</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 54R) Machinegun PKT Mount Type: Turret coax Maximum Aimed Range (m): 2,000</p>	<p>Max Effective Range (m): Day: 1,000 Night: 850-1,300 Fire on Move: Yes Rate of Fire (rd/min): 250 practical / 650 cyclic, 2-10 round bursts</p> <p>Caliber, Type, Name: 12.7-mm (12.7x108) AA MG NSVT Mount Type: Turret top Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,500 ground/1,600 for air targets (APDS) Night: 800-1,300 Fire on Move: Yes Rate of Fire (rd/min): 210 practical/ 800 air targets in bursts</p> <p>ATGM Launcher: Name: 2A46-2 tank gun Launch Method: Gun-launched Guidance: SACLOS Command Link: Encoded radio frequency Launcher Dismountable: No</p> <p>FIRE CONTROL FCS Name: FCS 1A33 Main Gun Stabilization: 2E26M 2-plane Rangefinder: Laser Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: 1G42 Field of View (°): INA Acquisition Range (m): 5,000 Night: 1-4A Field of View (°): INA Acquisition Range (m): 800-1,300 (est) Commander Fire Main Gun: No</p> <p>VARIANTS T-80BV: Variant noted in the above line drawing has ERA mounted. This variant is more likely for encounter by US forces.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 125-mm APFSDS-T, BM-42M Maximum Aimed Range (m): 3,000-4,000 Max Effective Range (m): Day: 2,000-3,000 Night: 850-1,300 Armor Penetration (mm): 590-630 at 2,000 meters</p>	

Russian Main Battle Tank T-80B continued

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<p>125-mm Frag-HE-T, OF-26 Maximum Aimed Range (m): 5,000 Max Effective Range (m): Day: INA Night: 850-1,300 Armor Penetration (mm): INA</p> <p>125-mm HEAT-MP, BK-29M Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: 2,000-3,000 Night: 850-1300 Armor Penetration (mm): 650-750</p> <p>125-mm HEAT, BK-27 Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: 2,000-3,000 Night: 850-1,300 Armor Penetration (mm): 700-800</p>	<p>Other Ammunition Types: Giat 125G1 APFSDS-T, Russian BM-42 and BM-32 APFSDS-T. Note: The Russians may have a version of the BM-42M with a DU penetrator.</p> <p>Antitank Guided Missile: Name: AT-8/SONGSTER Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 700 (RHA) conventional Range (m): 4,000</p>
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NOTES

The T-80B and -BV variants are often misidentified as T-80. They are visibly different and bear other distinctions, such as T-80B/-BV capability for launching AT-8/ Songster ATGM.

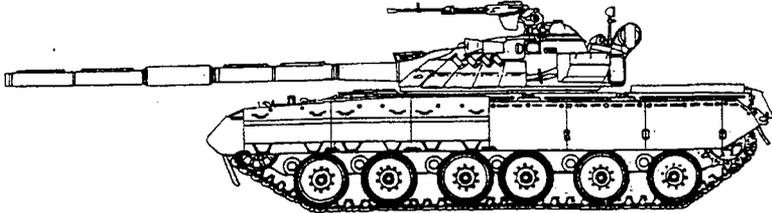
The night sight cannot be used to launch the ATGM. The daysight can be used at night for launching ATGMs if the target is illuminated. A variety of thermal sights is available. They include the Russian Agava-2, French SAGEM-produced ALIS and Namut sight from Peleng. There are thermal sights available for installation which permit night launch of ATGMs.

The 12.7-mm MG NSVT has both remote electronically operated sight PZU-5 and gun-mounted K10-T reflex sight.

The more recent BK-27 HEAT round offers a triple-shaped charge warhead and increased penetration against conventional armors and ERA. The BK-29 round, with a hard penetrator in the nose is designed for use against reactive armor, and as an MP round has fragmentation effects. If the BK-29 HEAT-MP is used, it may substitute for Frag-HE (as with NATO countries) or complement Frag-HE. With three round natures (APFSDS-T, HEAT-MP, ATGMs) in the autoloader vs four, more antitank rounds would available for the higher rate of fire.

The ATGM may be launched while moving slowly (NFI). The AT-8 can be auto-loaded with the two halves mated during ramming; but the stub charge is manually loaded.

Russian Main Battle Tank T-80U

	<p>Weapons & Ammunition Types</p> <p>125-mm smoothbore gun APFSDS-T HEAT Frag-HE ATGM</p> <p>7.62-mm coax MG 12.7-mm NSVT AA MG</p>	<p>Typical Combat Load</p> <p>45 (mix est) 15 3 21 6</p> <p>1,250 500</p>
	<p>SYSTEM Alternative Designations: SMT (Soviet Medium Tank) M1989 Date of Introduction: 1987 Proliferation: At least 3 countries Description: Crew: 3 Combat Weight (mt): 46.0 Chassis Length Overall (m): 7.01 Height Overall (m): 2.20 Width Overall (m): 3.60 Ground Pressure (kg/cm²): 0.92</p> <p>Automotive Performance: Engine Type: 1250-hp Gas turbine (multi-fuel), diesel on T-80UD Cruising Range (km): 335 km/600 km with extra tanks Speed (km/h): Max Road: 70 Max Off-Road: 48 Average Cross-Country: 40 Max Swim: N/A Fording Depths (m): 1.8 Unprepared, 5.0 w/snorkel, 12.0 with BROD-M system</p> <p>Radio: R-173, R-174 intercom</p> <p>Protection: Armor, Turret Front (mm): Against 120-mm ammunition Applique Armor (mm): Side of hull, over track skirt Explosive Reactive Armor (mm): Kontakt-5 2nd Generation ERA Active Protective System: ARENA is available Mineclearing Equipment: Roller-plow set and plows available Self-Entrenching Blade: Yes NBC Protection System: Yes Smoke Equipment: Smoke grenade launchers (4x 81-mm each side of turret), and 24 grenades. Vehicle engine exhaust smoke system.</p> <p>ARMAMENT Main Armaments: Caliber, Type, Name: 125-mm smoothbore gun 2A46M-1 Rate of Fire (rd/min): 7-8 (lower in manual mode) Loader Type: KORZINA separate-loading autoloader, and manual Ready/Stowed Rounds: 28 in carousel/17 stowed (manual loaded) Elevation (°): -4 to +18 Fire on Move: Yes (gun rounds and ATGMs)</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 54R) Machinegun PKT Mount Type: Turret coaxial Maximum Aimed Range (m): 2,000</p> <p>Max Effective Range (m): Day: 800 Night: 800 Fire on Move: Yes Rate of Fire (rd/min): 250 practical / 650 cyclic, 2-10 round bursts</p> <p>Caliber, Type, Name: 12.7-mm (12.7x108) AA MG NSVT Mount Type: Turret top Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,500 Night: 800-1,300 Fire on Move: Yes Rate of Fire (rd/min): 210 practical/ 800 air targets in bursts</p> <p>ATGM Launcher: Name: 2A46M-1 tank gun Launch Method: Gun-launched Guidance: SACLOS, Laser-beam rider Command Link: Encoded infrared laser-beam Launcher Dismountable: No</p> <p>FIRE CONTROL FCS Name: FCS 1A42 Main Gun Stabilization: 2342, 2-plane Rangefinder: Laser Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: 1G46/PERFECT, 3.6/12x Field of View (°): INA Acquisition Range (m): 5,000 (70%P-hit for ATGM) Night: AGAVA-2 Field of View (°): INA Acquisition Range (m): 2,600 (gun rounds only) Commander Fire Main Gun: Yes</p> <p>VARIANTS T-80UD: Version produced in the Ukraine with a 1000-hp diesel engine instead of the turbine engine, and 1st generation ERA. T-80UK: Command version with R-163-50K and R-163-U radios, TNA-4 land navigation system, and an electronic fuze-setting device that permits use of Ainet Shrapnel Round. The AGAVA thermal sight provides a 2,600-meter night acquisition range. T-84: Recent Ukrainian upgrade of T-80UD with a welded turret, a French ALIS thermal sight, a more powerful engine, optional use of ARENA active protection system (APS) and SHTORA-1 active IR ATGM jammer system. Prototypes have been demonstrated, and the tank is available for export.</p>	

Russian Main Battle Tank T-80U continued

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<p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 125-mm APFSDS-T, BM-42M Maximum Aimed Range (m): 3,000-4,000 Max Effective Range (m): Day: 2,000-3,000 Night: 800-1,300 Armor Penetration (mm): 590-630 at 2,000 meters</p> <p>125-mm HE-Shapnel Focused-fragmentation, Ainet Maximum Aimed Range (m): 5,000 Max Effective Range (m): Day: 4,000 Night: 800-1,300 Tactical AA Range: 4,000-5,000 Armor Penetration (mm): INA</p> <p>125-mm Frag-HE-T, OF-26 Maximum Aimed Range (m): 5,000 Max Effective Range (m): Day: INA Night: 800-1,300 Armor Penetration (mm): INA</p> <p>125-mm HEAT-MP, BK-29M Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: INA Night: 800-1300 Armor Penetration (mm): 650-750</p>	<p>125-mm HEAT, BK-27 Maximum Aimed Range (m): 4,000 Max Effective Range (m): Day: INA Night: 800-1,300 Armor Penetration (mm): 700-800</p> <p>Other Ammunition Types: Giat 125G1 APFSDS-T, Russian BM-42 and BM-32 APFSDS-T. Note: The Russians may have a version of the BM-42M with a DU penetrator.</p> <p>Antitank Guided Missiles: Name: AT-11/SVIR Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 700 (RHA) behind ERA/800 conventional Range (m): 5,000</p> <p>Name: AT-11B/INVAR Warhead Type: Tandem shaped charge Armor Penetration (mm): 800 (RHA) behind ERA /870 conventional Range (m): 5,000</p>
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NOTES

Line drawing is a T-80UD.

GTA-18A Auxiliary Power Unit is used when the engine is off.

The BK-29 round, with a hard penetrator in the nose is designed for use against reactive armor, and as an MP round has fragmentation effects. The more recent BK-27 HEAT round offers a triple-shaped charge warhead and 50 mm more penetration.

The electronic round fuzing system for Ainet rounds is available for other tanks. This round uses technology similar to that for French Oerlikon's AHEAD rounds. The round is specially designed to defeat targets by firing fragmentation patterns forward and radially, based on computer calculated settings from the laser range-finder and other inputs. Targets are helicopters and dug in or defilade priority ground threats, such as ATGM positions. Rate of fire is 4 rd/min.

The 12.7-mm MG NSVT has both remote electronically operated sight PZU-5 and gun-mounted K10-T reflex sight.

The original night sight is the II Buran-PA (800-1300 meters range). The sight cannot be used to launch the ATGM. The daysight can be used at night for launching ATGMs if the target is illuminated. A variety of thermal sights is available. They include the Russian Agava-2, French SAGEM-produced ALIS and Namut sight from Peleng. There are thermal sights available for installation which permit night launch of ATGMs.

Chinese Main Battle Tank Type 59-II

	Weapons & Ammunition Types 105-mm rifled gun L7 New CH APFSDS-T M456 HEAT L35 HESH 7.62-mm coax MG 7.62-mm bow MG 12.7-mm AA MG	Typical Combat Load 34 12 6 16 2,000 1,000 500
<p>SYSTEM Alternative Designations: WZ 120B Date of Introduction: 1951 Proliferation: At least 2 countries Description: Crew: 4 Combat Weight (mt): 36.5-37.0 Chassis Length Overall (m): 6.04 Height Overall (m): 2.59 Width Overall (m): 3.30 Ground Pressure (kg/cm²): 0.8</p> <p>Automotive Performance: Engine Type: 520-hp Diesel Cruising Range (km): 440/600 with external tanks Speed (km/h): Max Road: 50 Max Off-Road: 25 Average Cross-Country: INA Max Swim: N/A Fording Depths (m): 1.4 Unprepared, 5.5 with snorkel</p> <p>Radio: INA</p> <p>Protection: Armor, Turret Front (mm): 203 Applique Armor (mm): Track skirts are fitted to some tanks Explosive Reactive Armor (mm): N/A Active Protective System: N/A Mineclearing Equipment: Mine plows and roller-plows available Self-Entrenching Blade: N/A NBC Protection System: N/A Smoke Equipment: 8 x 81-mm smoke grenade launchers Vehicle engine exhaust smoke system</p> <p>ARMAMENT Main Armaments: Caliber, Type, Name: 105-mm rifled gun, similar to L7 Rate of Fire (rd/min): 6-10 Loader Type: Manual Ready/Stowed Rounds: INA Elevation (°): -5/+18 Fire on Move: Yes</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 54R) Machine gun Type 59T Mount Type: Turret coax Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,000 Night: 800</p>	<p>Fire on Move: Yes Rate of Fire (rd/min): 250 practical, 600 cyclic in 2-10 round bursts</p> <p>Caliber, Type, Name: 7.62-mm (7.62x 54R) Machine gun Type 59T Mount Type: Bow ball mount Maximum Aimed Range (m): 1,000 Max Effective Range (m): Day: 1,000 Night: N/A Fire on Move: Yes Rate of Fire (rd/min): 250 practical, 600 cyclic in 2-10 round bursts</p> <p>Caliber, Type, Name: 12.7-mm (12.7x108) AA MG Type 54 Mount Type: Turret cupola Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,500 ground/1,600 for air targets (APDS) Night: N/A, II sights available Fire on Move: Yes Rate of Fire (rd/min): 80-100 practical, 600 air targets 2-10 rd bursts</p> <p>FIRE CONTROL FCS Name: UI light spot fire control system Main Gun Stabilization: 2-plane Rangefinder: LRF Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: INA Field of View (°): INA Acquisition Range (m): INA Night: Type DC 1024/00 II sights, x7 Field of View (°): 6 Acquisition Range (m): 1,000 Commander Fire Main Gun: No</p> <p>VARIANTS: Type 59: Original model is a copy of the Former Soviet T-54 MBT and has a 100-mm main gun.</p> <p>T-72Z/ Safir 74: Iranian variant which constitutes state of the art for upgraded 50s-generation former Warsaw Pact tanks. This tank has a 780-hp diesel engine, track skirts, and smoke grenade launchers. An Iranian ERA package will fit T-72Z. Armament includes an M68 105-mm rifled gun, 7.62-mm Type 59T (PKT) MG, and a 12.7-mm Type 59 (DSHKM) MG. The cannon can launch AT-10/ Bastion ATGMs (to 4000 meters) and fire a broad range of NATO 105-mm ammunition. Fire control includes the robust Slovenian EFCS-3-55 fire control system with stabilization, a laser rangefinder, and a ballistic computer. The FCS includes a commander's independent viewer and target designation system, and II gunner night sights.</p>	

Chinese Main Battle Tank Type 59-II continued

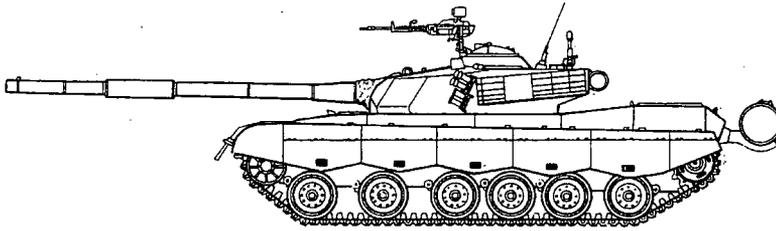
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<p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 105-mm APFSDS, H6/62 Maximum Aimed Range (m): 3,000 Max Effective Range (m): Day: 2,000-3,000 (est) Night: 800-1,300 Armor Penetration (mm): INA</p> <p>105-mm APFSDS, UI (New Chinese) Maximum Aimed Range (m): 3,000 Max Effective Range (m): Day: 2,000-3,000 (est) Night: 800-1,300 Armor Penetration (mm): 460 at 2,000 m</p>	<p>105-mm HEAT, M456 (multinational) Maximum Aimed Range (m): 3,000 Max Effective Range (m): Day: 1,500-2,500 (est) Night: 800-1,300 Armor Penetration (mm): 432, NATO single heavy target</p> <p>105-mm HESH, L35 (UK) Maximum Aimed Range (m): 5,000 Max Effective Range (m): Day: 2,000-3,000 (est) Night: 800-1,300 Armor Penetration (mm): NATO single heavy target</p> <p>Other Ammunition Types: Chinese Type 83/ UK L64/ US M735 APFSDS, UK L52 APDS, multinational M393 HEP-T, French OE 105-F1 HE, L39 Smoke, cannister</p>
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NOTES

GEC-Marconi Centaur fire control system is available. British Barr and Stroud thermal based FCS can be fitted.

Chinese Main Battle Tank Type 85-IIM

	<p>Weapons & Ammunition Types-</p> <p>125-mm smoothbore gun APFSDS-T HEAT Frag-HE</p> <p>7.62-mm coax MG</p> <p>12.7-mm cupola AAMG</p>	<p>Typical Combat Load-</p> <p>42 (mix est) 15 6 21</p> <p>2,000</p> <p>500</p>
	<p>SYSTEM Alternative Designations: INA Date of Introduction: 1991 Proliferation: At least 2 countries Description: Crew: 3 Combat Weight (mt): 41.0 Chassis Length Overall (m): 10.28 Height Overall (m): 2.30 Width Overall (m): 3.450 Ground Pressure (kg/cm²): 0.771</p> <p>Automotive Performance: Engine Type: 730-hp Diesel Cruising Range (km): 700/900 with external tanks Speed (km/h): Max Road: 57 Max Off-Road: 45 Average Cross-Country: 35 Max Swim: N/A Fording Depths (m): 1.4 Unprepared, 2.4 with snorkel</p> <p>Radio: INA</p> <p>Protection: Armor, Turret Front (mm): INA Applique Armor (mm): Track skirts. Composite panels available. Explosive Reactive Armor (mm): N/A Active Protective System: N/A Mineclearing Equipment: Mine plows and roller-plov set Self-Entrenching Blade: N/A NBC Protection System: Yes Smoke Equipment: 12x 81-mm smoke grenade launchers Vehicle engine exhaust smoke system</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 125-mm smoothbore gun 2A46M/ D-81TM Rate of Fire (rd/min): 4-6/2 in manual mode Loader Type: Autoloader (separate loading) and manual Ready/Stowed Rounds: 22/23 (22 in carousel) Elevation (°): -6 to +14 Fire on Move: Yes, up to 25 km/h. Depending on the road and distance to the target, most crews may halt before firing.</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x 54R) Machine gun Type 59 Mount Type: Turret coax Maximum Aimed Range (m): 1,800 Max Effective Range (m): Day: 1,000 Night: 800</p> <p>Fire on Move: Yes Rate of Fire (rd/min): 250 practical, 600 cyclic, 2-10 rd bursts</p> <p>Caliber, Type, Name: 12.7-mm (12.7x108) AA MG Type 54 Mount Type: Cupola Maximum Aimed Range (m): 2,000 Max Effective Range (m): Day: 1,500 ground/1600 for air targets (APDS) Night: N/A Fire on Move: Yes Rate of Fire (rd/min): 80-100 practical, 600 air targets, 2-10 rd bursts</p> <p>FIRE CONTROL FCS Name: ISFCS-212 (Image-Stabilized Fire Control System) Main Gun Stabilization: 2-plane Rangefinder: LRF Infrared Searchlight: Yes Sights w/Magnification: Gunner: Day: UI stabilized gunner sight Field of View (°): INA Acquisition Range (m): INA Night: 2nd Generation II sights Field of View (°): INA Acquisition Range (m): INA Commander Fire Main Gun: No</p> <p>VARIANTS Type 85-IIAP: Variant assembled from Type 59s and Type 69-IIs and upgrade kits, or from licensed production in Pakistan. Type 85-III: Upgraded variant with 1,000-hp engine and composite armor panels. Variant is in prototype stage.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 125-mm APFSDS-T, BM-42M Maximum Aimed Range (m): 3,000 Max Effective Range (m): Day: 2,000-3,000 Night: 850-1,300 Armor Penetration (mm): 590-630 at 2,000 meters</p> <p>125-mm Frag-HE-T, OF-26 Maximum Aimed Range (m): 5,000 Max Effective Range (m): Day: INA Night: 850-1,300 Armor Penetration (mm): INA</p>	

Chinese Main Battle Tank Type 85-IIM continued

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<p>125-mm HEAT-MP, BK-29M Maximum Aimed Range (m): 3,000 Max Effective Range (m): Day: INA Night: 850-1300 Armor Penetration (mm): 650-750</p> <p>125-mm HEAT, BK-27 Maximum Aimed Range (m): 3,000 Max Effective Range (m): Day: INA Night: 850-1,300 Armor Penetration (mm): 700-800</p>	<p>Other Ammunition Types: Giat 125G1 APFSDS-T, Russian BM-42 and BM-32 APFSDS-T. Note: The Russians may have a version of the BM-42M with a DU penetrator.</p>
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NOTES

GEC-Marconi Centaur fire control system is available. British Barr and Stroud thermal based FCS can be fitted.

The more recent BK-27 HEAT round offers a triple-shaped charge warhead and increased penetration against conventional armors and ERA. The BK-29 round, with a hard penetrator in the nose is designed for use against reactive armor, and as an MP round has fragmentation effects. If the BK-29 HEAT-MP is used, it may substitute for Frag-HE (as with NATO countries) or complement Frag-HE. With three round natures (APFSDS-T, HEAT-MP, ATGMs) in the autoloader vs four, more antitank rounds would be available for the higher rate of fire.

Chapter 5 Antitank

As armored combat vehicles have ascended in importance on the battlefield, so have the systems designed to stop those vehicles. The umbrella term *antitank* originally denoted systems specifically designed to destroy tanks. But today it is also more broadly constructed. Modern combat is combined arms combat. Mechanized forces include other armored combat vehicles, such as armored reconnaissance vehicles, infantry fighting vehicles, armored personnel carriers, etc. Tanks cannot survive or achieve their tactical objectives without support from other armored systems. The more recent term *antiarmor* may supplant the current term; because antitank weapons which cannot penetrate tank armor can still be a formidable threat if they can defeat or damage more lightly armored fighting vehicles. With upgrades and innovative tactics even older, seemingly obsolete, weapons can be used as OPFOR antiarmor weapons.

Antitank weapons can include guns of various sizes, antitank guided missile launcher systems, rocket and grenade launchers, mines and their delivery systems, and other obstacle systems. The rocket and grenade launchers are described in Chapter 1, Infantry Weapons. Mines and other obstacle systems are noted at Chapter 8, Engineer Systems. Because the OPFOR place a high priority on stopping and destroying armored combat vehicles, they will use all other available assets which can doctrinally support the effort. These include fixed and rotary-wing aircraft, artillery, NBC assets, etc. A number of recent systems have been fielded seemingly for other roles, but available for use as antitank weapons: light tanks, heavy armored reconnaissance vehicles with guns of 60 millimeters or more, assault vehicles, fire support vehicles, and artillery/mortar-type combination guns, such as Russian 120-mm 2S9, 2S23, and 2S31. Many OPFOR countries will employ antitank weapons for roles other than antitank, including AT guns against personnel and soft targets, and ATGMs against personnel and rotary-wing aircraft.

Antitank guns include towed guns and self-propelled antitank guns (also known as tank destroyers). A number of guns were designed as field guns, with multi-role capability as both artillery and antitank guns. The modern focus on maneuver warfare has brought a slight decline in development of uniquely antitank guns. Thus, the 85-mm D-44 gun, which can be used as artillery, is effective for use in an antitank role. Although recent systems have been developed, the number fielded has not kept pace with production of armored combat vehicles. Nevertheless, their effectiveness and selected armies' continued reliance on linear positional battles and protracted defenses have kept a large number of these systems in inventories. Based on numbers fielded and likelihood of their threat to US forces, only towed antitank guns were included.

A number of upgrades are available. These include night sights, such as passive image intensifier sights and thermal sights for the Russian 100-mm MT-12. This is a robust antitank weapon, with a high rate of fire and rapid mobility. Note the Russian innovation in the MT-12R, an AT gun with a radar-directed all-weather fire control system. Improved ammunition is critical for continued effectiveness of antitank weapons. The MT-12 and its variants can fire a variety of modern ammunition, including the Russian gun-launched ATGM, Kastet.

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The *antitank guided missile* (ATGM) is the singular greatest threat to tanks today. These systems are distinguished from other antitank weapons in that they are guided to the target. Most employ SACLOS guidance (see Glossary). An operator holds crosshairs on the target, and the missile tracker directs the missile to that point. There is a wide variety of countermeasures (such as smoke and counterfire, due to long flight time and operator vulnerability) for use against ATGMs. Thus, a 90% probability of hit is a technical figure, and does not mean a 90% probability of success. On the other hand, there is a variety of counter-countermeasures which the ATGMs, launchers, and operators can use to increase the chance for success. Tactics, techniques and procedures within the antitank arena are critical to mission success.

As armor protection levels and antitank weapon lethality levels continue to rise, armor protection for many modern tanks has outpaced most AT weapons. However, ATGMs have been able to increase their size, range, and warhead configurations to threaten even the heaviest tanks. Among notable trends in ATGMs is the worldwide proliferation and variety of manportable and portable *antitank guided missile launchers*. These include shoulder-launched, short-range systems, such as the French Eryx, and a variety of copies of former Soviet systems, such as the AT-3/Malyutka ("Suitcase SAGGER). Another notable trend is in development of upgrade ATGMs, with increased lethality. The most common type of lethality upgrade is addition of a nose precursor or tandem warhead. A more recent lethality upgrade has been the use of warheads that permit the "fly-over, shoot-down" mode. These missiles can over-fly a vehicle behind a hill, and fire an explosively-formed penetrator (EFP, in the shape of a cannon kinetic-energy penetrator round) downward through the relatively soft top of armored vehicles. Other improvements include improved guidance and resistance to countermeasures, reduced smoke and noise signature, and increased range. A fairly common trend has been addition of night sights, including thermal sights for the launcher. As the missiles and launchers have been improved, weight loads have increased. Most of the so-called portable launchers (AT-4 launcher, TOW, and HOT) have outgrown the portability weight limit, and must be carried in vehicles and only dismounted short distances from the carriers.

Although there are unique *ATGM launcher vehicles* with unique ATGMs, most numerous launcher vehicles are military and commercial vehicles adapted with pintel mounts for portable ground launchers, with ATGMs manually loaded and launched. Configurations of those vehicles consist of simply pairing of vehicle and launcher, and can be executed with equipment at hand; therefore, they were not described in this guide. The number of fielded ATGM launcher vehicles specially designed for the mission numbers no more than a few dozen systems. They constitute a high level threat to vehicles and rotary-winged aircraft in the US Army.

Systems selected for this chapter are the more common threat systems, or represent the spectrum of antitank systems which can threaten US Army forces in the world today.

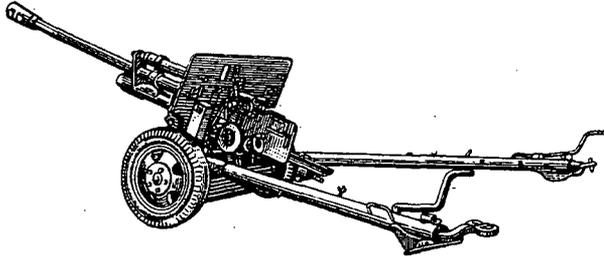
Questions and comments on data listed in this chapter should be addressed to:

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Russian 76-mm Towed Antitank Gun ZIS-3

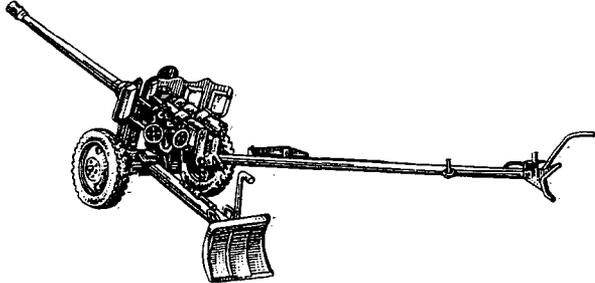
	<p>Weapons & Ammunition Types</p> <p>76-mm rifled gun HVAP-T HEAT APC-T Frag-HE</p>	<p>Typical Combat Load</p> <p>INA</p>
<p>SYSTEM Alternative Designations: M1942 Date of Introduction: INA Proliferation: At least 14 countries</p> <p>Description: Crew: 5-7 Combat Weight (mt): 1.12 Length Overall, Travel (m): 6.10 Height Overall, Travel (m): 1.3 Width Overall, Travel (m): 1.4</p> <p>Mobility: Mount: Two-wheeled carriage with twin trails Prime mover: AT-P tractor, light trucks Towed Speed (km/h): Max Road: INA Max Off-Road: INA Average Cross-Country: INA Fording Depth (m): N/A Emplace Time (min): INA Displace Time (min): INA Radio: N/A Protection: Gun shield</p> <p>ARMAMENT Main Armaments: Caliber, Type, Name: 76-mm rifled gun Rate of Fire (rd/min): 8-10 normal / 15-20 burst indirect fire Loader Type: Manual Ready/Stowed Rounds: N/A Elevation (°): -5/+37 Fire on Move: No</p> <p>FIRE CONTROL FCS Name: N/A Main Gun Stabilization: N/A Rangefinder: N/A Sights w/Magnification: Gunner: Day: INA Field of View (°): INA Acquisition Range (m): INA Night: INA Field of View (°): INA Acquisition Range (m): INA</p>	<p>VARIANTS N/A</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 76-mm HVAP-T, BR-354P Maximum Aimed Range (m): INA Max Effective Range (m): Day: 1,000 Night: INA Armor Penetration (mm): 58 at 1,000 meters 92 at 500 meters</p> <p>76-mm APC-T, BR-350B Maximum Aimed Range (m): INA Max Effective Range (m): INA Day: 1,000 Night: INA Armor Penetration (mm): 61 at 1,000 meters</p> <p>76-mm HEAT, BK-354M Maximum Aimed Range (m): 1,000 Max Effective Range (m): INA Day: 500 Night: INA Armor Penetration (mm): 120 (RHA)</p> <p>76-mm Frag-HE, OF-350A Maximum Aimed Range (m): INA Max Effective Range (m): Day: INA Night: INA Armor Penetration (mm): INA</p> <p>76-mm Frag-HE Maximum Aimed Range (m): INA Max Effective Range (m): Day: 1,500 Night: INA Armor Penetration (mm): INA</p> <p>Other Ammunition Types: API-T BZR-350B, Smoke (WP)</p>	

NOTES

Although the ZIS-3 is categorized as an antitank gun, some OPFOR forces will employ it for general support, especially against light targets. Typical combat load is based on the prime mover; and a wide variety of systems can be used as prime movers.

Russian 85-mm Towed Gun D-44

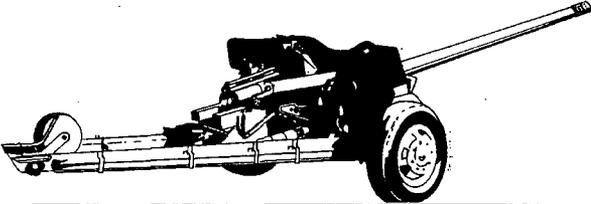
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	<p>Weapons & Ammunition Types</p> <p>85-mm rifled gun. HVAP-T HEAT-FS AP HE Frag-HE Smoke</p>	<p>Typical Combat Load</p> <p>21 (est) 3 3 3 9 3</p>
	<p>SYSTEM Alternative Designations: M1945 Date of Introduction: 1944 Proliferation: At least 16 countries Description: Crew: 8 Combat Weight (mt): 3.1 Length Overall, Travel (m): 8.34 Height Overall, Travel (m): 1.42 Width Overall, Travel (m): 1.73</p> <p>Mobility: Mount: Two-wheeled carriage with twin trails and coaster wheel Prime mover: AT-P tractor, light trucks Towed Speed (km/h): Max Road: 60 Max Off-Road: 35 Average Cross-Country: INA Forging Depth (m): INA Emplace Time (min): 2 Displace Time (min): 2 Radio: N/A Protection: Gun shield</p> <p>ARMAMENT Main Armaments: Caliber, Type, Name: 85-mm rifled gun Rate of Fire (rd/min): 8 normal / 15 burst Indirect Fire Loader Type: Manual Ready/Stowed Rounds: 0 / 140 on prime mover Elevation (°): -7/+35 Fire on Move: No</p> <p>FIRE CONTROL FCS Name: N/A Main Gun Stabilization: N/A Rangefinder: N/A Sights w/Magnification: Gunner: Day: OP-2-7 Direct Fire, 5.5x / PG-1M Indirect Fire Field of View (°): INA Acquisition Range (m): 1,500 Night: INA Field of View (°): INA Acquisition Range (m): INA</p> <p>VARIANTS D-44-N: Variant with II night sight.</p> <p>SD-44: Airborne version with auxiliary propulsion unit which permits self-propulsion for short distances at speeds of up to 25 km/h on the road, 5.5 km/h off road.</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 85-mm HVAP-T, BR-365P/365PK Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,150 Night: INA Armor Penetration (mm): 180 (RHA) at 1,000 meters 113 (RHA, 30°) at 500 meters</p> <p>85-mm HEAT-FS, BK-2M Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,500 Night: INA Armor Penetration (mm): 300</p> <p>85-mm AP HE Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 950 Night: INA Armor Penetration (mm): 91 (30° angle) at 500 meters</p> <p>85-mm Frag-HE, O-365K Maximum Aimed Range (m): 1,500 Max Effective Range (m): Day: 1,500 Night: INA Armor Penetration (mm): INA</p> <p>Other Ammunition Types: HE, BR-365 and -365K AP-T and APC-T (obsolete)</p>	

NOTES

The gun is variously referred to as artillery, as a field gun or as an antitank gun. It can be used for all roles or specifically for artillery or antitank. Typical combat load is based on the prime mover; and a wide variety of systems can be used as prime movers. PG-1M indirect fire sight characteristics are: 4x, 10° field of view. The PG-1 and -M can be used to a limited extent as direct fire sights.

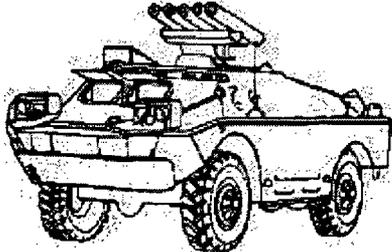
Russian 100-mm Towed Antitank Gun MT-12

	<p>Weapons & Ammunition Types</p> <p>100-mm smoothbore gun APFSDS-T HEAT Frag-HE AT-10 ATGM</p>	<p>Typical Combat Load</p> <p>20 8 4 4 4</p>
<p>SYSTEM Alternative Designations: T-12A, 2A29 Date of Introduction: 1972 Proliferation: At least 12 countries Description: Crew: 6 Combat Weight (mt): 3.1 Length Overall, Travel (m): 9.65 Height Overall, Travel (m): 1.6 Width Overall, Travel (m): 2.3</p> <p>Automotive Performance: Mount: Two-wheeled carriage with twin trails and coaster wheel Prime mover: MT-LB-T, URAL-375D and other trucks Towed Speed (km/h): Max Road: 60 Max Off-Road: INA Average Cross-Country: 25 Fording Depth (m): INA Emplace Time (min): 2-3 Displace Time (min): 2-3 Radio: N/A Protection: Gun shield</p> <p>ARMAMENT Main Armaments: Caliber, Type, Name: 100-mm smoothbore gun 2A29 Rate of Fire (rd/min): 6-8/up to 15 indirect fire Loader Type: Manual Ready/Stowed Rounds: 0/20 Elevation (°): -7/+20 Fire on Move: No</p> <p>ATGM Launcher: Launch Method: Gun-launched, 2A29 smoothbore gun Guidance: Laser-beam rider Command Link: Encoded laser-beam Launcher Dismountable: No</p> <p>FIRE CONTROL FCS Name: N/A Main Gun Stabilization: N/A Rangefinder: N/A Sights w/Magnification: Gunner: Day: OP40M-40U direct fire, 5.5x / PG-1M indirect fire Field of View (°): 11 Acquisition Range (m): 3,000/8,200 indirect fire Night: APN6-40 II sight, 6.8x</p>	<p>Field of View (°): 7 Acquisition Range (m): 2,000</p> <p>VARIANTS T-12: Original version of Russian gun. MT-12 has changes in carriage and obturator, which do not affect lethality performance. MT-12R: Russian upgrade with radar-directed fire control system, for use at night and adverse weather. Topaz: Former-Yugoslav variant of T-12, with the 2A19M gun mounted on a D-30 carriage. Some have AT FCS-1 (see NOTE).</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 100-mm APFSDS-T, BM-412M, Romanian Maximum Aimed Range (m): 2,500, 3,000 platoon volley Max Effective Range (m): Day: INA Night: INA Armor Penetration (mm): 418 at 2,000 m/380 at 3,000 m</p> <p>100-mm APFSDS-T, M1000, Belgian Maximum Aimed Range (m): 3,000/platoon volley INA Max Effective Range (m): Day: INA Night: INA Armor Penetration (mm): Triple heavy target at 4,000 meters</p> <p>100-mm HEAT, BK-17 Maximum Aimed Range (m): 2,500, 3,000 platoon volley Max Effective Range (m): Day: INA Night: INA Armor Penetration (mm): 380</p> <p>Other Ammunition Types: Russian BM-2/-20/-25 APFSDS-T; OF-15 Frag-HE; BK-5M HEAT-FS</p> <p>Antitank Guided Missiles: Name: AT-10/Kastet Warhead Type: Shaped charge (HEAT) Armor Penetration (mm): 650 (RHA) Range (m): 5,000</p> <p>Name: AT-10b/Kan Warhead Type: Tandem Shaped charge (HEAT) Armor Penetration (mm): 700 (RHA) behind ERA Range (m): 5,000</p>	

NOTES

Russian 2nd generation II sights are available. The daysight can be used at night if the target is illuminated. Thermal sights are available. The MT-12R radar FCS can be used for surveillance, acquisition, and tracking. The Serb Iskra AT FCS-1 computerized laser rangefinder FCS is on is offered for sale. Range is 500-3,000 meters. The ATGM sight and laser guidance device has a 5,000-meter range and is a day sight only. Ranges (m) for Frag-HE: 8,200 indirect fire/3,000 direct-fire. Rate of fire for indirect fire (Frag-HE) is up to 15 rd/min.

Russian ATGM Launcher Vehicle 9P148

		<p>Weapons & Ammunition Types</p> <p>Launcher AT-5/AT-5B ATGM</p> <p>Mixed (see NOTES) AT-4/AT-4B ATGM AT-5/AT-5B ATGM</p>	<p>Typical Combat Load</p> <p>15-20 15</p> <p>10 10</p>
<p>SYSTEM Alternative Designations: BRDM-2/AT-5 Date of Introduction: 1977 Proliferation: At least 6 countries Description: Crew: 2 Platform: BRDM-2M/GAZ-41-08 Combat Weight (mt): 7.0 Chassis Length Overall (m): 5.73 Height (m): Overall: 2.31 In Firing Position: INA Width Overall (m): 2.26 Drive Formula: 4 x 4 (+ 4 auxiliary wheels)</p> <p>Automotive Performance: Engine Type: 140-hp Gasoline Cruising Range (km): 750 Speed (km/h): Max Road: 100 Max Off-Road: INA Average Cross-Country: INA Max Swim: 10 Fording Depth (m): Amphibious Self-Entrenching Blade: N/A</p> <p>Radio: R-123</p> <p>Protection: Armor, Turret Front (mm): 10 Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Active Protective System: N/A NBC Protection System: Collective Smoke Equipment: N/A</p> <p>ARMAMENT Antitank Guided Missile Launcher Name: 9P135M3 (recent upgrade) Launch Method: tube-launched Number of missiles on launcher: 5 Elevation (°): INA Rate of Launch: (missiles/min): 2-3, depending on range Reaction Time (sec): INA Emplacement Time (min): INA Displacement Time (min): INA Can Launch Missiles Simultaneously : NA Ready/Stowed Missiles: 15 (launcher + autoloader)/ 0-5 by mix Loader Type: Automated Launcher dismountable: No Auxiliary Launcher: Yes Fire on the Move: No</p>	<p>FIRE CONTROL FCS Name: N/A Guidance: SACLOS Command Link: Wire Beacon Type: Incandescent bulb Tracker Type: IR, 9S451M1 Susceptible To Countermeasures: EO jammers, smoke, counterfire Counter-countermeasures: Electro-optical jamming alarm (See note) Rangefinder: N/A Infrared Searchlight: N/A Sights w/Magnification: Gunner: Day: 9Sh119M1 Field of View (°): INA Acquisition Range (m): INA Night: 1PN65 Field of View (°): INA Acquisition Range (m): 2,500</p> <p>VARIANTS 9P137: Original launcher vehicle with 5 AT-5 (only) launch rails</p> <p>AMMUNITION Antitank Guided Missiles: Name: AT-5/SPANDREL Alternative Designations: Konkurs Missile Weight (kg): 25.2 (in tube) Warhead Type: Shaped Charge (HEAT) Armor Penetration (mm): 650 Minimum/Maximum Range (m): 75/4,000 Probability of Hit (%): 90 Average Velocity (m/s): 200 Time of Flight to Max Range (sec): 20</p> <p>Name: AT-5B Alternative Designations: Konkurs-M Missile Weight (kg): 26.5 (in tube) Warhead Type: Tandem Shaped Charge (HEAT) Armor Penetration (mm): 925 Minimum/Maximum Range (m): 75/4,000 Probability of Hit (%): 90 Average Velocity (m/s): 208 Time of Flight to Max Range (sec): 19</p> <p>Name: AT-4/SPIGOT Alternative Designations: Fagot Missile Weight (kg): 13.0 (in tube) Warhead Type: Shaped Charge (HEAT) Armor Penetration (mm): 480 Minimum/Maximum Range (m): 70/2,000 Probability of Hit (%): 90 Average Velocity (m/s): 186 Time of Flight to Max Range (sec): 11</p>		

Russian ATGM Launcher Vehicle 9P148 continued

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<p>Name: AT-4B Alternative Designations: Factoria, Konkurs M Missile Weight (kg): 13.4 (in tube) Warhead Type: Shaped Charge (HEAT) Armor Penetration (mm): 550 Minimum/Maximum Range (m): 70/2,500 Probability of Hit (%): 90 Average Velocity (m/s): 180 Time of Flight to Max Range (sec): 13.2-14.0</p>	<p>Other Missile Types: N/A</p>
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NOTES

A variety of ATGM mixes have been seen with 9P148, between AT-4 and AT-5-type ATGMS. The primary benefit of adaptability is increased launcher load and adaptability to user countries' inventories of ATGMS. Most common ATGM is AT-5. As AT-5B is produced, it is likely to replace AT-5 in better-budgeted country inventories.

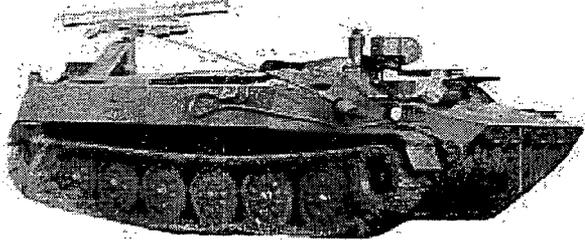
Reload time for the launcher is 25 seconds.

Russian firms have developed countermeasures, such as encoded-pulse beacons for ATGMS and counter-dazzler adjustments to the 9S451M1 guidance box. Filters can be mounted in front of reticles.

The 1PN66 thermal sight is available for the ATGM launcher. Acquisition range is approximately 2,500 meters.

Russian KBP offers a drop-in one-man turret, called Kliver, with a stabilized 2A72 30-mm gun, a 4 Kornet ATGM launcher, thermal sights, and improved fire control system.

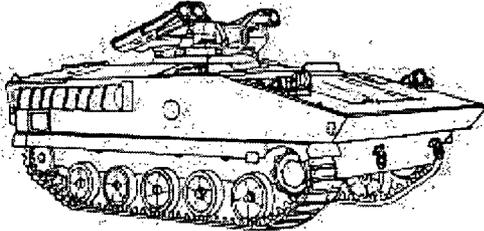
Russian ATGM Launcher Vehicle 9P149

	<p>Weapons & Ammunition Types</p> <p>Launcher</p> <p>AT-6 HEAT ATGM AT-9 HEAT ATGM AT-6 HE ATGM AT-9 HE ATGM</p>	<p>Typical Combat Load</p> <p>12</p>
<p>SYSTEM Alternative Designations: Shturm-S Date of Introduction: 1990 Proliferation: At least 9 countries Description: Crew: 2 Platform: MT-LB Combat Weight (mt): 12.3 Chassis Length Overall (m): 6.35 Height (m): Overall: 1.8 In Firing Position: INA Width Overall (m): 2.85</p> <p>Automotive Performance: Engine Type: 290-hp Diesel Cruising Range (km): 500 km Speed (km/h): Max Road: 65 Max Off-Road: INA Average Cross-Country: INA Max Swim: 3-4 Fording Depths (m): Amphibious Self-Entrenching Blade: Yes</p> <p>Radio: R-123M or R-173</p> <p>Protection: Armor, Turret Front (mm): 7-14 Applique Armor (mm): N/A Explosive Reactive Armor (mm): N/A Active Protective System: N/A NBC Protection System: Collective Smoke Equipment: N/A</p> <p>ARMAMENT Antitank Guided Missile Launcher Name: INA Launch Method: tube-launched Number of missiles on launcher: 1 Elevation (°): -5/+15 Rate of Launch (missiles/min): 2-3, depending on range Reaction Time (sec): INA Emplacement Time (min): INA Displacement Time (min): INA Can Launch Missiles Simultaneously: N/A Ready/Stowed Missiles: 12/ 0 Loader Type: Automated</p>	<p>Launcher dismountable: No Auxiliary Launcher: No Fire on the Move: No</p> <p>FIRE CONTROL FCS Name: INA Guidance: SACLOS Command Link: Radio frequency Beacon Type: INA Tracker Type: IR Susceptible To Countermeasures: Smoke, counterfire Counter-countermeasures: 5 encoded frequencies Rangefinder: INA Infrared Searchlight: INA Sights w/Magnification: Gunner: Day: INA Field of View (°): INA Acquisition Range (m): 5,000 Night: Yes Field of View (°): INA Acquisition Range (m): INA</p> <p>VARIANTS N/A</p> <p>AMMUNITION Antitank Guided Missiles Name: AT-6a/SPIRAL Alternative Designations: Kokon Missile Weight (kg): 46.5 (in tube) Warhead Type: Shaped Charge (HEAT) Armor Penetration (mm): 750, 600 behind ERA Minimum/ Maximum Range (m): 400/5,000 Probability of Hit (%): 90 Average Velocity (m/s): 345 Time of Flight to Max Range (sec): 14.5</p> <p>Name: AT-9 Alternative Designations: Ataka Missile Weight (kg): 48.3 (in tube) Warhead Type: Tandem Shaped Charge (HEAT) Armor Penetration (mm): 950, 800 behind ERA Minimum/Maximum Range (m): 400/6,000, 5,000 ground use Probability of Hit (%): 90 Average Velocity (m/s): 400 Time of Flight to Max Range (sec): 15.0 (12.5 in ground use)</p> <p>Other Missile Types: AT-6 HE thermobaric, AT-9 HE thermobaric</p>	

NOTES

Other missiles (AT-6b and AT-6c) can be launched from helicopters; but their length exceeds the 1832-mm limit for the Shturm-S autoloader. A modular AT-6 ATGM launcher system with launcher and autoloader is available for installation on vehicles, fixed sites and boats.

French ATGM Launcher Vehicle AMX-10 HOT

		<p>Weapons & Ammunition Types</p> <p style="text-align: center;">Total</p> <p>HOT/ HOT 2, 2T/ HOT 3</p>	<p>Typical Combat load</p> <p style="text-align: center;">18</p>	
	<table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <p>SYSTEM</p> <p>Alternative Designations: INA</p> <p>Date of Introduction: INA</p> <p>Proliferation: At least 1 country</p> <p>Description:</p> <p>Crew: 4-5</p> <p>Platform: AMX-10P</p> <p>Combat Weight (mt): 14.1</p> <p>Chassis Length Overall (m): 5.78</p> <p>Height (m):</p> <p style="padding-left: 20px;">Overall: 2.57</p> <p style="padding-left: 20px;">In Firing Position: INA</p> <p>Width Overall (m): 2.78</p> <p>Automotive Performance:</p> <p>Engine Type: 300-hp Diesel</p> <p>Cruising Range (km): 600 km</p> <p>Speed (km/h):</p> <p style="padding-left: 20px;">Max Road: 65</p> <p style="padding-left: 20px;">Max Off-Road: INA</p> <p style="padding-left: 20px;">Average Cross-Country: 30-40</p> <p style="padding-left: 20px;">Max Swim: 7 (with optional water jets)</p> <p>Fording Depths (m): Amphibious</p> <p>Self-Entrenching Blade: N/A</p> <p>Radio: VHF and intercom</p> <p>Protection:</p> <p>Armor, Turret Front (mm): 12.7-mm frontal (distance NFI)</p> <p>Applique Armor (mm): N/A</p> <p>Explosive Reactive Armor (mm): Available (see NOTES)</p> <p>Active Protective System: N/A</p> <p>NBC Protection System: Collective</p> <p>Smoke Equipment: 3 smoke grenade launchers</p> <p>ARMAMENT</p> <p>Antitank Guided Missile Launcher</p> <p>Name: Lancelot 3</p> <p>Launch Method: tube-launched</p> <p>Number of missiles on launcher: 4</p> <p>Elevation (°): -12/+18</p> <p>Rate of Launch: (missiles/min): INA</p> <p>Reaction Time (sec): INA</p> <p>Emplacement Time (min): INA</p> <p>Displacement Time (min): INA</p> <p>Can Launch Missiles Simultaneously: INA</p> <p>Ready/Stowed Missiles: 4/14</p> <p>Loader Type: Manual</p> <p>Launcher dismountable: No</p> <p>Auxiliary Launcher: No</p> <p>Fire on the Move: No</p> </td> <td style="width: 50%; vertical-align: top;"> <p>FIRE CONTROL</p> <p>FCS Name: INA</p> <p>Guidance: SACLOS</p> <p>Command Link: Wire</p> <p>Beacon Type: INA</p> <p>Tracker Type: INA</p> <p>Susceptible To Countermeasures: Smoke, counterfire</p> <p>Counter-countermeasures: Infrared CM hardening on later ATGMs</p> <p>Rangefinder: M427 Laser rangefinder</p> <p>Infrared Searchlight: INA</p> <p>Sights w/Magnification:</p> <p>Gunner:</p> <p style="padding-left: 20px;">Day: M509, 3x/12x</p> <p style="padding-left: 40px;">Field of View (°): INA</p> <p style="padding-left: 40px;">Acquisition Range (m): INA</p> <p style="padding-left: 20px;">Night: Castor Thermal Image System available</p> <p style="padding-left: 40px;">Field of View (°): INA</p> <p style="padding-left: 40px;">Acquisition Range (m): INA</p> <p>VARIANTS N/A</p> <p>Antitank Guided Missiles</p> <p>Name: HOT</p> <p style="padding-left: 20px;">Alternative Designations: Euromissile</p> <p style="padding-left: 20px;">Missile Weight (kg): 32 (in tube)</p> <p style="padding-left: 20px;">Warhead Type: Shaped Charge (HEAT)</p> <p style="padding-left: 20px;">Armor Penetration (mm): 800</p> <p style="padding-left: 20px;">Minimum/ Maximum Range (m): 75/4,000</p> <p style="padding-left: 20px;">Probability of Hit (%): INA</p> <p style="padding-left: 20px;">Average Velocity (m/s): 233</p> <p style="padding-left: 20px;">Time of Flight to Max Range (sec): 17.3</p> <p>Name: HOT 2</p> <p style="padding-left: 20px;">Alternative Designations: INA</p> <p style="padding-left: 20px;">Missile Weight (kg): 32 (in tube)</p> <p style="padding-left: 20px;">Warhead Type: Tandem Shaped Charge (HEAT)</p> <p style="padding-left: 20px;">Armor Penetration (mm): 900</p> <p style="padding-left: 20px;">Minimum/Maximum Range (m): 75/4,000</p> <p style="padding-left: 20px;">Probability of Hit (%): INA</p> <p style="padding-left: 20px;">Average Velocity (m/s): 233</p> <p style="padding-left: 20px;">Time of Flight to Max Range (sec): 17.3</p> <p>Name: HOT 2T</p> <p style="padding-left: 20px;">Alternative Designations: INA</p> <p style="padding-left: 20px;">Missile Weight (kg): 32 (in tube)</p> <p style="padding-left: 20px;">Warhead Type: Tandem shaped Charge (HEAT)</p> <p style="padding-left: 20px;">Armor Penetration (mm): 1250</p> <p style="padding-left: 20px;">Minimum/Maximum Range (m): 75/4,000</p> <p style="padding-left: 20px;">Probability of Hit (%): INA</p> <p style="padding-left: 20px;">Average Velocity (m/s): INA</p> <p style="padding-left: 20px;">Time of Flight to Max Range (sec): INA</p> <p>Other Missile Types: HOT 3--similar to HOT 2T, but with improved countermeasures</p> </td> </tr> </table>			<p>SYSTEM</p> <p>Alternative Designations: INA</p> <p>Date of Introduction: INA</p> <p>Proliferation: At least 1 country</p> <p>Description:</p> <p>Crew: 4-5</p> <p>Platform: AMX-10P</p> <p>Combat Weight (mt): 14.1</p> <p>Chassis Length Overall (m): 5.78</p> <p>Height (m):</p> <p style="padding-left: 20px;">Overall: 2.57</p> <p style="padding-left: 20px;">In Firing Position: INA</p> <p>Width Overall (m): 2.78</p> <p>Automotive Performance:</p> <p>Engine Type: 300-hp Diesel</p> <p>Cruising Range (km): 600 km</p> <p>Speed (km/h):</p> <p style="padding-left: 20px;">Max Road: 65</p> <p style="padding-left: 20px;">Max Off-Road: INA</p> <p style="padding-left: 20px;">Average Cross-Country: 30-40</p> <p style="padding-left: 20px;">Max Swim: 7 (with optional water jets)</p> <p>Fording Depths (m): Amphibious</p> <p>Self-Entrenching Blade: N/A</p> <p>Radio: VHF and intercom</p> <p>Protection:</p> <p>Armor, Turret Front (mm): 12.7-mm frontal (distance NFI)</p> <p>Applique Armor (mm): N/A</p> <p>Explosive Reactive Armor (mm): Available (see NOTES)</p> <p>Active Protective System: N/A</p> <p>NBC Protection System: Collective</p> <p>Smoke Equipment: 3 smoke grenade launchers</p> <p>ARMAMENT</p> <p>Antitank Guided Missile Launcher</p> <p>Name: Lancelot 3</p> <p>Launch Method: tube-launched</p> <p>Number of missiles on launcher: 4</p> <p>Elevation (°): -12/+18</p> <p>Rate of Launch: (missiles/min): INA</p> <p>Reaction Time (sec): INA</p> <p>Emplacement Time (min): INA</p> <p>Displacement Time (min): INA</p> <p>Can Launch Missiles Simultaneously: INA</p> <p>Ready/Stowed Missiles: 4/14</p> <p>Loader Type: Manual</p> <p>Launcher dismountable: No</p> <p>Auxiliary Launcher: No</p> <p>Fire on the Move: No</p>
<p>SYSTEM</p> <p>Alternative Designations: INA</p> <p>Date of Introduction: INA</p> <p>Proliferation: At least 1 country</p> <p>Description:</p> <p>Crew: 4-5</p> <p>Platform: AMX-10P</p> <p>Combat Weight (mt): 14.1</p> <p>Chassis Length Overall (m): 5.78</p> <p>Height (m):</p> <p style="padding-left: 20px;">Overall: 2.57</p> <p style="padding-left: 20px;">In Firing Position: INA</p> <p>Width Overall (m): 2.78</p> <p>Automotive Performance:</p> <p>Engine Type: 300-hp Diesel</p> <p>Cruising Range (km): 600 km</p> <p>Speed (km/h):</p> <p style="padding-left: 20px;">Max Road: 65</p> <p style="padding-left: 20px;">Max Off-Road: INA</p> <p style="padding-left: 20px;">Average Cross-Country: 30-40</p> <p style="padding-left: 20px;">Max Swim: 7 (with optional water jets)</p> <p>Fording Depths (m): Amphibious</p> <p>Self-Entrenching Blade: N/A</p> <p>Radio: VHF and intercom</p> <p>Protection:</p> <p>Armor, Turret Front (mm): 12.7-mm frontal (distance NFI)</p> <p>Applique Armor (mm): N/A</p> <p>Explosive Reactive Armor (mm): Available (see NOTES)</p> <p>Active Protective System: N/A</p> <p>NBC Protection System: Collective</p> <p>Smoke Equipment: 3 smoke grenade launchers</p> <p>ARMAMENT</p> <p>Antitank Guided Missile Launcher</p> <p>Name: Lancelot 3</p> <p>Launch Method: tube-launched</p> <p>Number of missiles on launcher: 4</p> <p>Elevation (°): -12/+18</p> <p>Rate of Launch: (missiles/min): INA</p> <p>Reaction Time (sec): INA</p> <p>Emplacement Time (min): INA</p> <p>Displacement Time (min): INA</p> <p>Can Launch Missiles Simultaneously: INA</p> <p>Ready/Stowed Missiles: 4/14</p> <p>Loader Type: Manual</p> <p>Launcher dismountable: No</p> <p>Auxiliary Launcher: No</p> <p>Fire on the Move: No</p>	<p>FIRE CONTROL</p> <p>FCS Name: INA</p> <p>Guidance: SACLOS</p> <p>Command Link: Wire</p> <p>Beacon Type: INA</p> <p>Tracker Type: INA</p> <p>Susceptible To Countermeasures: Smoke, counterfire</p> <p>Counter-countermeasures: Infrared CM hardening on later ATGMs</p> <p>Rangefinder: M427 Laser rangefinder</p> <p>Infrared Searchlight: INA</p> <p>Sights w/Magnification:</p> <p>Gunner:</p> <p style="padding-left: 20px;">Day: M509, 3x/12x</p> <p style="padding-left: 40px;">Field of View (°): INA</p> <p style="padding-left: 40px;">Acquisition Range (m): INA</p> <p style="padding-left: 20px;">Night: Castor Thermal Image System available</p> <p style="padding-left: 40px;">Field of View (°): INA</p> <p style="padding-left: 40px;">Acquisition Range (m): INA</p> <p>VARIANTS N/A</p> <p>Antitank Guided Missiles</p> <p>Name: HOT</p> <p style="padding-left: 20px;">Alternative Designations: Euromissile</p> <p style="padding-left: 20px;">Missile Weight (kg): 32 (in tube)</p> <p style="padding-left: 20px;">Warhead Type: Shaped Charge (HEAT)</p> <p style="padding-left: 20px;">Armor Penetration (mm): 800</p> <p style="padding-left: 20px;">Minimum/ Maximum Range (m): 75/4,000</p> <p style="padding-left: 20px;">Probability of Hit (%): INA</p> <p style="padding-left: 20px;">Average Velocity (m/s): 233</p> <p style="padding-left: 20px;">Time of Flight to Max Range (sec): 17.3</p> <p>Name: HOT 2</p> <p style="padding-left: 20px;">Alternative Designations: INA</p> <p style="padding-left: 20px;">Missile Weight (kg): 32 (in tube)</p> <p style="padding-left: 20px;">Warhead Type: Tandem Shaped Charge (HEAT)</p> <p style="padding-left: 20px;">Armor Penetration (mm): 900</p> <p style="padding-left: 20px;">Minimum/Maximum Range (m): 75/4,000</p> <p style="padding-left: 20px;">Probability of Hit (%): INA</p> <p style="padding-left: 20px;">Average Velocity (m/s): 233</p> <p style="padding-left: 20px;">Time of Flight to Max Range (sec): 17.3</p> <p>Name: HOT 2T</p> <p style="padding-left: 20px;">Alternative Designations: INA</p> <p style="padding-left: 20px;">Missile Weight (kg): 32 (in tube)</p> <p style="padding-left: 20px;">Warhead Type: Tandem shaped Charge (HEAT)</p> <p style="padding-left: 20px;">Armor Penetration (mm): 1250</p> <p style="padding-left: 20px;">Minimum/Maximum Range (m): 75/4,000</p> <p style="padding-left: 20px;">Probability of Hit (%): INA</p> <p style="padding-left: 20px;">Average Velocity (m/s): INA</p> <p style="padding-left: 20px;">Time of Flight to Max Range (sec): INA</p> <p>Other Missile Types: HOT 3--similar to HOT 2T, but with improved countermeasures</p>			

French ATGM Launcher Vehicle AMX-10 HOT continued

Worldwide Equipment Guide

NOTES

The HOT Antitank guided missile is produced by a European consortium which includes France and Germany. It can be launched from a ground launcher, the same launcher mounted on a variety of vehicles, from infantry fighting vehicles and ATGM launcher vehicles, and from helicopters. The AMX-10 HOT constitutes a high-end application on that spectrum, and has not been widely proliferated.

The cruciform-based single-tube ground launcher system exceeds the weight limit for the portable class of ATGM launchers. An updated launcher for HOT-2T offers a Thermal Modular System night sight and a dual band tracker. Alternate mounts for the launcher include the ATLAS/Commando lightweight launcher (140 kg) mounted on the Spanish Santana (4 x 4 Land Rover light truck):

The Lancelot turret used on AMX-10 HOT can be mounted on other armored fighting vehicles.

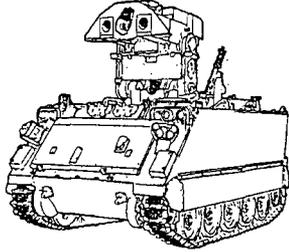
The French-produced VAB HOT uses a Mephisto retractable twin-tube launcher, and has an onboard load of 10 HOT ATGMs.

The UTM800 turret holds four HOT missiles, with a stabilized sight and Castor thermal night sight. The UTM800 is used on two applications. The French VCR/TH employs the turret on a Panhard VCR/TT 6 x 6 APC chassis. The other is the UTM turret on a VAB APC chassis.

The German Jaguar 1 Jagdpanzer is a modified Leopard 1 tank chassis with a single-tube HOT launcher.

French SNPE explosive reactive armor can be employed on AMX-10 type vehicles.

US ATGM Launcher Vehicle M901

	<p>Weapons & Ammunition Types</p> <p>ATGM Launcher TOW, ITOW, TOW 2, TOW 2A, TOW 2B</p> <p>7.62-mm Cupola MG</p>	<p>Typical Combat Load</p> <p>12</p> <p>2,000</p>
	<p>SYSTEM Alternative Designations: ITV (Improved TOW Vehicle), ITOW Date of Introduction: 1978 Proliferation: At least 8 countries Description: Crew: 4-5 Platform: M113A1 Combat Weight (mt): 11.79 Chassis Length Overall (m): 4.90 Height (m): Overall: 2.91 In Firing Position: 3.35 Width Overall (m): 2.70</p> <p>Automotive Performance: Engine Type: 212-hp Diesel Cruising Range (km): 483 Speed (km/h): Max Road: 64 Max Off-Road: INA Average Cross-Country: INA Max Swim: 5.8 Fording Depths (m): Amphibious Self-Entrenching Blade: N/A</p> <p>Radio: Various, including intercom</p> <p>Protection: Armor, Turret Front (mm): INA Applique Armor (mm): Available. Anti-mine armor on bottom. Explosive Reactive Armor (mm): Available Active Protective System: No NBC Protection System: No Smoke Equipment: 4 smoke grenade launchers on each front corner</p> <p>ARMAMENT Antitank Guided Missile Launcher Name: M27 cupola with launcher head ("Hammerhead") Launch Method: Tube-launched Number of missiles on launcher: 2 Elevation (°): -30/+34 Rate of Launch: (missiles/min): 2 Reaction Time (sec): 4.25 Emplacement Time (min): 0.33 Displacement Time (min): INA Can Launch Missiles Simultaneously: No Ready/Stowed Missiles: 2/10 Loader Type: Manual Launcher dismountable: No Auxiliary Launcher: No Fire on the Move: No</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm (7.62x51) MG Mount Type: Cupola Direct Fire Range (m): INA Max Effective Range (m): Day: INA Night: INA Fire on Move: Yes Rate of Fire: INA</p> <p>Firing Ports: INA</p> <p>FIRE CONTROL FCS Name: INA Guidance: SACLOS Command Link: Wire Beacon Type: Xenon (Infrared), thermal on TOW-2 and after Tracker Type: INA Susceptible To Countermeasures: Smoke, counterfire Counter-countermeasures: Rangefinder: INA Infrared Searchlight: INA Sights w/Magnification: Gunner: Day: Day sight/tracker, 13x Field of View (°): 5.5 x Acquisition Range (m): INA Night: AN/TAS-4 thermal sight Field of View (°): INA Acquisition Range (m): INA</p> <p>VARIANTS ITOW: Launcher variants have been upgraded with new turrets and launcher heads to fit the later TOW variants, such as ITOW, TOW 2, 2A and 2B. M901A2: Launcher vehicle fitted for TOW 2.</p> <p>A variety of M113-based vehicles have incorporated TOW "hammerhead" launcher for use as ATGM launcher vehicles. These include the Italian VCC-1-based launcher vehicle, and the Dutch Armored Infantry Fighting Vehicle (AIFV) -based launcher vehicle.</p> <p>AMMUNITION Antitank Guided Missiles Name: TOW Alternative Designations: BGM-71 Missile Weight (kg): 25.5 (in tube) Warhead Type: Shaped Charge (HEAT) Armor Penetration (mm): 600 Minimum/ Maximum Range (m): 65/3,750 Probability of Hit (%): INA Average Velocity (m/s): 179 Time of Flight to Max Range (sec): 21</p>	

US ATGM Launcher Vehicle M901 continued

Worldwide Equipment Guide

<p>Name: ITOW Alternative Designations: BGM-71C Missile Weight (kg): 25.7 (in tube) Warhead Type: Tandem Shaped Charge (HEAT, short probe) Armor Penetration (mm): 800 Minimum/ Maximum Range (m): 65/3,750 Probability of Hit (%): INA Average Velocity (m/s): 179 Time of Flight to Max Range (sec): 21</p> <p>Name: TOW 2 Alternative Designations: BGM-71D Missile Weight (kg): 28.1 (in tube) / 21.5 (missile only) Warhead Type: Tandem Shaped Charge (Larger HEAT, long probe) Armor Penetration (mm): INA Minimum/ Maximum Range (m): 65/3,750 Probability of Hit (%): 90 Average Velocity (m/s): 179 Time of Flight to Max Range (sec): 21</p>	<p>Name: TOW 2A Alternative Designations: BGM-71E Missile Weight (kg): 22.65 (missile only) Warhead Type: Tandem Shaped Charge (Larger HEAT, long probe) Armor Penetration (mm): INA Minimum/ Maximum Range (m): 65/3,750 Probability of Hit (%): INA Average Velocity (m/s): 188 Time of Flight to Max Range (sec): 20</p> <p>Name: TOW 2B Alternative Designations: BGM-71F Missile Weight (kg): 22.60 (missile only) Warhead Type: Dual explosive-formed penetrators (EFP), top-attack Armor Penetration (mm): INA Minimum/ Maximum Range (m): 200/3,750 Probability of Hit (%): INA Average Velocity (m/s): 179 Time of Flight to Max Range (sec): 21</p> <p>Other Missile Types: See NOTES, below</p>
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NOTES

The loader has side and overhead protection during loading, which requires 40 seconds.

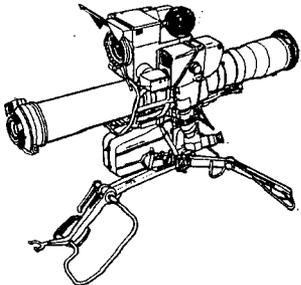
The Improved Target Acquisition System (ITAS) was developed for TOW 2 and later. It includes a laser rangefinder, increased acquisition range, improved night capabilities (second-generation thermal channel), an automatic boresight and greater hit probability.

The UK-developed Further-Improved TOW (FITOW) program is expected to be similar to TOW 2B, but with two smaller warheads.

The Israeli MAPATS is a TOW missile variant with laser-beam rider guidance and a laser guidance system.

The Israeli TAAS tandem warhead is the same diameter as the warhead on the original TOW missile, and appears to be a candidate for retrofit. The warhead is claimed to be able to penetrate 1,020 mm of armor.

Worldwide Equipment Guide

 <p style="text-align: center;">9P135M3 w/AT-5B and thermal sight</p>	<p>Weapons & Ammunition Types</p> <p>ATGM Launcher Total AT-4/AT-4B ATGM</p> <p>AT-5/AT-5B ATGM</p>	<p>Typical Combat Load</p> <p style="text-align: center;">4 or 8 (see NOTES)</p>
<p>SYSTEM Alternative Designations: 9P135M Firing Post, Fagot/Fagot-M Date of Introduction: 1973 Proliferation: At least 25 countries Description: Crew: 3 Primary Mount: Ground mount on folding tripod Alternate Mounts: Pintel (post) on BMP-1P, BTR-D, UAZ-469, etc. Weight Overall, Excluding Missile (kg): 22.5 Length Overall in Firing Position (m): 1.1/1.3 AT-4/5 tube Height Overall In Firing Position (m): INA Width Overall In Firing Position (m): INA</p> <p>ARMAMENT Launcher: Name: 9P135 (AT-4 only), 9P135M (AT-4/AT-5), -M1, -M2, -M3 Launch Method: Tube-launched Elevation (°) (-/+): INA Rate of Launch: (missiles/min): 2-3, depending on range Reaction Time (sec): INA Emplacement Time (min): INA Displacement Time (min): INA Ready/Stowed Missiles: 4/0 full dismount, 4/4 on or near vehicle</p> <p>FIRE CONTROL FCS Name: 9S451M1 Guidance control box Guidance: SACLOS Command Link: Wire Beacon Type: Incandescent infrared bulb Tracker Type: IR, 9S451M1 Susceptible To Countermeasures: EO jammers, smoke, counterfire Counter-countermeasures: EO jamming alarm (see NOTES) Rangefinder: INA Sights w/Magnification: Gunner: Day: 9Sh119M1, 4x Field of View (°): 4.5 Acquisition Range (m): INA Night: Available (See NOTES)</p>	<p>VARIANTS P135M3: Konkurs-M Complex. Launcher with 1PN65 thermal sight and AT-5B/Konkurs-M missiles. Night range is 2,500m.</p> <p>AMMUNITION Antitank Guided Missiles Name: AT-5B/SPANDREL-B Alternative Designations: Konkurs-M Missile Weight (kg): 26.5 (in tube) Warhead Type: Tandem Shaped Charge (HEAT) Armor Penetration (mm): 925 Minimum/Maximum Range (m): 75/4,000 Probability of Hit (%): 90 Average Velocity (m/s): 208 Time of Flight to Max Range (sec): 19</p> <p>Name: AT-5/SPANDREL Alternative Designations: Konkurs Missile Weight (kg): 25.2 (in tube) Warhead Type: Shaped Charge (HEAT) Armor Penetration (mm): 650 Minimum/Maximum Range (m): 75/4,000 Probability of Hit (%): 90 Average Velocity (m/s): 200 Time of Flight to Max Range (sec): 20</p> <p>Name: AT-4/SPIGOT Alternative Designations: Fagot Missile Weight (kg): 13.0 (in tube) Warhead Type: Shaped Charge (HEAT) Armor Penetration (mm): 480 Minimum/Maximum Range (m): 70/2,000 Probability of Hit (%): 90 Average Velocity (m/s): 186 Time of Flight to Max Range (sec): 11</p> <p>Other Missiles: AT-4B/Factoria (see NOTES)</p>	

NOTES

Because of its weight, the Russians categorize the AT-4/4B system as portable (21-40 kg) rather than manportable. For dismounted carry load is divided among three packs. Due to the greater weight, AT-5/-5B fits into the "heavy" class (40+ kg), and should only be carried short distances from vehicles (<500 meters). For crews using both ATGM classes and operating near vehicles, combat load is 8 (4 stowed in the vehicle).

The AT-4B/Factoria is an upgrade ATGM with a 2,500 meter range, 550-mm penetration, and a velocity of 180 m/s (13.2 - 14.0 sec TOF). Russian firms have developed counter-countermeasures, such as encoded-pulse beacons for ATGMs and counter-dazzler adjustments to the 9S451M1 guidance box. Filters can be mounted in front of reticles.

TPVP/1PN65 thermal sight is available, with the range approximately 2,500 meters (see VARIANTS, above). Weight is 13 kg. Slovenian TS-F sight and Russian 1PN86-1/1PN86/Mulat have a 3,600 meter detection range.

French ATGM Launcher Eryx

	<p>Weapons & Ammunition Types</p> <p>ATGM Launcher Eryx ATGM</p>	<p>Typical Combat Load</p> <p>1</p>
<p>SYSTEM Alternative Designations: Anti-Char Courtee Portee (ACCP) Date of Introduction: 1991 Proliferation: At least 5 countries Description: Crew: 1 Primary mount: Ground mount on tripod or shoulder launch Alternate mounts: Shoulder launch--standing, kneeling or prone Weight Overall, Excluding Missile (kg): 3, 4 with tripod Length Overall in Firing Position (m): 0.905 Height Overall In Firing Position (m): INA Width Overall In Firing Position (m): INA tripod, 0.16 on shoulder</p> <p>ARMAMENT Launcher Name: Eryx Launch Method: Tube (disposable canister/ launch tube) Elevation (°): INA, tripod; unlimited on shoulder launch. Rate of Launch: (missiles/min): INA Reaction Time (sec): 20-30 (includes emplace time) Emplacement Time (min): See Reaction Time (above) Displacement Time (min): < 0.03 Ready/Stowed Missiles: 1/ 0</p> <p>FIRE CONTROL FCS Name: INA Guidance: SACLOS Command Link: Wire Beacon Type: Infrared laser diode Tracker Type: Charged couple device (CCD) Susceptible To Countermeasures: EO jammers, smoke, counterfire Counter-countermeasures: Flight time less than 4 seconds</p>	<p>Rangefinder: INA Sights w/Magnification: Gunner: Day: INA, 3x Field of View (°): 3.4 Acquisition Range (m): INA Night: Sopelem OB50 II sight Field of View (°): INA Acquisition Range (m): INA</p> <p>VARIANTS N/A</p> <p>AMMUNITION Antitank Guided Missile Name: Eryx Alternative Designations: ACCP Missile Weight (kg): 11 (in tube) Warhead Type: Tandem Shaped Charge (HEAT) Armor Penetration (mm): 900 Minimum/Maximum Range (m): 50/600 Probability of Hit (%): 90 Average Velocity (m/s): 162 Time of Flight to Max Range (sec): 3.7</p> <p>Other missiles: N/A</p>	

NOTES

The disposable canister/launch tube is attached to the reusable firing post (which includes sight systems).

Eryx employs a recoil reduction system with reduced back-blast, which permits launch from inside of buildings. Signature reduction includes noise and smoke reduction.

A rest such as a ledge or sandbag is required for launches beyond 350 meters.

The optional French Mirabel thermal night sight is available for use on Eryx. The Mirabel offers an acquisition range of 1,000 meters, but weighs an additional 3.4 kg.

Chapter 6 Artillery

This chapter provides the basic characteristics of selected artillery weapon systems either in use or readily available to the OPFOR. Therefore, the artillery systems discussed in this chapter are those likely to be encountered by U.S. forces in varying levels of conflict. The selection of artillery systems is not intended to be all-inclusive, rather a representative sampling of weapons and equipment supporting various military capabilities.

This chapter is divided into the following categories—artillery reconnaissance, towed artillery systems, self-propelled artillery systems, and multiple rocket launchers. Later updates of this guide will include data sheets addressing the aforementioned categories as well as mortars, artillery locating radars, sound and flash systems, and surface to surface missiles (SSMs).

OPFOR artillery units begin a battle with a full complement of ammunition to include special types of ammunition. The number and type of rounds vary according to the tactical situation and mission. Therefore, we have used frag-HE, smoke, and illumination as the default rounds to represent a typical combat load. Generally, the Typical Combat Load section represents the number and type of rounds carried on the self-propelled artillery system or rocket launcher. The numbers of rounds for the towed artillery systems vary according to the cargo capacity of the prime mover.

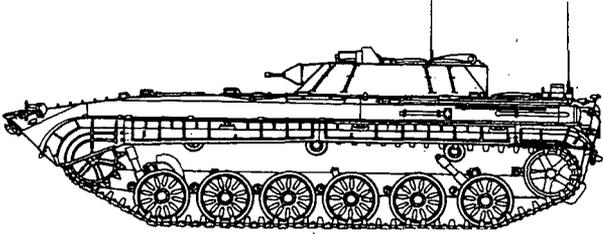
Questions and comments on data listed in this chapter should be addressed to:

Mr. Walter L. Williams

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e-mail address: williamw@leav-emh1.army.mil

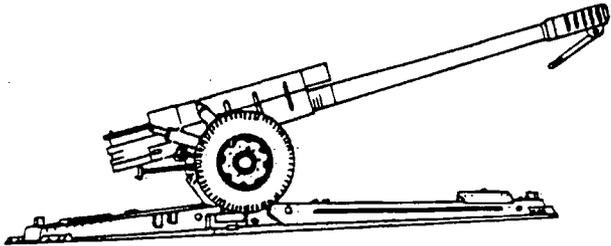
Russian Artillery Mobile Reconnaissance Vehicle PRP-3/PRP-4M

	<p>Weapons & Ammunition Types</p> <p>7.62 PKT MG</p>	<p>Typical Combat Load</p> <p>2,000</p>	
	<table border="0"> <tr> <td style="vertical-align: top;"> <p>SYSTEM</p> <p>Alternative Designations: None</p> <p>Date of Introduction: 1975</p> <p>Proliferation: At least 1 country</p> <p>Description:</p> <p>Crew: 5</p> <p>Platform (chassis): BMP-1</p> <p>Combat Weight (mt): 13.2</p> <p>Chassis Length Overall (m): 6.73</p> <p>Height Overall (m): 2.14</p> <p>Width Overall (m): 2.94</p> <p>Automotive Performance:</p> <p>Engine Type: 293 hp Diesel</p> <p>Cruising Range (km): 600 km</p> <p>Speed (km/h):</p> <ul style="list-style-type: none"> Max Road: 60 Max Off-Road: 35 Cross-Country: INA Max Swim: 7 <p>Fording Depths (m): Amphibious</p> <p>Radio: R-173</p> <p>Protection:</p> <p>Armor, Turret (mm): 23</p> <p>Armor Hull (mm): 19</p> <p>Self-Entrenching Blade: No</p> <p>NBC Protection System: Yes</p> <p>Smoke Equipment: Vehicle engine exhaust smoke system (VEESS)</p> <p>ARMAMENT</p> <p>Main Armament:</p> <p>Caliber, Type, Name: 7.62-mm machinegun PKT</p> <p>Mount Type: coax</p> <p>Direct Fire Range (m): 1300</p> <p>Max Effective Range (m):</p> <ul style="list-style-type: none"> Day: 1000 / 400-500 on the move Night: 800 <p>Fire on Move: Yes</p> <p>Rate of Fire (rpm): 600 cyclic in 2-10 round bursts</p> </td> <td style="vertical-align: top;"> <p>VARIANTS</p> <p>None</p> <p>SENSORS/COMPONENTS</p> <p>PRP-3 Sensors/Components:</p> <p>navigation: 1G25 gyrocompass and 1G13 gyro course indicator</p> <p>fire direction: 1V520 Ballistic Computer</p> <p>right side sensors: 1PN61 Night Vision sensor and 1D11 Laser Range-finder</p> <p>left side sensors: none</p> <p>Radar: 1RL126 Small Fred Radar</p> <ul style="list-style-type: none"> operating band: K (36.2 – 37.0 GHz) detection range: 20 km tracking range: 7–12 km <p>PRP-4 Sensors/Components:</p> <p>navigation: 1G25-1 gyrocompass and 1G13 gyro course indicator</p> <p>fire direction: 1V520 Ballistic Computer</p> <p>right side sensors: 1PN61 Night Vision sensor and 1D11M-1 Laser Rangefinder</p> <p>left side sensors: 1PN59 Thermal Imaging Night Vision Device and 1D14 Laser Rangefinder</p> <p>Radar: 1RL133M-1 Tall Mike Radar</p> <ul style="list-style-type: none"> operating band: I (9.0 GHz) detection range (personnel): 3.0 km detection range (vehicle): 12 km </td> </tr> </table>		<p>SYSTEM</p> <p>Alternative Designations: None</p> <p>Date of Introduction: 1975</p> <p>Proliferation: At least 1 country</p> <p>Description:</p> <p>Crew: 5</p> <p>Platform (chassis): BMP-1</p> <p>Combat Weight (mt): 13.2</p> <p>Chassis Length Overall (m): 6.73</p> <p>Height Overall (m): 2.14</p> <p>Width Overall (m): 2.94</p> <p>Automotive Performance:</p> <p>Engine Type: 293 hp Diesel</p> <p>Cruising Range (km): 600 km</p> <p>Speed (km/h):</p> <ul style="list-style-type: none"> Max Road: 60 Max Off-Road: 35 Cross-Country: INA Max Swim: 7 <p>Fording Depths (m): Amphibious</p> <p>Radio: R-173</p> <p>Protection:</p> <p>Armor, Turret (mm): 23</p> <p>Armor Hull (mm): 19</p> <p>Self-Entrenching Blade: No</p> <p>NBC Protection System: Yes</p> <p>Smoke Equipment: Vehicle engine exhaust smoke system (VEESS)</p> <p>ARMAMENT</p> <p>Main Armament:</p> <p>Caliber, Type, Name: 7.62-mm machinegun PKT</p> <p>Mount Type: coax</p> <p>Direct Fire Range (m): 1300</p> <p>Max Effective Range (m):</p> <ul style="list-style-type: none"> Day: 1000 / 400-500 on the move Night: 800 <p>Fire on Move: Yes</p> <p>Rate of Fire (rpm): 600 cyclic in 2-10 round bursts</p>
<p>SYSTEM</p> <p>Alternative Designations: None</p> <p>Date of Introduction: 1975</p> <p>Proliferation: At least 1 country</p> <p>Description:</p> <p>Crew: 5</p> <p>Platform (chassis): BMP-1</p> <p>Combat Weight (mt): 13.2</p> <p>Chassis Length Overall (m): 6.73</p> <p>Height Overall (m): 2.14</p> <p>Width Overall (m): 2.94</p> <p>Automotive Performance:</p> <p>Engine Type: 293 hp Diesel</p> <p>Cruising Range (km): 600 km</p> <p>Speed (km/h):</p> <ul style="list-style-type: none"> Max Road: 60 Max Off-Road: 35 Cross-Country: INA Max Swim: 7 <p>Fording Depths (m): Amphibious</p> <p>Radio: R-173</p> <p>Protection:</p> <p>Armor, Turret (mm): 23</p> <p>Armor Hull (mm): 19</p> <p>Self-Entrenching Blade: No</p> <p>NBC Protection System: Yes</p> <p>Smoke Equipment: Vehicle engine exhaust smoke system (VEESS)</p> <p>ARMAMENT</p> <p>Main Armament:</p> <p>Caliber, Type, Name: 7.62-mm machinegun PKT</p> <p>Mount Type: coax</p> <p>Direct Fire Range (m): 1300</p> <p>Max Effective Range (m):</p> <ul style="list-style-type: none"> Day: 1000 / 400-500 on the move Night: 800 <p>Fire on Move: Yes</p> <p>Rate of Fire (rpm): 600 cyclic in 2-10 round bursts</p>	<p>VARIANTS</p> <p>None</p> <p>SENSORS/COMPONENTS</p> <p>PRP-3 Sensors/Components:</p> <p>navigation: 1G25 gyrocompass and 1G13 gyro course indicator</p> <p>fire direction: 1V520 Ballistic Computer</p> <p>right side sensors: 1PN61 Night Vision sensor and 1D11 Laser Range-finder</p> <p>left side sensors: none</p> <p>Radar: 1RL126 Small Fred Radar</p> <ul style="list-style-type: none"> operating band: K (36.2 – 37.0 GHz) detection range: 20 km tracking range: 7–12 km <p>PRP-4 Sensors/Components:</p> <p>navigation: 1G25-1 gyrocompass and 1G13 gyro course indicator</p> <p>fire direction: 1V520 Ballistic Computer</p> <p>right side sensors: 1PN61 Night Vision sensor and 1D11M-1 Laser Rangefinder</p> <p>left side sensors: 1PN59 Thermal Imaging Night Vision Device and 1D14 Laser Rangefinder</p> <p>Radar: 1RL133M-1 Tall Mike Radar</p> <ul style="list-style-type: none"> operating band: I (9.0 GHz) detection range (personnel): 3.0 km detection range (vehicle): 12 km 		

NOTES

The PRP-4M has improved 1PN71 night vision sensors. The vehicles are also equipped with a NBC filtration and overpressure system.

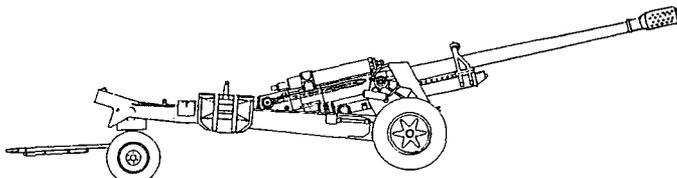
Russian 122-mm Towed Howitzer D-30A

	<p>Weapons & Ammunition Types</p> <p>122-mm howitzer</p> <p>Frag-HE Smoke Illumination</p>	<p>Typical Combat Load</p>
<p>SYSTEM Alternative Designations: 122-mm D-30A Lyagushka Date of Introduction: 1963 Proliferation: At least 13 countries Description: Crew: 5 (section of 6) Carriage: D-30 Combat Weight (mt): 3.2 Chassis Length Overall (m): Travel Position: 5.4 Firing Position: INA Height Overall (m): 1.6 Width Overall (m): Travel Position: 1.9 Firing Position: INA Towing Speed (km/h): Max Road: 60 Max Off-Road: 25 Max Cross-Country: Fording Depths (m): .5 Emplacement Time (min): 1.5 Displacement Time (min): 3.5</p> <p>Prime Mover: MT-LB; Ural-375, or equivalent</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 122-mm, 2A18M canon Barrel Length (cal): 38 (approximately) Rate of Fire (rpm): Burst: 8 Normal: 6 Sustained: 4 Loader Type: Semi-automatic Breech Type: Vertical sliding wedge Muzzle Brake Type: Multi-baffle Traverse: (°): Left: 360 Right: 360 Total: 360 Elevation (°) (-/+): -7/+70°</p>	<p>FIRE CONTROL Indirect Fire: PG-1M Panoramic Telescope (PANTEL) Direct Fire: OP 4M-45 Collimator: K-1 Gun Display Unit: None Fire Control Computer: None</p> <p>VARIANTS Saddam: Iraqi produced version of the D-30 D30J: Yugoslavian produced version of the D-30 SP 122: Egyptian self-propelled howitzer (M109A2 chassis and turret with an Egyptian made D-30 howitzer). Type 85: Chinese self-propelled howitzer (Chinese Type 85 APC chassis and a licensed produced version of the D-30 in a semi-open superstructure.)</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 122-mm Frag-HE, OF-81 Indirect Fire Range (m): Minimum Range: 1000 Maximum Range: 15,300 Complete Projectile Weight (kg): 21.76 (OF-56) Muzzle Velocity: 680 m/s Fuze Type: RGM-2 PD</p> <p>122-mm, HEAT-FS Direct Fire Range (m): Minimum Range: 0 Maximum Range: 1000 Armor Penetration (mm): 460 (@ 0° obliquity any range) Complete Projectile Weight (kg): 21.58 Muzzle Velocity: 740 m/s Fuze Type: GPV-2 PIBD</p> <p>122-mm Frag-HE Rocket Assisted Indirect Fire Range (m): Minimum Range: INA Maximum Range: 21,900 Complete Projectile Weight (kg): 21.76 (3OF-56) Muzzle Velocity: INA Fuze Type: PD</p> <p>Other Ammunition Types: Incendiary, Chemical, Flechette, Semi-active laser-guided Kitolov-2M Frag-HE</p>	

NOTES

The D-30A is a midlife product improvement of the D-30. The original D-30 was fielded in 1963 and the midlife product improvements occurred in the mid to late 1970's. The original D-30 is in use with at least 50 different countries.

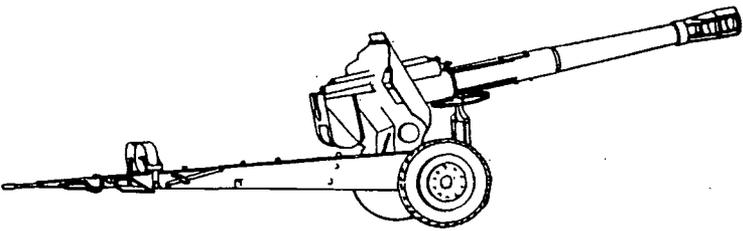
Russian 130-mm Towed Gun M-46

	<p>Weapons & Ammunition Types</p> <p>130-mm howitzer</p> <p>Frag-HE Smoke Illumination</p>	<p>Typical Combat Load</p>
<p>SYSTEM</p> <p>Alternative Designations: None</p> <p>Date of Introduction: 1954</p> <p>Proliferation: At least 25 countries</p> <p>Description:</p> <p>Crew: 8</p> <p>Carriage: M-46</p> <p>Combat Weight (mt): 8.45</p> <p>Chassis Length Overall (m):</p> <p>Travel Position: 11.73</p> <p>Firing Position: 11.10</p> <p>Height Overall (m): 2.55</p> <p>Width Overall (m):</p> <p>Travel Position: 2.45</p> <p>Firing Position: INA</p> <p>Towing Speed (km/h):</p> <p>Max Road: 50</p> <p>Max Off-Road: 20</p> <p>Max Cross-Country: 10</p> <p>Fording Depths (m): INA</p> <p>Emplacement Time (min): 6</p> <p>Displacement Time (min): 7</p> <p>Prime Mover: AT-S 59, KrAZ-255 or equivalent</p> <p>ARMAMENT</p> <p>Main Armament:</p> <p>Caliber, Type, Name: 130-mm, canon</p> <p>Barrel Length (cal): 52 (approximately)</p> <p>Rate of Fire (rpm):</p> <p>Burst: 8</p> <p>Normal: 6</p> <p>Sustained: 5</p> <p>Loader Type: Manual</p> <p>Breech Type: Horizontal sliding wedge</p> <p>Muzzle Brake Type: Multiperforated (pepperpot)</p> <p>Traverse (°):</p> <p>Left: 25</p> <p>Right: 25</p> <p>Total: 50</p> <p>Elevation (°) (-/+): -2.5/+45°</p>	<p>FIRE CONTROL</p> <p>Indirect Fire: PG-1 Panoramic Telescope (PANTEL)</p> <p>Direct Fire: OP 4-35</p> <p>Collimator: K-1</p> <p>Gun Display Unit: None</p> <p>Fire Control Computer: None</p> <p>VARIANTS</p> <p>None</p> <p>MAIN ARMAMENT AMMUNITION</p> <p>Caliber, Type, Name:</p> <p>130-mm Frag-HE, OF44</p> <p>Indirect Fire Range (m):</p> <p>Minimum Range: INA</p> <p>Maximum Range: 22,500</p> <p>Complete Projectile Weight (kg): 33.40 (OF33)</p> <p>Muzzle Velocity: 930 m/s</p> <p>Fuze Type: V-429 PD</p> <p>130-mm, APC-T</p> <p>Direct Fire Range (m):</p> <p>Minimum Range: 0</p> <p>Maximum Range: 1140</p> <p>Armor Penetration (mm): INA</p> <p>Complete Projectile Weight (kg): 33.49 (BR-482B)</p> <p>Muzzle Velocity: INA</p> <p>Fuze Type: DBR BD</p> <p>130-mm Frag-HE, OF-43</p> <p>Indirect Fire Range (m):</p> <p>Minimum Range: INA</p> <p>Maximum Range: 27,500</p> <p>Complete Projectile Weight (kg): 33.40 (OF-33)</p> <p>Muzzle Velocity: 930 m/s</p> <p>Fuze Type: V-429 PD</p> <p>130-mm Frag-HE, ERFB-BB</p> <p>Indirect Fire Range (m):</p> <p>Minimum Range: INA</p> <p>Maximum Range: 38,000</p> <p>Complete Projectile Weight (kg): 33.40</p> <p>Muzzle Velocity: 940 m/s</p> <p>Fuze Type: ML-5 PD</p> <p>Other Ammunition Types: Smoke, Chemical, Illumination</p>	

NOTES:

The M-46 gun crew is provided limited frontal protections by virtue of a frontal V-shaped shield (approximately 7-mm thick). Otherwise, the crew, ammunition supply, and equipment are vulnerable to casualties and damage from small arms fire, artillery fire, and bomb shrapnel. The Extended Range Full Bore-Base Bleed round was specifically designed by NORINCO Industries (China) for use with the Chinese 130-mm Type 59 Field Gun. However, this round may be fired by the M-46.

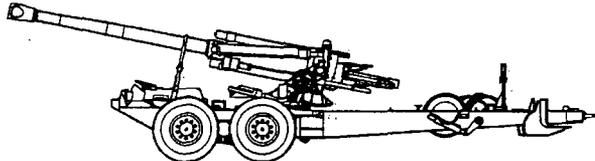
Russian 152-mm Towed Gun-Howitzer D-20

	<p>Weapons & Ammunition Types</p> <p>152-mm howitzer</p> <p>Frag-HE Smoke Illumination</p>	<p>Typical Combat Load</p>
<p>SYSTEM Alternative Designations: None Date of Introduction: 1955 Proliferation: At least 13 countries Description: Crew: 8 Carriage: 122-mm gun D-74 Combat Weight (mt): 5.7 Chassis Length Overall (m): Travel Position: 8.10 Firing Position: 8.69 Height Overall (m): 2.52 Width Overall (m): Travel Position: 2.35 Firing Position: INA Towing Speed (km/h): Max Road: 60 Max Off-Road: 30 Max Cross-Country: 15 Forging Depths (m): .5 Emplacement Time (min): 2.5 Displacement Time (min): 2.5 Prime Mover: AT-S Tracked vehicle; MT-LB; Ural-375; Ural-4320</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 152-mm, canon Barrel Length (cal): 25 Rate of Fire (rpm): Burst: 5-6 Normal: INA Sustained: 1 (65 rounds the first hour) Loader Type: Manual Breech Type: Vertical sliding wedge Muzzle Brake Type: Double flared Traverse (°): Left: 29 Right: 29 Total: 58 Elevation (°) (-/+):-5/+45°</p>	<p>FIRE CONTROL Indirect Fire: PG-1M Panoramic Telescope (PANTEL) Direct Fire: OP 4M Collimator: K-1 Gun Display Unit: None Fire Control Computer: None</p> <p>VARIANTS None</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 152-mm Frag-HE, OF32 Indirect Fire Range (m): Minimum Range: 4600 Maximum Range: 17,400 Complete Projectile Weight (kg): 43.56 (OF25) Muzzle Velocity: 655 m/s Fuze Type: V-90 PD</p> <p>152-mm, HEAT, BP-540 Direct Fire Range (m): Minimum Range: 0 Maximum Range: 1000 Armor Penetration (mm): INA Complete Projectile Weight (kg): 27.00 Muzzle Velocity: 655 m/s Fuze Type: GPV-3 PD</p> <p>152-mm Frag-HE, OF-96 Indirect Fire Range (m): Minimum Range: INA Maximum Range: 24,400 Complete Projectile Weight (kg): 43.56 (OF-64) Muzzle Velocity: INA Fuze Type: PD</p> <p>Other Ammunition Types: DPICM, DPICM-BB, Incendiary, Expendable Jammer, Chemical, Flechette, Semi-active laser-guided Krasnopol-M Frag-HE</p>	

NOTES

The D-20 was the first 152-mm cannon system to incorporate a semiautomatic vertical-sliding-wedge breech block. Although the ammunition for the system was not changed, this modification allowed a slightly higher rate of fire to be achieved (6 rounds per minute rather than 4), although the sustained rate of fire was unchanged. Because the carriage is based on that of the 122-mm gun D-74, the D-20 cannot be elevated above 45°.

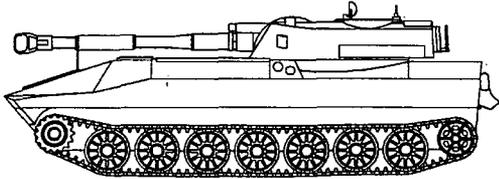
South African 155-mm Towed Gun-Howitzer G5

	Weapons & Ammunition Types 155-mm howitzer Frag-HE Smoke Illumination	Typical Combat Load
<p>SYSTEM Alternative Designations: None Date of Introduction: 1981 Proliferation: At least 4 countries Description: Crew: 8 Carriage: G5 Combat Weight (mt): 13.75 Chassis Length Overall (m): Travel Position: 12.1 Firing Position: 11.0 Height Overall (m): 2.3 Width Overall (m): Travel Position: 3.3 Firing Position: 2.7 Towing Speed (km/h): Max Road: 90 Max Off-Road: 50 Max Cross-Country: 15 Fording Depths (m): .6 Emplacement Time (min): 2 Displacement Time (min): 1</p> <p>Auxiliary Propulsion Unit Performance: Engine Type: 76 hp air-cooled diesel Cruising Range (km): 100 Speed (km/h): Max Road: 16 Max Off-Road: INA Cross-Country: 3 Max Swim: N/A</p> <p>Prime Mover: Samil 100 6x6 artillery tractor or a 10 ton equivalent</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 155-mm, canon Barrel Length (cal): 45 Rate of Fire (rpm): Burst: 3 Normal: 2 Sustained: 2</p>	<p>Loader Type: Semi-automatic Breech Type: Interrupted screw Muzzle Brake Type: Single baffle Traverse: (°): Left: 41 Right: 41 Total: 82 Elevation (°) (-/+): -3/+75°</p> <p>FIRE CONTROL Indirect Fire: Digital Panoramic Telescope Direct Fire: Trunnion mounted telescopic sight Collimator: INA Gun Display Unit: None Fire Control Computer: None</p> <p>VARIANTS G-5 MkIII Upgrade of G-5 (see NOTES)</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 155-mm Frag-HE, M1 HE Indirect Fire Range (m): Minimum Range: 3000 Maximum Range: 30,000 Complete Projectile Weight (kg): 8.7 Muzzle Velocity: 897 m/s Fuze Type: PD M841</p> <p>155-mm Frag-HE BB, M1 HE Indirect Fire Range (m): Minimum Range: INA Maximum Range: 39,000 Complete Projectile Weight (kg): 8.7 Muzzle Velocity: 895 m/s Fuze Type: PD M841</p> <p>Other Ammunition Types: See NOTES</p>	

NOTES

The G5 is fully compatible with NATO standard 155-mm ammunition and has a direct fire range of 3000 meters (using a Frag-HE round). The APU, combined with the tandem walking-beam suspension, gives the G5 excellent self-propelled mobility over short distances. The four wheels are all powered and give the gun excellent traction over most terrain. But, the APU serves purposes other than mobility. It provides power to open and close the trails, raise and lower the trail wheels, and raise and lower the firing platform. However, there is no power traverse or elevation. Although designed for an eight-man section, the South African Defense Force normally operates the G5 with a five-man section. However, the G5 can operate with minimum of two people when all of the powered systems are working. The G-5 MkIII includes 35 reliability modifications and performance improvements. The improvements include the addition of the AS2000 Gun Monitor, an improved braking system, bigger diameter and wider trail wheels (specifically designed for sand), and incorporation of the REUTECH ACV 58 Communications System.

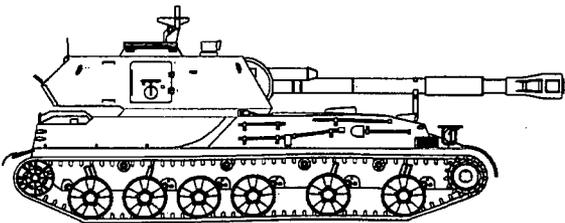
Russian 122-mm Self-Propelled Howitzer 2S1

	<p>Weapons & Ammunition Types</p> <p>122-mm howitzer</p> <p>Frag-HE HEAT-FS Smoke Illumination</p>	<p>Typical Combat Load</p> <p>45</p>
<p>SYSTEM</p> <p>Alternative Designations: 122-mm 2S1 Gvozdika</p> <p>Date of Introduction: 1974</p> <p>Proliferation: At least 12 countries</p> <p>Description:</p> <p>Crew: 4 (section of 6 with 2 in ammo carrier)</p> <p>Platform (chassis): MT-LBu</p> <p>Combat Weight (mt): 15.7</p> <p>Chassis Length Overall (m): 7.26</p> <p>Height Overall (m): 2.72</p> <p>Width Overall (m): 2.85</p> <p>Automotive Performance:</p> <p>Engine Type: V-8, 300 hp, Diesel</p> <p>Cruising Range (km): 500 km</p> <p>Speed (km/h):</p> <ul style="list-style-type: none"> Max Road: 60 Max Off-Road: 30 Cross-Country: INA Max Swim: 4.5 <p>Fording Depths (m): Amphibious</p> <p>Emplacement Time (min): 2</p> <p>Displacement Time (min): 1</p> <p>Radio: R-123M</p> <p>Protection:</p> <p>Armor, Turret (mm): 20</p> <p>Armor Turret Top (mm): 10</p> <p>Armor Hull (mm): 15</p> <p>Self-Entrenching Blade: No</p> <p>NBC Protection System: Yes</p> <p>Smoke Equipment: No</p> <p>ARMAMENT</p> <p>Main Armament:</p> <p>Caliber, Type, Name: 122-mm, canon, 2A31</p> <p>Barrel Length (cal): 36</p> <p>Rate of Fire (rpm):</p> <ul style="list-style-type: none"> Burst: 5 Normal: 4 Sustained: 1-2 <p>Fire from Ground: INA</p> <p>Loader Type: Semi-automatic</p> <p>Breech Type: Horizontal sliding wedge</p>	<p>Muzzle Brake Type: Double baffle</p> <p>Traverse (°):</p> <ul style="list-style-type: none"> Left: 360 Right: 360 Total: 360 <p>Elevation (°) (-/+): -3/+70°</p> <p>FIRE CONTROL</p> <p>Indirect Fire: PG-2 Panoramic Telescope (PANTEL)</p> <p>Direct Fire: OP 5-37</p> <p>Collimator: K-1</p> <p>Gun Display Unit: None</p> <p>Fire Control Computer: None</p> <p>VARIANTS</p> <p>None</p> <p>MAIN ARMAMENT AMMUNITION</p> <p>Caliber, Type, Name:</p> <p>122-mm Frag-HE, OF-81</p> <p>Indirect Fire Range (m):</p> <ul style="list-style-type: none"> Minimum Range: 1000 Maximum Range: 15,300 <p>Complete Projectile Weight (kg): 21.76 (OF-56)</p> <p>Muzzle Velocity: 680 m/s</p> <p>Fuze Type: RGM-2 PD</p> <p>122-mm, HEAT-FS</p> <p>Direct Fire Range (m):</p> <ul style="list-style-type: none"> Minimum Range: 0 Maximum Range: 1000 <p>Armor Penetration (mm): 460 (@ 0° obliquity any range)</p> <p>Complete Projectile Weight (kg): 21.58</p> <p>Muzzle Velocity: 740 m/s</p> <p>Fuze Type: GPV-2 PIBD</p> <p>122-mm Frag-HE Rocket Assisted</p> <p>Indirect Fire Range (m):</p> <ul style="list-style-type: none"> Minimum Range: INA Maximum Range: 21,900 <p>Complete Projectile Weight (kg): 21.76 (3OF-56)</p> <p>Muzzle Velocity: INA</p> <p>Fuze Type: PD</p> <p>Other Ammunition Types: Incendiary, Chemical, Flechette, Expendable Jammer, Semi-active laser-guided Kitolov-2M Frag-HE</p>	

NOTES:

The 2S1's ammunition stowage rack is not mechanized. The 2S1 is manually loaded with a semiautomatic ramming capability. The four-man crew consists of the commander, driver, gunner, and loader.

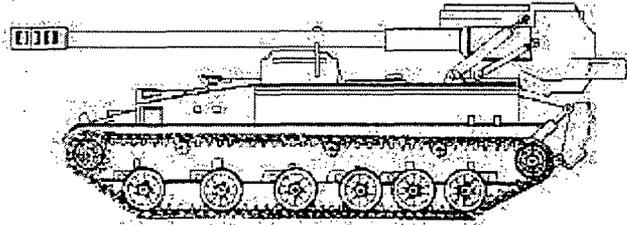
Russian 152-mm Self-Propelled Gun-Howitzer 2S3M

	<p>Weapons & Ammunition Types</p> <p>152-mm howitzer</p> <p>Frag-HE Smoke Illumination</p> <p>7.62 PKT MG</p>	<p>Typical Combat Load</p> <p>46</p> <p>1500</p>
	<p>SYSTEM</p> <p>Alternative Designations: 152-mm 2S3M Akatsiya Date of Introduction: 1973 Proliferation: At least 8 countries Description: Crew: 4 Platform (chassis): Modified SA-4 Ganef Combat Weight (mt): 27.5 Chassis Length Overall (m): 7.75 Height Overall (m): 3.13 Width Overall (m): 3.21</p> <p>Automotive Performance: Engine Type: 520-hp V-59 V-12 multi-fuel diesel Cruising Range (km): 450 km Speed (km/h): Max Road: 60 Max Off-Road: 25 Cross-Country: INA Max Swim: N/A Fording Depth (m): 1.00 Emplacement Time (min): 3 Displacement Time (min): 3</p> <p>Radio: R-123M</p> <p>Protection: Armor, Turret (mm): 20 Armor Turret Top (mm): 15 Armor Hull (mm): INA Self-Entrenching Blade: Yes NBC Protection System: Yes Smoke Equipment: No</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 152-mm, 2A33 Barrel Length (cal): 34 Rate of Fire (rpm): Burst: 4 Normal: 3 Sustained: 1 Fire from Ground: INA Loader Type: Semiautomatic Breech Type: Vertical sliding wedge Muzzle Brake Type: Double baffle Traverse: (°): Left: 360 Right: 360 Total: 360 Elevation (°) (-/+): -4/+60°</p> <p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm machinegun PKT Mount Type: Bow (ball-mounted) Direct Fire Range (m): 1000 Max Effective Range (m): Day: 1000/400-500 on the move Night: 800 Fire on Move: Yes Rate of Fire (rpm): 650 (cyclic)</p> <p>FIRE CONTROL Indirect Fire: PG-4 Panoramic Telescope (PANTEL) Direct Fire: OP 5-38 Collimator: K-1 Gun Display Unit: None Fire Control Computer: None</p> <p>VARIANTS 2S3M1: Upgrade of 2S3M</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 152-mm Frag-HE, OF32 Indirect Fire Range (m): Minimum Range: 4600 Maximum Range: 17,400 Complete Projectile Weight (kg): 43.56 (OF25) Muzzle Velocity: 655 m/s Fuze Type: V-90 PD</p> <p>152-mm, HEAT, BP-540 Direct Fire Range (m): Minimum Range: 0 Maximum Range: 1000 Armor Penetration (mm): INA Complete Projectile Weight (kg): 27.00 Muzzle Velocity: 655 m/s Fuze Type: GPV-3 PD</p> <p>152-mm Frag-HE, OF-96 Indirect Fire Range (m): Minimum Range: INA Maximum Range: 24,400 Complete Projectile Weight (kg): 43.56 (OF-64) Muzzle Velocity: INA Fuze Type: PD</p> <p>Other Ammunition Types: DPICM, DPICM-BB, Incendiary, Chemical, Flechette, Semi-active laser-guided Krasnopol-M Frag-HE</p>	

NOTES

The 2S3M is an upgrade version of the 2S3. The 2S3M turret contains the 2A33 cannon, fire-control equipment, ammunition storage space, and work positions for commander, gunner, and loader. The cannon extends beyond the vehicle front and has an electrical loader/rammer attached to the cradle. Ammunition is stored in the rear of the chassis and can be replenished through a hatch in the rear panel.

Russian 152-mm Self-Propelled Gun 2S5

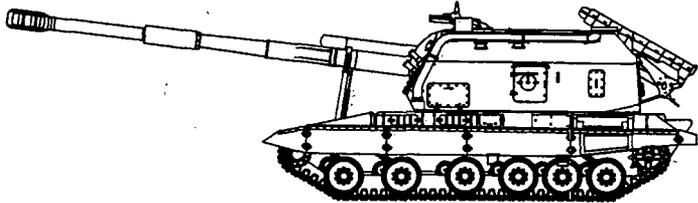
	Weapons & Ammunition Types:	Typical Combat Load
	152-mm howitzer Frag-HE Smoke Illumination 7.62 PKT MG	30 1500

<p>SYSTEM: Alternative Designations: 152-mm 2S5 Giatsint-S Date of Introduction: 1981 Proliferation: At least 4 countries Description: Crew: 5 (section of 7 with 2 in ammo carrier) Platform (chassis): Modified 2S3 Combat Weight (mt): 28.2 Chassis Length Overall (m): 8.33 Height Overall (m): 2.76 Width Overall (m): 3.25</p> <p>Automotive Performance: Engine Type: 520-hp V-59-V-12 multi-fuel diesel Cruising Range (km): 500 km Speed (km/h): Max Road: 63 Max Off-Road: 25 Cross-Country: INA Max Swim: 4.5 Fording Depths (m): 1.05 Emplacement Time (min): 2 Displacement Time (min): 1</p> <p>Radio: R-123M</p> <p>Protection: Armor, Turret (mm): INA Armor Turret Top (mm): 15 Armor Hull (mm): 15 Self-Entrenching Blade: Yes NBC Protection System: Yes Smoke Equipment: None</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 152-mm, canon, 2A37 Barrel Length (cal): 52 Rate of Fire (rpm): Burst: 6 Normal: 5 Sustained: 1-2 Fire from Ground: INA Loader Type: Semi-automatic Breech Type: Horizontal sliding wedge Muzzle Brake Type: Multi baffle Traverse (°): Left: 15 Right: 15 Total: 30 Elevation (°) (-/+): -2/+57°</p>	<p>Auxiliary Weapon: Caliber, Type, Name: 7.62-mm machinegun PKT Mount Type: Bow (ball-mounted) Direct Fire Range (m): 1000 Max Effective Range (m): Day: 1000 /400-500 on the move Night: 800 Fire on Move: Yes Rate of Fire (rpm): 650 (cyclic)</p> <p>FIRE CONTROL Indirect Fire: PG-1M Panoramic Telescope (PANTEL) Direct Fire: N/A Collimator: K-1 Gun Display Unit: None Fire Control Computer: None</p> <p>VARIANTS None</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 152-mm Frag-HE, OF-39 Indirect Fire Range (m): Minimum Range: 9100 Maximum Range: 28,400 Complete Projectile Weight (kg): 43.51 (OF-29) Muzzle Velocity: 945 m/s Fuze Type: V-429 PD</p> <p>152-mm, HEAT, BP-540 Direct Fire Range (m): Minimum Range: 0 Maximum Range: 1000 Armor Penetration (mm): INA Complete Projectile Weight (kg): 27.00 Muzzle Velocity: 655 m/s Fuze Type: GPV-3 PD</p> <p>152-mm Frag-HE, OF-86 Indirect Fire Range (m): Minimum Range: INA Maximum Range: 30,500 Complete Projectile Weight (kg): 43.8 (OF-59) Muzzle Velocity: 945 m/s Fuze Type: V-429 PD</p> <p>Other Ammunition Types: DPICM, DPICM-BB, Incendiary, Chemical, Flechette, Semi-active laser-guided Krasnopol-M Frag-HE</p>
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NOTES

The 2S5 is more powerful, has a longer range and a higher rate of fire than the 2S3. However, the 2S5 has a limited main armament traverse and a narrower elevation range than the 2S3.

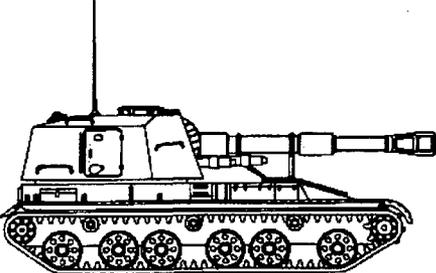
Russian 152-mm Self-Propelled Howitzer 2S19

	<p>Weapons & Ammunition Types</p> <p>152-mm howitzer</p> <p>Frag-HE Smoke Illumination</p> <p>12.7-mm MG</p>	<p>Typical Combat Load</p> <p>50</p> <p>300</p>
	<p>SYSTEM</p> <p>Alternative Designations: 152-mm 2S19 Msta-S Date of Introduction: 1989 Proliferation: At least 4 countries Description: Crew: 5 (section of 7 with 2 in ammo carrier) Platform (chassis): Modified T-72 Combat Weight (mt): 42 Chassis Length Overall (m): 11.91 Height Overall (m): 2.98 Width Overall (m): 3.58</p> <p>Automotive Performance: Engine Type: 840-hp V84-A diesel Cruising Range (km): 500 km Speed (km/h): Max Road: 60 Max Off-Road: 25 Cross-Country: INA Max Swim: N/A Fording Depths (m): Unprepared: 1.5 Emplacement Time (min): 1-2 Displacement Time (min): 1-2</p> <p>Radio: R-173</p> <p>Protection: Armor, Turret (mm): 15 Armor Turret Top (mm): 15 Armor Hull (mm): 15 Self-Entrenching Blade: Capable of digging a complete firing pit in 40-60 minutes NBC Protection System: Yes Smoke Equipment: Six Type 902 smoke grenade launchers and Vehicle engine exhaust smoke system (VEESS)</p> <p>ARMAMENT</p> <p>Main Armament: Caliber, Type, Name: 152-mm, canon, 2A64 Barrel Length (cal): 48 Rate of Fire (rpm): Burst: 8 Normal: 6 Sustained: 2 Fire from Ground: 6-7 Loader Type: autoloader Breech Type: Vertical sliding wedge Muzzle Brake Type: Double baffle Traverse (°): Left: 360 Right: 360</p> <p>Other Ammunition Types: All standard 152-mm artillery rounds</p> <p>Total: 360 Elevation (°) (-/+): -4/+68°</p> <p>Auxiliary Weapon: Caliber, Type, Name: 12.7-mm NSVT machinegun Mount Type: PZU-5 AA Direct Fire Range (m): 2000 Max Effective Range (m): Day: 1500 (AA)/1500 (Ground) Night: N/A Fire on Move: Yes Rate of Fire (rpm): 800 (cyclic)</p> <p>FIRE CONTROL Indirect Fire: 1P22 Panoramic Telescope (PANTEL) Direct Fire: 1P23 Collimator: K-1 Gun Display Unit: None Fire Control Computer: None</p> <p>VARIANTS None</p> <p>MAIN ARMAMENT AMMUNITION</p> <p>Caliber, Type, Name: 152-mm Frag-HE, OF-72 Indirect Fire Range (m): Minimum Range: 6500 Maximum Range: 24,700 Complete Projectile Weight (kg): 43.56 (OF-45) Muzzle Velocity: 864 m/s Fuze Type: RGM-2 PD</p> <p>152-mm, HEAT, BP-540 Direct Fire Range (m): Minimum Range: 0 Maximum Range: 1000 Armor Penetration (mm): INA Complete Projectile Weight (kg): 27.00 Muzzle Velocity: 655 m/s Fuze Type: GPV-3 PD</p> <p>152-mm Frag-HE BB, OF-91 Indirect Fire Range (m): Minimum Range: 6710 Maximum Range: 29,000 Complete Projectile Weight (kg): 42.86 (OF-61) Muzzle Velocity: 828 m/s Fuze Type: KZ-88 PD</p>	

NOTES

The 2S19's gun crew can load the gun at any angle of elevation. The 2S19 can also produce a smokescreen by injecting diesel fuel into the exhaust outlet. The 21-hp gas turbine AP-18D Auxiliary Power Unit provides power for turret operations when the vehicle engine is shut down.

Chinese 152-mm Self-Propelled Gun-Howitzer Type 83

	Weapons & Ammunition Types	Typical Combat Load
	152-mm howitzer Frag-HE Smoke Illumination 12.7-mm MG 7.62-mm MG	30 650 650
<p>SYSTEM Alternative Designations: None Date of Introduction: 1984 Proliferation: At least 1 country Description: Crew: 5 Platform (chassis): Type 83 Combat Weight (mt): 30.0 Chassis Length Overall (m): 7.33 Height Overall (m): 3.50 Width Overall (m): 3.24</p> <p>Automotive Performance: Engine Type: Type 12150L, V-12, 520-hp liquid-cooled diesel Cruising Range (km): 450 km Speed (km/h): Max Road: 55 Max Off-Road: 35 Cross-Country: INA Max Swim: N/A Fording Depth (m): 1.3 Emplacement Time (min): 1 Displacement Time (min): 1</p> <p>Radio: Type 889D</p> <p>Protection: Armor, Turret (mm): INA Armor Turret Top (mm): INA Armor Hull (mm): INA Self-Entrenching Blade: No NBC Protection System: No Smoke Equipment: No</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 152-mm, Type 66 cannon Barrel Length (cal): 29 Rate of Fire (rpm): Burst: 4 Normal: INA Sustained: INA Fire from Ground: INA</p>	<p>Loader Type: Semiautomatic Breech Type: Vertical sliding wedge Muzzle Brake Type: Double baffle Traverse (°): Left: 360 Right: 360 Total: 360 Elevation (°) (-/+): -5/+65°</p> <p>Auxiliary Weapon: Caliber, Type, Name: 12.7-mm (12.7x108) AA MG Type 54 Mount Type: Turret top Direct Fire Range (m): 1500 Max Effective Range (m): Day: 1500 ground/1600 for air targets (APDS) Night: INA Fire on Move: Yes Rate of Fire (rpm): 80-100 practical, 600 for air targets in 2-10 round bursts</p> <p>Caliber, Type, Name: 7.62 (7.62 x 54R) Machinegun Type 59 Mount Type: Turret coax Direct Fire Range (m): 1800 Max Effective Range (m): Day: 1000 Night: 800 Fire on Move: Yes Rate of Fire (rpm): 250 practical, 600 cyclic in 2-10 round bursts</p> <p>FIRE CONTROL Indirect Fire: Panoramic Direct Fire: INA Collimator: INA Gun Display Unit: None Fire Control Computer: None</p> <p>VARIANTS 425-mm Mineclearing Rocket Launcher Type 462: 2-round rocket launcher for use in clearing minefields.</p> <p>120-mm SP Anti-Tank Gun: The AT gun is fitted with a 120-mm smoothbore mounted inside a turret on a Type 83 Gun-Howitzer chassis.</p>	

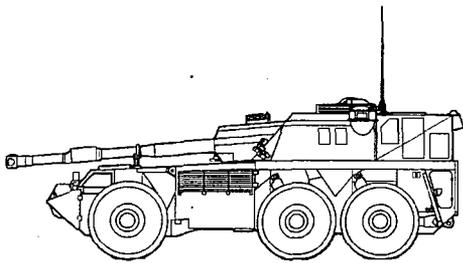
Chinese 152-mm Self-Propelled Gun-Howitzer Type 83 continued

<p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 152-mm Frag-HE, Type 66 Indirect Fire Range (m): Minimum Range: 9600 Maximum Range: 17,230 Complete Projectile Weight (kg): 43.6 Muzzle Velocity: 655 m/s Fuze Type: Liu-4 PD and Proximity</p> <p>152-mm Frag-HE Rocket Assisted Projectile Indirect Fire Range (m): Minimum Range: INA Maximum Range: 21,880 Complete Projectile Weight (kg): INA Muzzle Velocity: INA Fuze Type: PD</p>	<p>152-mm Frag-HE Type 83 Indirect Fire Range (m): Minimum Range: INA Maximum Range: 30,370 Complete Projectile Weight (kg): 46.95 Muzzle Velocity: 955 m/s Fuze Type: Liu-4 PD and Proximity</p> <p>Other Ammunition Types: HE-I, Illumination, Smoke</p>
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NOTES

The Type 83 152-mm SP Gun-Howitzer is capable of firing all standard types of 152-mm rounds. The main armament cannon is based on the Chinese 152-mm Towed Type 66 mounted on a vehicle hull similar to the Russian 152-mm SP Gun-Howitzer 2S3. The crew communicates with each other using the Type 803 intercom system. There are reports of the Type 83 being equipped with an anti-tank rocket launcher referred to as the Type 40. However, it is suspected that the rocket launcher is really the 40-mm anti-tank rocket launcher Type 69-1 (an upgraded variant of the Russian RPG-7).

South African 155-mm Self-Propelled Howitzer G6

	Weapons & Ammunition Types	Typical Combat Load
	155-mm howitzer Frag-HE Smoke Illumination .50 Cal. M2 HB MG	45 900
<p>SYSTEM Alternative Designations: 155-mm G6 Rhino Date of Introduction: 1988 Proliferation: At least 2 countries Description: Crew: 6 Platform (chassis): Purpose built 6x6 wheeled Combat Weight (mt): 48 Chassis Length Overall (m): 10.4 Height Overall (m): 3.5 Width Overall (m): 3.4</p> <p>Automotive Performance: Engine Type: 525-hp air-cooled diesel Cruising Range (km): 700 km Speed (km/h): Max Road: 85 Max Off-Road: 30 Cross-Country: INA Max Swim: N/A Fording Depth (m): 1.00 Emplacement Time (min): 1 Displacement Time (min): 0.5</p> <p>Radio: INA</p> <p>Protection: Armor, Turret (mm): See NOTES Armor Turret Top (mm): See NOTES Armor Hull (mm): See NOTES Self-Entrenching Blade: No NBC Protection System: Yes Smoke Equipment: 8 81-mm grenade launchers</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 155-mm, canon Barrel Length (cal): 45 Rate of Fire (rpm): Burst: 3 Normal: 2 Sustained: 1 Fire from Ground: INA Loader Type: Semi-automatic Breech Type: Interrupted screw</p>	<p>Muzzle Brake Type: Single baffle Traverse: (°): Left: 40 Right: 40 Total: 80 Elevation (°) (-/+): -5/+75°</p> <p>Auxiliary Weapon: Caliber, Type, Name: .50 (12.7x99) heavy machinegun, M2HB Mount Type: Cupola AA mount Direct Fire Range (m): INA Max Effective Range (m): Day: 1000 Night: INA Fire on Move: Yes Rate of Fire (rpm): 450-550 (cyclic)</p> <p>FIRE CONTROL Indirect Fire: Digital Panoramic Telescope Direct Fire: Trunnion mounted telescopic sight Collimator: INA Gun Display Unit: None Fire Control Computer: None</p> <p>VARIANTS None</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 155-mm Frag-HE, M1 HE Indirect Fire Range (m): Minimum Range: 3000 Maximum Range: 30,000 Complete Projectile Weight (kg): 8.7 Muzzle Velocity: 897 m/s Fuze Type: PD M841</p> <p>155-mm Frag-HE BB, M1 HE Indirect Fire Range (m): Minimum Range: INA Maximum Range: 39,000 Complete Projectile Weight (kg): 8.7 Muzzle Velocity: 895 m/s Fuze Type: PD M841</p> <p>Other Ammunition Types: See NOTES</p>	

South African 155-mm Self-Propelled Howitzer G6 continued

NOTES

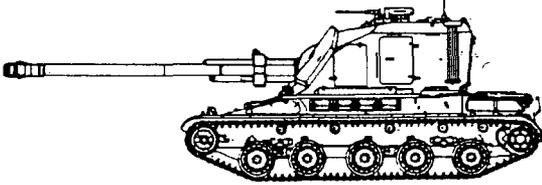
The G6 is a three-axle, six-wheeled, heavily armored system mounting a modified version of the G5 cannon. The G6 is fully compatible with NATO standard 155-mm ammunition and has a direct fire range of 3000 meters (using a Frag-HE round). The rigid chassis is actually divided into two parts, a driver's/engine compartment and a crew compartment. In order to distribute its weight and to maintain mobility over sand and soft terrain, the G6 employs large 21x25 run-flat tires. The driver controls a central tire-inflation system to vary the ground pressure. The system can also be used to maintain some degree of tire pressure in case of air leakage from small punctures. The G6 is equipped with an electronically controlled hydraulic flick rammer that provides an initial rate of fire of 3 rounds per minute.

The vehicle hull and turret provide protection against 7.62-mm small arms fire and artillery shrapnel. The frontal 60° arc provides protection against 20-mm type ammunition. Additionally, the shape and armor thickness of the chassis hull allows it to withstand at least three mine detonations (against TM46 antitank landmine or equivalent) before being immobilized. The separation of the driver/engine compartment from the crew compartment also facilitates survival against mines. The connection between the two is perforated with blowout holes to direct the force of the blast upwards, away from any personnel compartments. The separation also allows the driver to be beyond the detonation point before the mine is activated. The driver also has bullet-resistant glass windows that can be further protected by armored shutters, although it limits him to the use of a periscopic viewing port. The vehicle commander has limited steering and braking capability if the driver becomes a casualty. The crew compartment has four firing ports (two each side) so the crew can engage targets without exposing themselves to return fire.

A 45-hp (34 kw) Auxiliary Power Unit (APU) provides power for turret operations, recharging the batteries, and the driver/crew compartment air conditioning system. A wide range of optional subsystems is available to increase the efficiency of the G6 and its crew. They include the following:

- Inertial navigation and laying or back-up laying systems
- Night vision equipment
- Barrel cooling and thermal warning systems
- Fire control computer interface
- Muzzle velocity analyzer
- Explosion control for fuel tanks

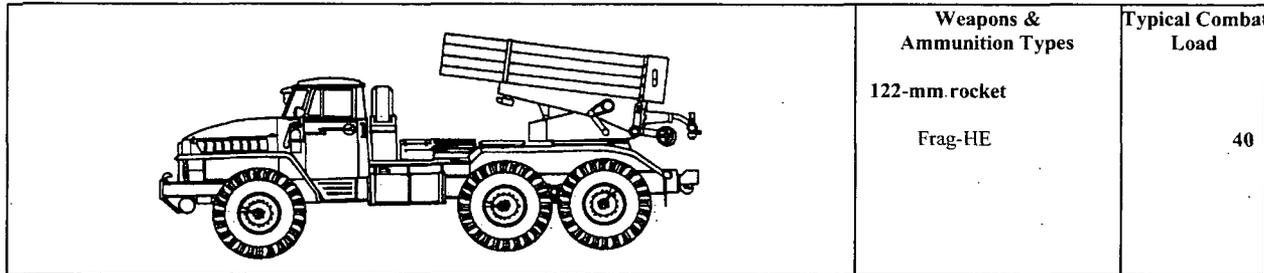
French 155-mm Self-Propelled Howitzer AU-F1

	<p style="text-align: center;">Weapons & Ammunition Types</p> <p>155-mm howitzer</p> <p>Frag-HE Smoke Illumination</p> <p>.50 Cal. M2 HB MG</p>	<p style="text-align: center;">Typical Combat Load</p> <p style="text-align: right;">42.</p> <p style="text-align: right;">800</p>
<p>SYSTEM: Alternative Designations: 155-mm GCT (Export Version) Date of Introduction: 1979 Proliferation: At least 4 countries Description: Crew: 4 Platform (chassis): Modified AMX-30 Combat Weight (mt): 42.0 Chassis Length Overall (m): 10.25 Height Overall (m): 3.25 Width Overall (m): 3.15</p> <p>Automotive Performance: Engine Type: Hispano-Suiza HS110, 720-hp water-cooled multi-fuel Cruising Range (km): 450 km Speed (km/h): Max Road: 60 Max Off-Road: 40 Cross-Country: INA Max Swim: N/A Fording Depth (m): 2.10 Emplacement Time (min): 1-2 Displacement Time (min): 1</p> <p>Radio: TRC 559 (VHF-FM)</p> <p>Protection: Armor, Turret (mm): See NOTES Armor Turret Top (mm): See NOTES Armor Hull (mm): See NOTES Self-Entrenching Blade: No NBC Protection System: Yes Smoke Equipment: 4 grenade launchers</p> <p>ARMAMENT Main Armament: Caliber, Type, Name: 155-mm, canon Barrel Length (cal): 40 Rate of Fire (rpm): Burst: 8 Normal: 6 Sustained: 2-3 (manual loading) Fire from Ground: INA Loader Type: Autoloader Breech Type: Vertical sliding wedge</p>	<p>Muzzle Brake Type: Double baffle Traverse: (°): Left: 360 Right: 360 Total: 360 Elevation (°) (-/+): -4/+66°</p> <p>Auxiliary Weapon: Caliber, Type, Name: .50 (12.7x99) heavy machinegun, M2HB Mount Type: Cupola AA mount Direct Fire Range (m): INA Max Effective Range (m): Day: 1000 Night: INA Fire on Move: Yes Rate of Fire (rpm): 450-550 (cyclic)</p> <p>FIRE CONTROL Indirect Fire: M 589 Optical Goniometer Direct Fire: INA Collimator: INA Gun Display Unit: ATILA fire direction system Fire Control Computer: None</p> <p>VARIANTS AU-FIT: Upgrade of AU-F1</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 155-mm Frag-HE, OE-155-56/69 Indirect Fire Range (m): Minimum Range: 9600 Maximum Range: 23,000 Complete Projectile Weight (kg): 43.75 Muzzle Velocity: 810 m/s Fuze Type: PD</p> <p>155-mm Frag-HE Rocket Assisted H3 Indirect Fire Range (m): Minimum Range: INA Maximum Range: 31,500 Complete Projectile Weight (kg): INA Muzzle Velocity: 830 m/s Fuze Type: PD</p> <p>Other Ammunition Types: DPICM, Illumination, Smoke</p>	

NOTES

The export version of the AU-F1 is known as the GCT (Grande Cadence de Tir or high rate of fire). The AU-F1T is fitted with the Sagem Cita 20 inertial navigation system as well as a 20-24 hp gas turbine auxiliary power unit (APU). A four-man gun crew can reload the AU-F1 in 15 minutes. A two-man gun crew can reload the AU-F1 in 20 minutes. The AU-F1's armor provides crew protection against artillery shrapnel and small arms fire.

Russian 122-mm Multiple Rocket Launcher BM-21



Weapons & Ammunition Types	Typical Combat Load
122-mm rocket	
Frag-HE	40

SYSTEM
Alternative Designations: BM-21 GRAD (Hail) MRL
Date of Introduction: 1963
Proliferation: At least 50 countries
Description:
 Crew: 5 (8 with 9K51 Complex)
 Chassis/Carriage: Ural 375-D 6x6 wheeled
 Combat Weight (mt): 13.7
 Chassis Length Overall (m): 7.35
 Height Overall (m): 3.09
 Width Overall (m): 2.40

Automotive Performance:
 Engine Type: ZIL 375, 180 hp water-cooled, V-8 gasoline engine
 Cruising Range (km): 450 km
 Speed (km/h):
 Max Road: 75
 Max Off-Road: 35
 Cross-Country: INA
 Max Swim: N/A
 Forging Depths (m): Unprepared: 1.5
 Emplacement Time (min): 3
 Displacement Time (min): 2

Radio: R-123M

Protection:
 Armor, Front (mm): None
 Armor Side (mm): None
 Armor Roof (mm): None
 Self-Entrenching Blade: No
 NBC Protection System: No
 Smoke Equipment: No

ARMAMENT
Launcher:
 Caliber, Type, Name: 122-mm, 9P132
 Number of Tubes: 40 (4 rows of 10 tubes)
 Launch Rate:
 Full Salvo Time: 40 rounds in 20 seconds
 Single Rocket Interval: .5 seconds per rocket
 Loader Type: Manual
 Reload Time: 10 minutes
 Launcher Drive: Electric
 Traverse (°):
 Left: 102
 Right: 70
 Total: 172
 Elevation (°) (-/+): - 0/+55°

FIRE CONTROL
Indirect Fire: PG-1M Panoramic Telescope (PANTEL)
Collimator: K-1
Fire Control Computer: None
Position Location System: None

VARIANTS
BM-21V: Russian 12-tube version for airborne divisions
BM-21B: Russian 36-tube MRL on a 6x6 ZIL-131 chassis
Grad-P: Russian 1 round rocket launcher
BM-11: North Korean 30-tube version
Type 81: Chinese 40- rail-launched version
RM-70: Czechoslovakian 40-tube version
Sakr: Egyptian 40- tube version

MAIN ARMAMENT AMMUNITION
Caliber, Type, Name:
 122-mm Frag-HE, 9M22U
Indirect Fire Range (m):
 Minimum Range: 5000
 Maximum Range: 20,380
 Warhead Weight (kg): 18.4 (M21OF)
 Rocket Length (m): 2.87
 Maximum Velocity: INA
 Fuze Type: MRV-U (PD)

122-mm Frag-HE, 9M28F
Indirect Fire Range (m):
 Minimum Range: 1500
 Maximum Range: 15,000
 Warhead Weight (kg): 21.0
 Rocket Length (m): 2.87
 Maximum Velocity: INA
 Fuze Type: MRV-U (PD) or AR-6 (proximity)

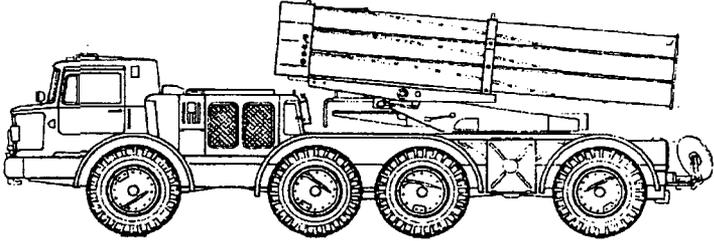
122-mm Frag-HE, Type 90A (Chinese)
Indirect Fire Range (m):
 Minimum Range: 12,700
 Maximum Range: 32,700
 Warhead Weight (kg): 18.3
 Rocket Length (m): 2.75
 Maximum Velocity: INA
 Fuze Type: PD

Other Ammunition Types: Smoke, Incendiary, Chemical, RF Jammer, Illumination, Antitank mines, Antipersonnel mines

NOTES

The BM-21 is unquestionably the world's most widely used MRL. The launcher with supporting equipment is referred to as the complex 9K51. A special electric generator powers the launcher. The 9V170 firing device is cab mounted. But, the rockets can be fired using a remote-firing device that has a 64-meter-long cable.

Russian 220-mm Multiple Rocket Launcher 9P140

	<p style="text-align: center;">Weapons & Ammunition Types</p> <p>220-mm rocket</p> <p>Frag-HE</p>	<p style="text-align: center;">Typical Combat Load</p> <p style="text-align: center;">16</p>
<p>SYSTEM Alternative Designations: 9P140 Uranan Date of Introduction: 1977 Proliferation: At least 7 countries Description: Crew: 4 Chassis/Carriage: ZIL-135LM 8x8 wheeled Combat Weight (mt): 20.0 Chassis Length Overall (m): 9.3 Height Overall (m): 3.2 Width Overall (m): 2.8</p> <p>Automotive Performance: Engine Type: 2 each - 177 hp, 8 cylinder, 4-stroke gasoline engines Cruising Range (km): 500 km Speed (km/h): Max Road: 65 Max Off-Road: INA Cross-Country: INA Max Swim: N/A Fording Depths (m): Unprepared: 1.2 Emplacement Time (min): 3 Displacement Time (min): 3</p> <p>Radio: R-123M</p> <p>Protection: Armor, Front (mm): None Armor Side (mm): None Armor Roof (mm): None Self-Entrenching Blade: No NBC Protection System: No Smoke Equipment: No</p> <p>ARMAMENT Launcher: Caliber, Type, Name: 220-mm, 9P140 Number of Tubes: 16 (2 rows of 6 tubes and 1 row of 4 tubes) Launch Rate: Full Salvo Time: 16 rounds in 20 seconds Single Rocket Interval: 1.25 seconds per rocket Loader Type: Manual Reload Time: 15-20 minutes Launcher Drive: Electric Traverse (°): Left: 30 Right: 30 Total: 60 Elevation (°) (-/+): -0/+55°</p>	<p>FIRE CONTROL Indirect Fire: PG-1M Panoramic Telescope (PANTEL) Collimator: K-1 Fire Control Computer: None Position Location System: None</p> <p>VARIANTS None</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 220-mm Frag-HE, 9M27F Indirect Fire Range (m): Minimum Range: 10,000 Maximum Range: 35,000 Warhead Weight (kg): 100 Rocket Length (m): 4.8 Maximum Velocity: INA Fuze Type: Electronic timing (ET)</p> <p>220-mm DPICM, 9M27K Indirect Fire Range (m): Minimum Range: 10,000 Maximum Range: 35,000 Warhead Weight (kg): 90 Rocket Length (m): 5.1 Maximum Velocity: INA Fuze Type: Electronic timing (ET)</p> <p>220-mm Antitank, 9M27K2 Indirect Fire Range (m): Minimum Range: 10,000 Maximum Range: 35,000 Warhead Weight (kg): 90 Rocket Length (m): 5.1 Maximum Velocity: INA Fuze Type: Electronic timing (ET)</p>	

Russian 220-mm Multiple Rocket Launcher 9P140 continued

<p>MAIN ARMAMENT AMMUNITION (continued) Caliber, Type, Name: 220-mm Antipersonnel, 9M27K3 Indirect Fire Range (m): Minimum Range: 10,000 Maximum Range: 35,000 Warhead Weight (kg): 90 Rocket Length (m): 5.1 Maximum Velocity: INA Fuze Type: Electronic timing (ET)</p>	<p>220-mm Antitank, 9M59 Indirect Fire Range (m): Minimum Range: 10,000 Maximum Range: 35,000 Warhead Weight (kg): 90 Rocket Length (m): 5.1 Maximum Velocity: INA Fuze Type: Electronic timing (ET) Other Ammunition Types: None</p>
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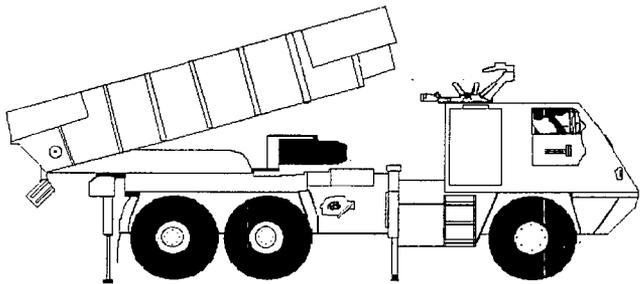
NOTES

The 9P140 Uragan (previously referred to incorrectly as BM-22 or BM-27) is the world's first modern fin and spin-stabilized heavy rocket system. Essentially a scaled-up version of the BM-21, the 9P140 use many of the same design features. The launcher, 9T452 transloader, rockets, and support equipment constitutes the 9K57 complex.

The 9P140 and its transloader are both based on variants of the gasoline-powered ZIL-135LM 8-ton 8x8 chassis. The truck is unusual in that it uses two engines, each driving the wheels on one side of the truck, and only the front and rear axles steer. The 9P140 cab has a blast shield that is raised during firing, and the vehicle is stabilized during firing by two manually emplaced hydraulic jacks at the rear of the chassis.

The launcher has electrically powered traversing and elevating mechanisms. During travel, the launcher assembly is oriented rearward and a light sheet metal cover over the muzzle end of the tubes prevents foreign material from entering the tube. This is a safety feature that is designed for travel when loaded. There is no such cover for the muzzle end of an unloaded launcher.

Brazilian 127-mm, 180-mm, & 300-mm Multiple Rocket Launcher ASTROS II _____

	Weapons & Ammunition Types	Typical Combat Load
	127-mm rocket Frag-HE	32
	180-mm rocket Frag-HE	16
	300-mm rocket Frag-HE	4
	.50 Cal. M2 HB MG	INA

<p>SYSTEM Alternative Designations: ASTROS II AV-LMU Date of Introduction: 1983 Proliferation: At least 6 countries Description: Crew: 3 Chassis/Carriage: TECTRAN 10-ton 6x6 wheeled Combat Weight (mt): 20.0 Chassis Length Overall (m): 8.0 Height Overall (m): 2.6 Width Overall (m): 2.4</p> <p>Automotive Performance: Engine Type: 280 hp, water-cooled turbocharged, diesel engine Cruising Range (km): INA Speed (km/h): Max Road: 70 Max Off-Road: 40 Cross-Country: INA Max Swim: N/A Fording Depths (m): Unprepared: 1.0 Emplacement Time (min): INA Displacement Time (min): INA</p> <p>Radio: INA</p> <p>Protection: Armor, Front (mm): None Armor Side (mm): None Armor Roof (mm): None Self-Entrenching Blade: No NBC Protection System: No Smoke Equipment: 6 smoke grenade launchers</p> <p>ARMAMENT Launcher: Caliber, Type, Name: 127-mm, 180-mm, 300-mm, ASTROS Number of Tubes: 127-mm (32), 180-mm (16), 300-mm (4) Launch Rate: Full Salvo Time: INA Single Rocket Interval: INA Loader Type: Manual Reload Time: INA Launcher Drive: Electric Traverse (°): Left: INA Right: INA Total: INA Elevation (°) (-/+): INA</p>	<p>Auxiliary Weapon: Caliber, Type, Name: .50 (12.7x99) heavy machinegun, M2HB Mount Type: Cab AA mount Direct Fire Range (m): INA Max Effective Range (m): Day: 1000 Night: INA Fire on Move: Yes Rate of Fire (rpm): 450-550 (cyclic)</p> <p>FIRE CONTROL Indirect Fire: INA Collimator: INA Fire Control Computer: FIELDGAURD Radar of the FILA System Position Location System: INA</p> <p>VARIANTS: None</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 127-mm Frag-HE, SS-30 Indirect Fire Range (m): Minimum Range: 9000 Maximum Range: 30,000 Warhead Weight (kg): INA Rocket Length (m): 3.9 Maximum Velocity: INA Fuze Type: INA</p> <p>Other Ammunition Types: None</p> <p>Caliber, Type, Name: 180-mm Frag-HE, SS-40 Indirect Fire Range (m): Minimum Range: 15,000 Maximum Range: 35,000 Warhead Weight (kg): INA Rocket Length (m): 4.2 Maximum Velocity: INA Fuze Type: INA</p> <p>Other Ammunition Types: DPICM, HE-Incendiary, Antitank mines, Antipersonnel mines, Runway Denial</p>
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Brazilian 127-mm, 180-mm, & 300-mm Multiple Rocket Launcher ASTROS II continued

<p>Caliber, Type, Name: 300-mm Frag-HE, SS-60</p> <p>Indirect Fire Range (m): Minimum Range: 20,000 Maximum Range: 60,000</p> <p>Warhead Weight (kg): INA Rocket Length: (m): 5.6 Maximum Velocity: INA Fuze Type: INA</p> <p>Other Ammunition Types: DPICM, HE-Incendiary, Antitank mines, Antipersonnel mines, Runway Denial</p>	<p>300-mm Frag-HE, SS-80</p> <p>Indirect Fire Range (m): Minimum Range: 22,000 Maximum Range: 90,000</p> <p>Warhead Weight (kg): INA Rocket Length: (m): 5.6 Maximum Velocity: INA Fuze Type: INA</p> <p>Other Ammunition Types: DPICM, HE-Incendiary, Antitank mines, Antipersonnel mines, Runway Denial</p>
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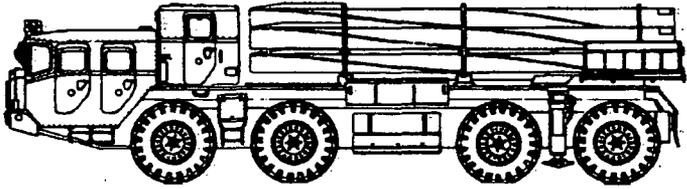
The ASTROS (Artillery SaTuration ROcket System) II is a modular multiple rocket launcher capable of firing three different caliber wrap-around fin rockets (for improved accuracy) using several types of warheads. The universal modules enable the system to accomplish fire missions with ranges from 9 to 90 kilometers.

The ASTROS II system consists of the following vehicles:

Universal Multiple Launcher (AV-LMU), Ammunition Supply Vehicle (AV-RMD), Command and Control Vehicle/Fire Control Unit (AV-VCC), Mobile Workshops (for field maintenance), and the Optional Electronic Fire Control Unit (AV-UCF). All of the ASTROS II vehicles use the Tectran Engenharia 10 ton, 6x6, wheeled vehicle chassis.

A typical firing battery consists of six AV-LMU launchers, six AV-RMD ammunition supply vehicles, and one AV-VCC fire control unit. A AV-VCC command and control unit and two mobile workshops are found at battalion level. The battalion level AV-VCC can coordinate and direct fire missions for three ASTROS batteries. The AV-RMD ammunition supply vehicle carries two complete loads for each launcher.

Russian 300-mm Multiple Rocket Launcher 9A52-2

	<p>Weapons & Ammunition Types</p> <p>300-mm rocket</p> <p>Frag-HE</p>	<p>Typical Combat Load</p> <p>12</p>
<p>SYSTEM Alternative Designations: 9A52-2 Smerch-M Date of Introduction: 1989 Proliferation: At least 4 countries Description: Crew: 4 (7 with 9K58 Complex) Chassis/Carriage: MAZ-543M 8x8 wheeled Combat Weight (mt): 43.7 Chassis Length Overall (m): 12.1 Height Overall (m): 3.05 Width Overall (m): 3.05</p> <p>Automotive Performance: Engine Type: 518 hp, V-12 diesel engine Cruising Range (km): 850 km Speed (km/h): Max Road: 60 Max Off-Road: 35 Cross-Country: INA Max Swim: N/A Fording Depths (m): Unprepared: 1.1 Emplacement Time (min): 3 Displacement Time (min): 3</p> <p>Radio: R-123M</p> <p>Protection: Armor, Front (mm): None Armor Side (mm): None Armor Roof (mm): None Self-Entrenching Blade: No NBC Protection System: No Smoke Equipment: No</p> <p>ARMAMENT Launcher: Caliber, Type, Name: 300-mm, 9A52 Number of Tubes: 12 (3 rows of 4 tubes) Launch Rate: Full Salvo Time: 12 rounds in 38 seconds Single Rocket Interval: 3 seconds per rocket Loader Type: Manual Reload Time: 36 minutes Launcher Drive: Electric Traverse (°): Left: 30 Right: 30 Total: 60 Elevation (°) (-/+): -0/+55°</p>	<p>FIRE CONTROL Indirect Fire: PG-1M Panoramic Telescope (PANTEL) Collimator: K-1 Fire Control Computer: None Position Location System: None</p> <p>VARIANTS None</p> <p>MAIN ARMAMENT AMMUNITION Caliber, Type, Name: 300-mm Frag-HE, 9M55F Indirect Fire Range (m): Minimum Range: 20,000 Maximum Range: 70,000 Warhead Weight (kg): 258 Rocket Length (m): 7.6 Maximum Velocity: INA Fuze Type: Electronic timing (ET)</p> <p>300-mm DPICM, 9M55K Indirect Fire Range (m): Minimum Range: 20,000 Maximum Range: 70,000 Warhead Weight (kg): 235 Rocket Length (m): 7.6 Maximum Velocity: INA Fuze Type: Electronic timing (ET)</p> <p>300-mm Sensor-fuzed (MOTIV-3M), 9M55K1 Indirect Fire Range (m): Minimum Range: 20,000 Maximum Range: 70,000 Warhead Weight (kg): 233 Rocket Length (m): 7.6 Maximum Velocity: INA Fuze Type: Electronic timing (ET)</p> <p>Other Ammunition Types: Smoke, Incendiary, Chemical, Leaflet, Fuel Air Explosive (FAE), R-90 expendable miniature UAV (experimental)</p>	

NOTES

The 9A52-2 launcher with all supporting equipment, including the 9T234-2 Transloader, and the 1K123 Vivary Fire Control System, is referred to as the complex 9K58.

Chapter 7 Air Defense

This chapter provides an overview of selected air defense systems either in use or readily available to an OPFOR. The selection of weapons is not intended to be all-inclusive, but rather a representative sampling of weapons and equipment supporting various OPFOR military capabilities.

This chapter is divided into three categories—*towed AA guns*, *self-propelled AA guns/combination guns* and *surface-to-air missiles (SAMs)*. *Towed AA guns* covers, in order, the KS-19M2 100-mm gun, S-60 57-mm gun and the ZU-23 23-mm gun. The next category, *self-propelled AA guns/combination guns*, contains the ZSU-23-4 23-mm gun and the 2S6 30-mm gun/missile system. The final category of *surface-to-air missiles (SAMs)* consists of the SA-7b, SA-8b, SA-14, SA-15b and the SA-18.

Tactical air defense is used to protect ground force units and other potential targets from attack by enemy fixed-wing aircraft and armed helicopters. Due to increases in performance and the sheer number of air defense systems, specifically manportable systems, the selected systems represent some of the most formidable threats to aircraft of all types.

Some trends in air defense development will become more widespread in the near future. These include the production of authorized and unauthorized copies of existing systems and the development of hybrid systems. The sensor package may consist of one or more radars, direct view optics, and electro-optics systems. The sensor package is the single most important aspect of air defense systems since these devices perform the surveillance and tracking functions. As the data classification permits, all attempts have been made to provide the user with as much information as possible in these areas. Radar systems have traditionally been the most popular sensor for air-defense systems, however, with the latest generation weapons they are usually supplemented with a variety of optic or electro-optic sensors such as; TV cameras, night vision sights, and laser rangefinders. As the trends become more defined and more information becomes available, updates to the systems will be produced.

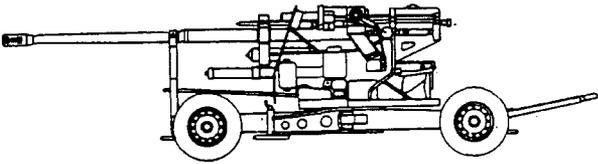
Questions and comments on data listed in this chapter should be addressed to:

Penny L. Mellies

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e-mail address: melliesp@leav-emhl.army.mil

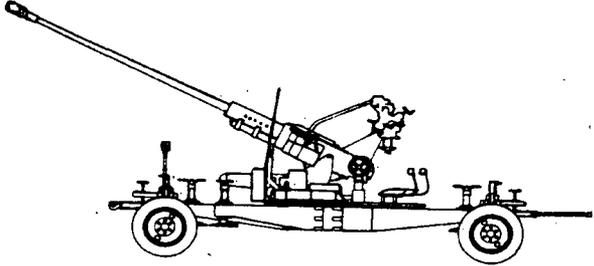
Russian 100-mm Towed AA Gun KS-19M2

	<p style="text-align: center;">Weapons & Ammunition Types</p> <p>100-mm gun</p> <p>Frag-HE AP-T APC-T</p>	<p style="text-align: center;">Typical Combat Load</p> <p style="text-align: center;">100</p>
<p>SYSTEM Alternative Designations: None Date of Introduction: 1949 Proliferation: At least 20 countries</p> <p>Description: Crew: 15 Carriage: Towed 2-axle, 4-wheel carriage Combat Weight (kg): 11,000 Length Overall (m): 9.3 Travel Position: 9.45 Firing Position: INA Length of Barrel (m): 5.74 Height (m): Overall: 2.2 Travel Position: INA Firing Position: 7.62 Width Overall (m): 2.32 Prime Mover: Towing vehicle AT-S or AT-T</p> <p>Automotive Performance: Max. Towed Speed (km/h): 35 Emplacement Time (min): 7 Displacement Time (min): 6</p>	<p>ARMAMENT Gun: Caliber, Type: 100-mm gun Number of Barrels: 1 Service Life of Barrel (rds): 2,800 Rate of Fire(rd/min): Maximum: INA Practical: 10-15 Loader Type: Manual Reload Time (min): INA Traverse (°): 360 Traverse Rate (°/sec): 20 Elevation (°) (-/+): -3 to 89 Elevation Rate (°/sec): 12 Reaction time (sec): 30</p> <p>FIRE CONTROL On-carriage: PO-1M telescope Field of View (°): 14 Power: 5x PG panoramic telescope: Field of View (°): 10 Power: 4x Off-carriage: Rangefinder: D-49 (off carriage) Radar: Name: SON-9/SON-9A (FIRE CAN) Function: Fire Control Detection Range (km): 80 Tracking Range (km): 35 Frequency: 2.7-2.9 GHz Frequency Band: E Peak Power (kW): 300 PUAZO 6-19 or 6-19M fire control director</p>	<p>VARIANTS Type 59: Chinese variant.</p> <p>MAIN ARMAMENT AMMUNITION Types: Frag-HE, AP-T, APC-T Range (m): With on-carriage sight: 4,000 With off-carriage radar: 12,600 Projectile Weight (kg): Frag-HE: 15.61 AP-T: 15.89 APC-T: 16 Muzzle Velocity (m/s): 900-1,000 Fuze Type: Proximity and Time Self-Destruct (sec): 30</p>

NOTES

The KS-19M2 may also be employed in a ground support role.

Russian 57-mm Towed AA Gun S-60

	<p>Weapons & Ammunition Types</p> <p>57-mm gun</p> <p>FRAG-T APC-T</p>	<p>Typical Combat Load</p> <p>200</p>
<p>SYSTEM Alternative Designations: None Date of Introduction: 1950 Proliferation: At least 46 countries</p> <p>Description: Crew: 7 Carriage: Four-wheel Weight (kg): 4,500 Length Overall (m): Travel Position: 8.50 Firing Position: 8.84 Length of Barrel (m): 4.39 Height (m): Overall: Travel Position: 2.37 Firing Position: 6.02 Width Overall (m): Travel Position: 2.08 Firing Position: 6.9 Prime Mover: Ural-375D</p> <p>Automotive Performance: Max. Towed Speed (km/h): 60 Emplacement Time (min): 1 Displacement Time (min): 3</p>	<p>ARMAMENT Gun: Caliber, Type: 57-mm automatic cannon Number of Barrels: 1 each Service Life of Barrel (rds): INA Rate of Fire (rd/min): Cyclic: 105-120 Practical: 70 Loader Type: 4 rd clip, manual Reload Time (sec): 4-8 Traverse (°): 360 Traverse Rate (°/sec): 40 Elevation (°) (-/+): -4 to +87 Elevation Rate (°/sec): 34 Reaction time (sec): 4.5</p> <p>FIRE CONTROL On-carriage: Optical mechanical computing sight AZP-57: Target Range (m): 5,500 Direct fire telescope</p> <p>Off-carriage: (see NOTES) Rangefinder: D-49 Radar: Name: SON-9/SO-9A Function: Fire Control Detection Range (km): 80 Tracking Range (km): 35 Frequency: 2.7-2.9 GHz Frequency Band: E Peak Power (kW): 300 PUAZO 6-60 fire control director</p>	<p>VARIANTS Type 59: Chinese variant SZ-60: Hungarian license-built variant</p> <p>MAIN ARMAMENT AMMUNITION Type: FRAG-T, APC-T Range (m): With on-carriage sight: 4,000 With off-carriage radar: 6,000 Projectile Weight (kg): FRAG-T: 2.81 APC-T: 2.82 Muzzle Velocity (m/s): 1,000 Fuze Type: FRAG-T: Point detonating APC-T: Base detonating Self-Destruct (sec): 13-17</p>

NOTES

Some versions may have the FLAP WHEEL as the primary fire control radar. A S-60 battery will generally consist of six guns, a fire-control radar, and a fire-control director. Four-round clips feed ammunition horizontally into weapon. The S-60 also has an ammunition ready rack that can hold 4 four-round clips near ammunition feed mechanism on left side of the breech. The S-60 can also be used in a ground support role.

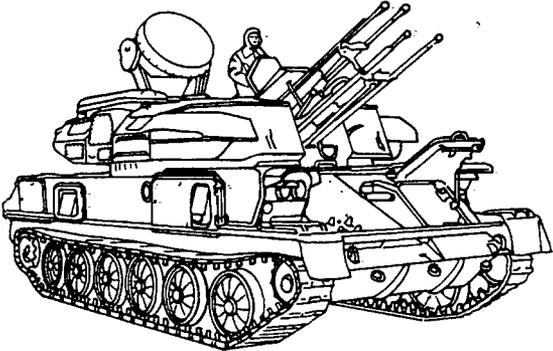
Russian 23-mm Towed AA Gun ZU-23

		<p>Weapons & Ammunition Types</p> <p>2 x 23-mm AA guns</p> <p>HE-I HEI-T API-T TP</p>	<p>Typical Combat Load</p> <p>2,400</p>
<p>SYSTEM Alternative Designation: None Date of Introduction: 1962 Proliferation: At least 50 countries</p> <p>Description: Crew: 5 Carriage: Two-wheeled Combat Weight (kg): 950 Length Overall (m): Travel Position: 4.57 Firing Position: 4.60 Length of Barrel (m): 2.01 Height (m): Overall: Travel Position: 1.87 Firing Position: 1.28 Width Overall (m): Travel Position: 1.83 Firing Position: 2.41 Prime Movers: GAZ-69 4 x 4 truck, MTLB-T, BMD-2</p> <p>Automotive Performance: Max. Towed Speed (km/h): 70 Emplacement Time (sec): 15-20 Displacement Time (sec): 35-40</p>	<p>ARMAMENT Gun: Caliber, Type: 23-mm, gas-operated gun Number of Barrels: 2 Breech Mechanism: Vertical Sliding Wedge Rate of Fire (rd/min): Cyclic: 800-1,000 Practical: 200 Feed: 50-rd ammunition canisters fitted on either side of the upper mount assembly Loader Type: Magazine Reload Time (sec): 15 Traverse (^o): 360 Traverse Rate (^o/sec): INA Elevation (^o) (-/+): -10^o to +90^o Elevation Rate: (^o/sec): 54 Reaction Time (min): 8 (est.)</p> <p>FIRE CONTROL</p> <p>Sights w/magnification: Optical mechanical sight for AA fire Straight tube telescope for ground targets</p>	<p>VARIANTS ZU-23M: Egyptian produced ZU-23, also referred to as the SH-23M.</p> <p>MAIN ARMAMENT AMMUNITION Type: HE-I, HEI-T, API-T, TP Range (m): Max. Range: 2,500 Min. Range: INA Altitude (m): Max. Altitude: 1,500 Min. Altitude: INA Projectile Weight (kg): HE-I: 0.18 HEI-T: 0.19 API-T: 0.189 TP: 0.18 Muzzle Velocity (m/s): 970 Fuze Type: HE-I: Point detonating HEI-T: Point detonating API-T: Base detonating TP: Dummy Self-Destruct (sec): 8</p>	

NOTES

Highly mobile air droppable system. Fires the same ammunition as the ZSU-23-4. The reload time will depend on the proficiency of the crew to manually reload. Can fire from the traveling position in emergencies. The ZU-23 can also be used in a ground support role.

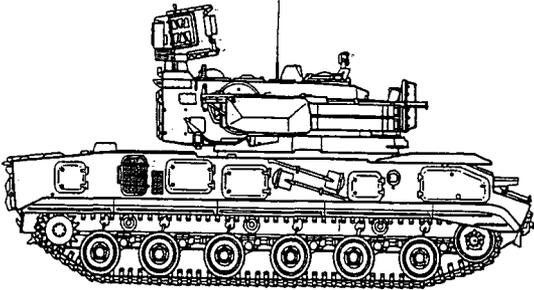
Russian 23-mm SP AA Gun ZSU-23-4

	<p>Weapons & Ammunition Types</p> <p>4x 23-mm AA guns</p> <p>HE-I HEI-T API-T</p>	<p>Typical Combat Load</p> <p>2,000</p>
<p>SYSTEM Alternative Designation: Shilka Date of Introduction: 1965 Proliferation: At least 28 countries</p> <p>Description: Crew: 4 Combat Weight (mt): 20.5 Chassis: GM-575 Tracked, six road wheels, no track support rollers Length (m): 6.5 Height (m): Radar up: 3.75 Radar down: 2.60 Width (m): 3.1</p> <p>Automotive Performance: Engine Type: V6R-1 diesel Cruising Range (km): 450 Speed (km/h): Max. Road: 50</p> <p>Radio: R-123</p> <p>Protection: NBC Protection System: Yes</p>	<p>ARMAMENT Gun: Caliber, Type, Name: 23-mm liquid-cooled AA 2A7/2A7M Rate of Fire(rd/min): Practical: INA Cyclic: 850-1,000 Reload Time (min): 20 Elevation (°) (-/+): -4° to +85° Fire on Move: Yes Reaction Time (sec): 12-18</p> <p>FIRE CONTROL Sights w/magnification: Day and night vision devices: Driver periscope: BMO-190 Driver IR periscope: INA Commander periscope: TPKU-2 Commander IR periscope: TKH-ITC IFF: INA</p> <p>Radar: IRL33M1 Name: GUN DISH Function: Search and Tracking Detection Range (km): 20 Tracking Range (km): 10 Frequency: 14.8 to 15.6 GHz Frequency Band: J</p> <p>Optical-mechanical computing sight: Part of fire-control subsystem designated as RPK-2</p>	<p>VARIANTS (see NOTES)</p> <p>MAIN ARMAMENT AMMUNITION Types: HE-I, HEI-T, API-T Range (m): Max. Range: 2,500 Min. Range: INA Altitude (m): Max. Altitude: 5,100 (about 3,500 w/self-destruct fuzing) Min. Altitude: INA Projectile Weight (kg): HE-I: 0.18 HEI-T: 0.19 API-T: 0.189 Muzzle velocity (m/s): 950-1,000 Fuze Type: HE-I: Point detonating HEI-T: Point detonating APT-T: Base detonating</p>

NOTES:

Ammunition is normally loaded with a ratio of three HE rounds to one AP round. ZSU 23-4 Shilka, is capable of acquiring, tracking and engaging low-flying aircraft (as well as mobile ground targets while either in place or on the move). Resupply vehicles carry an estimated additional 3,000 rounds for each of the four ZSUs in a typical battery. Recent (October 1997) information details ZSU-23-4 updates/modernization being offered by the Ukrainians that include: a new radar system replacing the GUN DISH radar, plus a sensor pod believed to include day/night camera, and a laser rangefinder; and mounted above radar/sensor pod is a layer of six fire-and-forget SAMs, believed to be Russian SA-18/GROUSE.

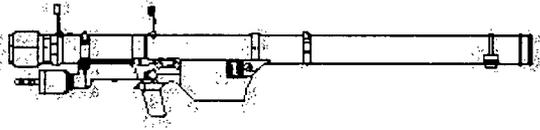
Russian 30-mm SP AA Gun/Missile System 2S6M

	<p>Weapons & Ammunition Types</p> <p>2 x 30-mm twin barrel cannons</p> <p>AP-T Frag-T HE-I</p> <p>SA-19/GRISON</p>	<p>Typical Combat Load</p> <p>1,904</p> <p>8</p>
	<p>SYSTEM Alternative Designations: 2K22M, Tunguska-M Date of Introduction: 1990 Proliferation: At least 2 countries</p> <p>Description: Crew: 4 Combat Weight (mt): 34 Chassis: GM-352M tracked vehicle Chassis Length Overall (m): 7.93 Height (m): TAR up: 4.02 TAR down: 3.36 Width Overall (m): 3.24</p> <p>Automotive Performance: Engine Type: V-12 turbo diesel Cruising Range (km): 500 Speed (km/h): Max. Road: 65 Max. Swim: INA Forcing Depths (m): INA</p> <p>Radio: R-173</p> <p>Protection: NBC Protection System: Yes</p>	<p>ARMAMENT Gun: Caliber, Type, Name: 30-mm gun, 2A38M Rate of Fire (rd/min): 4,800 (four gun total) Reload Time (min): gun ammunition and missiles in about 16 min. Elevation (°) (-/+): -10 to + 87° Fire on Move: Yes</p> <p>Missile: 9M311 Name: SA-19/GRISON Range (m): Max. Range: 8,000-10,000 (see NOTES) Min. Range: 2,500 Altitude (m): Max. Altitude: 3,500 Min. Altitude: 15 Dimensions: Length (m): 2.83 Weight (kg): 57 (in container) Missile Speed (m/s): 600-900 Guidance: SACLOS Seeker Field of View(°): INA Tracking Rate: INA Warhead Type: Frag-HE Warhead Weight (kg): 9 Fuze Type: Proximity Self-Destruct (sec): INA System Reaction Time (sec): 6-12 Fire on Move: No (must be at a halt to fire the missile)</p>

NOTES

Range out to 10 km for hovering aircraft and low flying targets. In addition to the 8 mounted ready missiles two additional missiles can be carried inside. There is a 2S6M1 variant/upgrade, which has improved missile control, range and altitude capabilities of 1.5-10 km, and 0.015-6 km respectively. However, as of November 1997 the 2S6M1 is not known to be fielded.

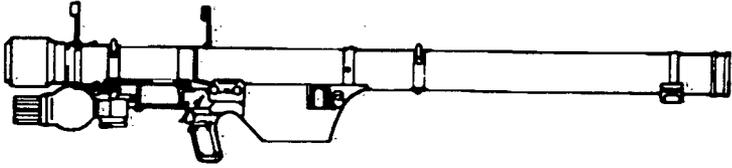
Russian Manportable SAM System SA-7b/GRAIL

		Weapons & Ammunition Types ready missile	Typical Combat Load 1
<p>SYSTEM Alternative Designation: 9K32M Strela-2M Date of Introduction: 1972 Proliferation: Worldwide</p> <p>Description: Crew: 1</p>	<p>ARMAMENT Launcher Name: 9P54M Dimensions: Length (m): 1.47 Diameter (mm): 70 Weight (kg): 4.71 Reaction Time (acquisition to fire) (sec): 5-10 Time Between Launches (sec): INA Reload Time (sec): 6-10</p> <p>Missile Name: 9M32M Range (m): Max. Range: 5,500 Min. Range: 500 Altitude (m): Max. Altitude: 4,500 Min. Altitude: 18 Dimensions: Length (m): 1.40 Diameter (mm): 70 Weight (kg): 9.97 Missile Speed (m/s): 580 Propulsion: Solid fuel booster and solid fuel sustainer rocket motor. Guidance: Passive IR homing device (operating in the medium IR range) Seeker Field of View(°): 1.9° Tracking Rate(°/sec): 6° Warhead Type: HE Warhead Weight (kg): 1.15 Fuze Type: Contact (flush or grazing) Self-Destruct (sec): 15</p>	<p>FIRE CONTROL Sights w/Magnification: Launcher has sighting device and a target acquisition indicator. The gunner visually identifies and acquires the target. Gunner: Field of View (°): INA Acquisition Range (m): INA</p> <p>IFF: Yes (see NOTES)</p> <p>VARIANTS SA-N-5: Naval version HN-5A: Chinese version Strela 2M/A: Yugoslavian upgrade Sakr Eye: Egyptian upgrade</p> <p>Mounted in several types of vehicles in four, six, and eight-tube launcher varieties. Can be mounted on several helicopters (Mi-24, S-342 Gazelle)</p>	

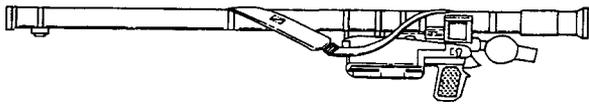
NOTES

The seeker is fitted with a filter to reduce the effectiveness of decoying flares and to block IR emissions. This missile is a tail-chasing heat (IR) seeker that depends on its ability to lock on to heat sources of usually low-flying fixed- and rotary-wing aircraft. An identification friend or foe (IFF) system can be fitted to the gunner/operator's helmet. Further, a supplementary early warning system consisting of a passive RF antenna and headphones can be used to provide early cue about the approach and rough direction of an enemy aircraft. The main difference between the SA-7 and SA-7b is the improved propulsion of the SA-7b. This improvement increases the speed and range of the newer version.

Russian Manportable SAM System SA-14/GREMLIN

	<p>Weapons & Ammunition Types</p> <p>ready missiles</p>	<p>Typical Combat Load</p> <p>1</p>		
	<table border="1"> <tr> <td> <p>SYSTEM Alternative Designation: 9K34 Strela-3 Date of Introduction: 1978 Proliferation: Worldwide</p> <p>Description: Crew: 1</p> </td> <td> <p>ARMAMENT Launcher Name: 9P59 Dimensions: Length (m): 1.40 Diameter (mm): 75 Weight (kg): 2.95 Reaction Time (sec): 14 Time Between Launches (sec): 35-40 Reload Time (sec): 25</p> <p>Missile Name: 9M36 or 9M36-1 Range (m): Max. Range: 6,000 Min. Range: 600 Altitude (m): Max. Altitude: 6,000 Min. Altitude: 50 Dimensions: Length (m): 1.4 m Diameter (mm): 75 mm Fin Span (mm): INA Weight (kg): 10.3 Missile Speed (m/s): 600 Propulsion: 2-stage solid-propellant rocket Guidance: passive IR homing Seeker Field of View: INA Tracking Rate: INA Warhead Type: Frag-HE Warhead Weight (kg): 1.0 Fuze Type: Contact/grazing Self-Destruct (sec): 14-17</p> </td> <td> <p>FIRE CONTROL Sights w/Magnification: Launch tube has simple sights Gunner: Field of View (°): INA Acquisition Range (m): INA IFF: Yes</p> <p>VARIANTS Iгла 9M39 (SA-N-8): Naval version</p> </td> </tr> </table>		<p>SYSTEM Alternative Designation: 9K34 Strela-3 Date of Introduction: 1978 Proliferation: Worldwide</p> <p>Description: Crew: 1</p>	<p>ARMAMENT Launcher Name: 9P59 Dimensions: Length (m): 1.40 Diameter (mm): 75 Weight (kg): 2.95 Reaction Time (sec): 14 Time Between Launches (sec): 35-40 Reload Time (sec): 25</p> <p>Missile Name: 9M36 or 9M36-1 Range (m): Max. Range: 6,000 Min. Range: 600 Altitude (m): Max. Altitude: 6,000 Min. Altitude: 50 Dimensions: Length (m): 1.4 m Diameter (mm): 75 mm Fin Span (mm): INA Weight (kg): 10.3 Missile Speed (m/s): 600 Propulsion: 2-stage solid-propellant rocket Guidance: passive IR homing Seeker Field of View: INA Tracking Rate: INA Warhead Type: Frag-HE Warhead Weight (kg): 1.0 Fuze Type: Contact/grazing Self-Destruct (sec): 14-17</p>
<p>SYSTEM Alternative Designation: 9K34 Strela-3 Date of Introduction: 1978 Proliferation: Worldwide</p> <p>Description: Crew: 1</p>	<p>ARMAMENT Launcher Name: 9P59 Dimensions: Length (m): 1.40 Diameter (mm): 75 Weight (kg): 2.95 Reaction Time (sec): 14 Time Between Launches (sec): 35-40 Reload Time (sec): 25</p> <p>Missile Name: 9M36 or 9M36-1 Range (m): Max. Range: 6,000 Min. Range: 600 Altitude (m): Max. Altitude: 6,000 Min. Altitude: 50 Dimensions: Length (m): 1.4 m Diameter (mm): 75 mm Fin Span (mm): INA Weight (kg): 10.3 Missile Speed (m/s): 600 Propulsion: 2-stage solid-propellant rocket Guidance: passive IR homing Seeker Field of View: INA Tracking Rate: INA Warhead Type: Frag-HE Warhead Weight (kg): 1.0 Fuze Type: Contact/grazing Self-Destruct (sec): 14-17</p>	<p>FIRE CONTROL Sights w/Magnification: Launch tube has simple sights Gunner: Field of View (°): INA Acquisition Range (m): INA IFF: Yes</p> <p>VARIANTS Iгла 9M39 (SA-N-8): Naval version</p>		

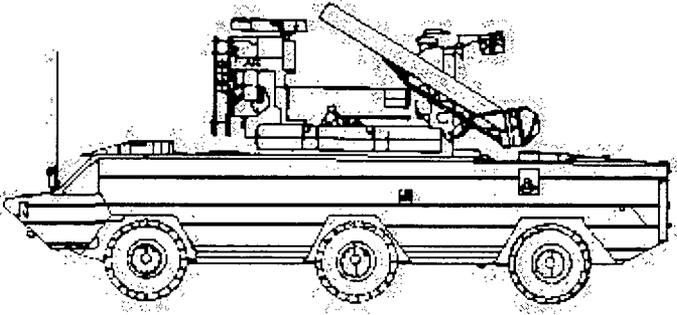
Russian Manportable SAM System SA-18/GROUSE

		Weapons & Ammunition Types	Typical Combat Load
		ready missiles	1
<p>SYSTEM Alternative Designation: 9K38 Igla Date of Introduction: 1983 Proliferation: At least 4 countries</p> <p>Description: Crew: 1</p>	<p>ARMAMENT Launcher Name: 9P39 Dimensions (m): Length: 1.708 Diameter: INA Weight (kg): 1.63 Reaction Time (sec): 6-7 Time Between Launches (sec): 16 Reload Time (sec): 10</p> <p>Missile Name: 9M39 Range (m): Max. Range: 6,000 Min. Range: 500 Altitude (m): Max. Altitude: 3,500 Min. Altitude: 10 Dimensions (mm): Length: 1708 Diameter: 70 Weight (kg): 10.6 Missile Speed: Mach 2 Propulsion: Solid fuel booster and dual-thrust solid fuel sustainer rocket motor. Guidance: Passive IR homing Seeker Field of View: INA Tracking Rate: INA Warhead Type: HE Warhead Weight (kg): 1.27 Fuze Type: Contact Self-Destruct (sec): 15</p>	<p>FIRE CONTROL Sights w/Magnification: Launcher has fore and rear sights Gunner: Field of View (°): INA Acquisition Range (m): INA</p> <p>IFF: Yes</p> <p>VARIANTS Igla-V: Air-to-air version Igla-D: Use in airborne forces Igla-N: Increased lethality Igla-S: Improved version of Igla-N</p>	

NOTES

The SAM gunner is provided information about location and direction of approaching target(s) using a portable electronic plotting board. Two variants (Igla-D and Igla-N) can be separated in two parts for easier portability, but this adds 60 seconds to the reaction time. Igla-N is heavier due primarily to the warhead mass increased to 3.5 kg.

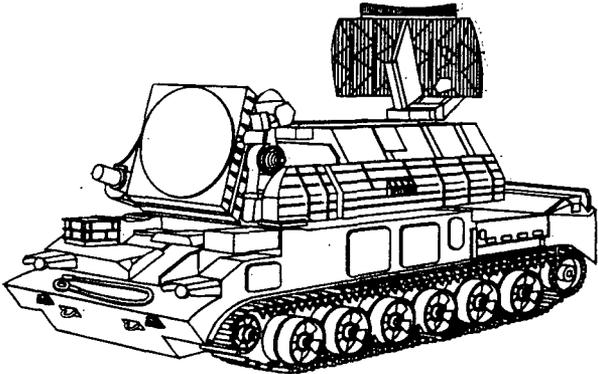
Russian SAM System SA-8b/GECKO

	<p>Weapons & Ammunition Types</p> <p>SA-8b in canisters</p>	<p>Typical Combat Load</p> <p>6</p>
<p>SYSTEM Alternative Designations: 9K33M3 Osa-AKM Date of Introduction: 1980 Proliferation: At least 25 countries</p> <p>Description: Crew: 3 Combat Weight (mt): 9 TELAR: BAZ-5937 6x6 amphibious cross-country capable vehicle Length (m): 9.14 Height (m): 4.2 (with surveillance radar folded down) Width (m): 2.75</p> <p>Automotive Performance: Engine Type: D20K300 diesel Cruising Range (km): 500 Speed (km/h): Max. Road: 80 Max. Swim: 8</p> <p>Radio: R-123M</p> <p>Protection: NBC Protection System: Yes</p>	<p>ARMAMENT Launcher: Name: 9P35M2 Dimensions: Length (m): 3.2 Diameter (mm): INA Weight (kg): 35 Reaction Time (sec): INA Time Between Launches (sec): 4 Reload Time (min): 5 Fire on Move: No Emplacement Time (min): 4 Displacement Time (min): Less than 4 (est.)</p> <p>Missile: Name: 9M33M3 Range (m): Max. Range: 15,000 Min. Range: 200 Altitude (m): Max. Altitude: 12,000 Min. Altitude: 10 Dimensions (mm): Length: 3158 Diameter: 209.6 Weight (kg): 170 Missile Speed (m/s): 1020 Propulsion: Solid propellant rocket motor Guidance: RF CLOS Warhead Type: Frag-HE Fuze Type: Contact and proximity Warhead Weight (kg): 16 Self-Destruct (sec): 25-28</p>	<p>FIRE CONTROL Sights w/Magnification: INA LLLTV/optical assist (for target tracking in low visibility and heavy ECM)</p> <p>IFF: Yes</p> <p>Radar: Name: LAND ROLL Function: Target Acquisition Detection Range (km): 20-30 Tracking Range (km): 20-25 Frequency: 6-8 GHz Frequency Band: H</p> <p>Radar: Name: Monopulse Target Tracking Radar Function: Target Tracking Detection Range (km): 20-25 Tracking Range (km): INA Frequency: 14.2-14.8 GHz Frequency Band: J</p> <p>2 Missile tracking radars: Frequency: 10-20 GHz</p> <p>VARIANTS SA-8a: Initial production model that carries four missiles on exposed rails. 4K33 Osa-M (SA-N-4): Naval variant</p>

NOTES

The first production version of this system was identified as SA-8a, which only had 4 launcher rails and exposed missiles. The SA-8b typically has two BAZ-5937 resupply/transloader vehicles, carrying 18 missiles each (boxed in sets of three) that supports a battery of four TELARs. A target can be brought under fire both with one missile as well as a volley of two missiles. This system is also air transportable.

Russian SAM System SA-15b/GAUNTLET

	<p>Weapons & Ammunition Types</p> <p>ready missiles</p>	<p>Typical Combat Load</p> <p>8</p>
<p>SYSTEM Alternative Designations: 9K331 Tor-M1 Date of Introduction: 1990 Proliferation: At least 5 countries</p> <p>Description: Crew: 3 TLAR: 9A331 combat vehicle Chassis: GM-355 Combat Weight (mt): 34 Length (m): 7.5 Height (m): 5.1 (TAR up) Width (m): 3.3</p> <p>Automotive Performance: Engine Type: V-12 diesel Cruising Range (km): 500 Speed (km/h): Max. Road: 65</p> <p>Radio: INA</p> <p>Protection: NBC Protection System: Yes</p>	<p>ARMAMENT Launcher: Name: INA Dimensions: INA Length (m): INA Diameter (mm): INA Weight (kg): INA Reaction Time (sec): 5-8 Time Between Launches (sec): (see NOTE) Reload Time (min): 10 Fire on Move: Yes Emplacement Time (min): 5 Displacement Time (min): Less than 5</p> <p>Missile: Name: 9M331 Range (m): Max. Range: 12,000 Min. Range: 100 Altitude (m): Max. Altitude: 6,000 Min. Altitude: 10 Dimensions (mm): Length: 2,900 Diameter: 235 Weight (kg): 167 Missile Speed (m/s): 850 Propulsion: INA Guidance: Command Warhead Type: Frag-HE Fuze Type: RF Proximity Warhead Weight (kg): 15 Self-Destruct (sec): INA</p>	<p>FIRE CONTROL Sights w/Magnification: Electro-optical (EO) television system: Range: 20 km</p> <p>IFF: Yes</p> <p>Radar: Name: INA Function: Target Acquisition Detection Range (km): 25 Tracking Range (km): INA Frequency: INA Frequency Band: H-band Doppler</p> <p>Radar: Name: INA Function: Target Tracking and Guidance Detection Range (km): INA Tracking Range (km): 25 Frequency: INA Frequency Band: K-band Doppler, Phased Array</p> <p>VARIANTS SA-N-9: Nayal version</p>

NOTES

SA-15b is designed to be a completely autonomous air defense system (at division level), capable of surveillance, command and control, missile launch and guidance functions from a single vehicle. The basic combat formation is the firing battery consisting of four TLARs and the Rangir battery command post. The TLAR carries eight ready missiles stored in two containers holding four missiles each. The SA-15b has the capability to automatically track and destroy 2 targets simultaneously in any weather and at any time of the day.

Chapter 8 Engineer and Logistics

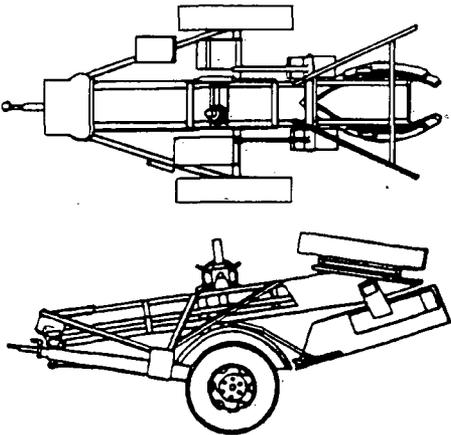
This chapter provides the basic characteristics of selected *engineer equipment* and *logistics vehicles*. *Engineer equipment* covers, in order, obstacle- and route-clearing vehicles, mine-laying systems, and mineclearing systems. It does not include engineer equipment designed primarily for civil engineering or construction in the rear areas. Also not included is dredging and gap crossing equipment. Data sheets addressing some of these systems will be sent with the next supplement to this guide.

The second category—*logistics vehicles*, provides the basic characteristics of selected trucks readily available to the OPFOR. It includes a representative vehicle from the light, utility, medium, and heavy truck categories. Later updates of this guide will include data on a wider selection of trucks, trailers, vans and other logistical equipment.

Questions and comments on data listed in this chapter should be addressed to:

Mr. Richard G. McCall
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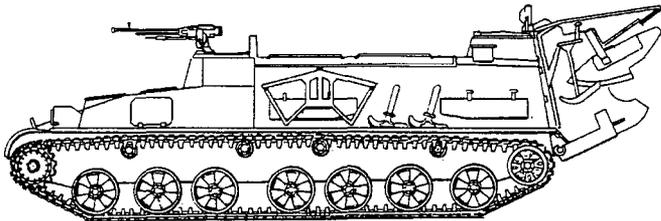
Russian Towed Mechanical Minelayer PMR-3

	<p>Mine Types</p> <p>Mines TM-44 TM-46 TM-57 TM-62 Series TM-72 TMD-B</p>	<p>Typical Combat Load</p> <p>(varies, see Prime Mover)</p>
<p>SYSTEM</p> <p>Alternative Designations: INA Date Of Introduction: INA Proliferation: At least 17 countries</p> <p>Description: Crew: 6 (commander, driver, four operators) Weight (mt): 1.3 Length (m): 5.6 Height (m): 2.7 Width (m): 2</p> <p>Prime Mover: 6x6 ZIL-131 truck (200 mines) or 4x4 URAL-375D (350 mines) or BTR-152 (120 mines)</p>	<p>MINELAYING EQUIPMENT</p> <p>Operating Speed (km/h): Burying: 2 to 3 Surface Laying: 4 to 10 In Snow: INA</p> <p>Minelaying Rate (min): 10 to 12 Minelaying Pattern: Straight line Mine Spacing (m): 3 to 4 Mine Capacity: Prime-mover dependent Max Burial Depth (cm): 20</p> <p>VARIANTS</p> <p>PMZ-4: Lays controlled minefields; uses the same mines as the PMR-3 with the exception of the controllable minefield and cable-laying options; uses the UMP-2 Controlled AT Minefield Set</p>	

NOTES

The PMR-3, shown above, (and the similar PMZ-4) consists of a single chute and a plow attachment. Although both systems look similar at first glance, there are significant differences. Most notably, is the addition of a cable layer on the PMZ-4, used for the laying controlled minefields and the absence of the conveyer-belt chain drive on the wheels. Additionally, the PMZ-4 is more automated and must be hand loaded only. The towed-minelayers are used in sections of three or four and operate 20 to 40 meters apart with each minelayer laying a straight-line row. The mines in different rows are staggered with the distance between mines depending on whether the mines are pressure-initiated or full-width attack (influenced or tiltrod fuzed).

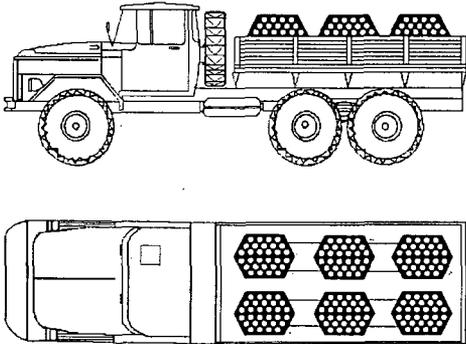
Russian Tracked Minelaying Vehicle GMZ-3

	<p style="text-align: center;">Mine Types</p> <p>Mines TM-57 w/fuze MVZ-57 TM-62 series w/fuzes TM-46 TMD-B MV4-62 MVP-62 & w/prox fuze MVN-80</p>	<p style="text-align: center;">Typical Combat Load</p> <p style="text-align: center;">208</p>
	<p>7.62-mm PKT MG</p>	<p style="text-align: center;">3,000</p>
<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: GMZ series-1963 Proliferation: Former Soviet Union</p> <p>Description: Crew: 3 (see NOTES) Chassis: Based on the SA-4 (GANEF) SAM Weight (mt): 28.5 Length (m): 8.62 Height (m): 2.7 Width (m): 3.25 Ground Clearance (mm): 470 Gradient (°): 30 Fording Depth (m): 1 Vertical Step (m): .7</p> <p>AUTOMOTIVE</p> <p>Engine: 4 cyl, 513 hp, multi-fuel diesel Cruising Range (km): 500 Speed (km/h): On Road: 60 Off Road: 30 Fuel Capacity (liters): INA Night Driving Equipment: Yes, TVNE-4B for the driver and K-3A for the vehicle commander (and PKT) Navigation Equipment: (see NOTES) Radio: R-123 NBC Protection System: Yes Smoke Screening System: VEES, plus 6 81-mm launchers, 3 on each side.</p>	<p>MINELAYING EQUIPMENT</p> <p>Operating Speed (km/h): Burying: 6 Surface Laying: 16 In Snow: 10 Minelaying Pattern: Straight line or staggered Mine Spacing (m): 5 and 10 Burial Depth (mm): Ground: 120 Snow: 500 Length of Single-row Minefield (m): Percussion Fuzes: 1,000 Proximity Fuzes: 2,000 Mine Capacity: 208 Mine Weight (kg): up to 12 Time Required to Load Minelayer with One Basic Mine Load (min) (7 men): 15 to 20 Men required to Load Minelayer with Mines: 7 (squad) Time Required to Load Minelayer with Crew Only (m): 60 Time from Travel to Operating Position (min): Automatic: Up to 2 Manual: Up to 8</p> <p>ARMAMENT</p> <p>Some GMZ may be armed with either the 12.7 or the 14.5 machineguns.</p> <p>Main Armament: Caliber, Type, Name: 7.62-mm PKT MG Mount Type: Cupola (GMZ-3) Max Effective Range (m): Day: 2,000 Night: INA Fire on Move: Yes Rate of Fire (rd/min): Practical: 250 Cyclic: 650</p> <p>VARIANTS</p> <p>GMZ: (shown above) GMZ-2: (see NOTES)</p>	

NOTES

The crew of the GMZ-3 consists of three people—the vehicle commander, driver-mechanic, and the minelayer operator. The commander and driver are located in the forward section while the operator compartment is located in the rear portion of the vehicle. The vehicle commander operates the 7.62-mm PKT machinegun. The GMZ-3 has a digital navigation system allowing precise topographic tie-in of the minefield being laid. The previous model minelayer (GMZ-2) was not designed for the employment of mines with proximity fuzes.

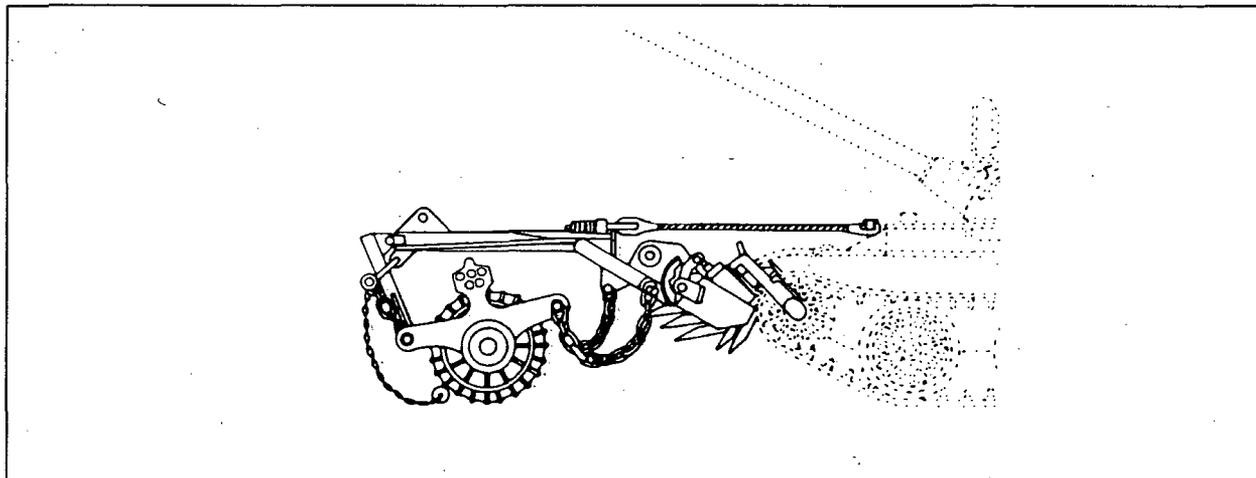
Russian Scatterable Minelaying System UMZ

	<p>Mine Types</p> <p>Mines PFM-1 PFM-1/S POM-1 (S) POM-2S PTM-1S (PGMDM) PTM-3</p>	<p>Typical Combat Load</p> <p>(varies with type of mine—see below)</p>
<p>SYSTEM</p> <p>Alternative Designations: Multipurpose Minelayer Date of Introduction: INA Proliferation: Former Soviet Union</p> <p>Description: Crew: 2 (driver and operator) Chassis: ZIL-131 Truck (see VARIANTS) Weight (mt): Without Mine Load: 8.3 With Mine Load: 10 Length (m): 7.1 Height (m): 2.5 Width (m): 3 Ground Clearance (mm): 330</p> <p>AUTOMOTIVE</p> <p>Engine: V8, 150 hp, gas Cooling: Water Cruising Range (km): 525 Speed (km/h): 80 Gradient (°): 30 Fording Depth (m): 1.4 Vertical Step (m): .53 Night Vision Equipment: Yes, PNV-57E Navigation Equipment: INA Radio: R-159</p>	<p>MINELAYING EQUIPMENT</p> <p>Operating Speed (km/h): 10 to 40 Distance Mines Launched from Vehicle (m): 30-60 Minefield (m): Length: 1,000 to 1,200 Depth: 30 to 120 Max Length of Minefield with One Basic Load (m): AP, PFM-1S: 3,200 AP, POM-2: 5,000 AT, PTM-3: 600 Length of Triple-Row Minefield (m): 150 to 1,500 depending on mine type Mine Capacity: From 180 to 11,520 depending on the type of mine Number of Mines in One Basic Load: AP, PFM-1S: 11,520 AP, POM-2: 720 AT, PTM-3: 180 Time Required to Load Minelayer (hr) (2 men): 1.5 to 2 Time from Travel to Operating Position (min): 5</p> <p>VARIANTS Although primarily mounted on the ZIL-131, the UMZ minelaying system has been observed mounted on several different carriers such as a modified MTLB-U chassis or on a PT-S tracked amphibious personnel carrier.</p>	

NOTES

While the UMZ, scatterable, mine system has been disclosed as the likely replacement for the GMZ-series, mechanical mineplanters, it probably will supplement the role formerly held by the GMZ. The UMZ consists of three launchers mounted on each side of the vehicle for a total of six mine launchers per vehicle. Each full turn launcher is hexagonally shaped and contains 30 launch tubes totaling 180. It can fire the mines to one or both sides, or to the rear. Both AP and AT mines are launched from the 140-mm launch tubes. The UMZ uses the same mine canisters as the PKM system. Depending on the position of the launch tubes, one-, two-, or three-lane mine fields can be laid.

Russian Tank-Mounted Mineclearing Roller-Plow KMT-5



SYSTEM	MINECLEARING EQUIPMENT
<p>Alternative Designations: INA Date of Introduction: 1960s Proliferation: At least 20 countries</p> <p>Description: Weight Total (kg): 7,500 Roller Section: 2,265 Plough: 420 Length (m): 3.2 Width (m): 4 Ditch Crossing (m): 2.5 System Components: Two plows (KMT-4) and two sets of three rollers</p>	<p>Type: Roller and plow Platform: Mounted on T-54, T-55, T-62, other medium tanks Form: 3 rollers x 2 Number of Rollers Per Set: 2 Total Number of Rollers: 6 Mine Removal Speed (km/h): 8-12 Cleared Lane Width, each (mm): 810 x 2 Mineclearing Track Width (mm): 810 Installation Time (min): 30 to 45</p>

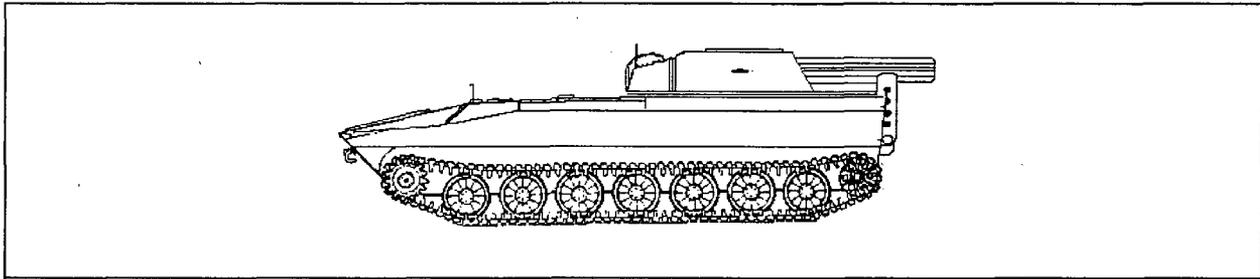
NOTES

The KMT-5M mine roller-plow is very flexible, since it allows for either the plows or the rollers to be used. The rollers function satisfactorily against mines equipped with simple pressure fuzes, but other mines will defeat this equipment. However, the roller-plow combination also allows the tank to counter more sophisticated fuzes with plows designed to uncover or push mines aside. The plows and rollers cannot work simultaneously.

The KMT-5M also includes a luminous lane-marking device for night operations. Because plows and rollers do not clear the area between them a "dogbone" or light chain with rollers is stretched between the roller sections to defeat tilt-rod mines. Quick disconnects allow the operator to drop either plows or rollers or both; otherwise, the crew can remove the system in 8 to 13 minutes. All current medium tanks have fittings for attaching mineclearing equipment.

There is one plow per tank platoon and one roller per company. For tanks newer than the T-55/62 the plows are no longer carried in the engineer company, but are permanently mounted on the tank. Therefore the engineers need only to transport the rollers. One KrAZ-255B truck (with KM-61 crane) or two ZIL-131 trucks can carry one KMT-5M.

Russian Tracked Mineclearing Vehicle MTK-2

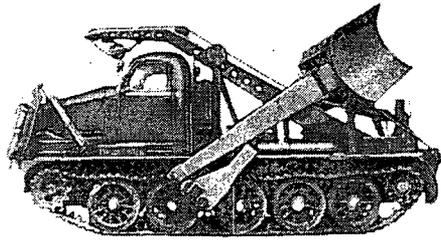


<p>SYSTEM</p> <p>Alternative Designations: UR-77 mineclearing vehicle, M1979 Date of Introduction: 1981 Proliferation: FSU and former Warsaw Pact armies</p> <p>Description: Crew: 2 (commander-operator, driver-mechanic) Chassis: Based on the 2S1 Weight (mt): 15.5 Length (m): 8.4 Height (m): 3.1 Width (m): 2.8 System Components: Vehicle and two mineclearing charges</p> <p>AUTOMOTIVE</p> <p>Cruising Range (km): 500 Speed (km/h): On Road: 60 Off Road: 30 Water: 5 NBC Protection System: Yes Smoke Screening System: No</p>	<p>MINECLEARING EQUIPMENT</p> <p>Type: Explosive line Charges Used: UZP-77, UZ-67 Length of Charge (m): 93 Length of Charge Feed (m): UZP-77: 200 and 500 UZ-67: 200 and 350 Size of Lane in AT Minefield (m): Width: Up to 6 Length (UZP-77): 80-90 Length (UZ-67): 75-80 Breaching Time (min): 3 to 5</p> <p>VARIANTS (INA)</p>
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NOTES

The MTK-2 clears lanes in minefields by using rocket propelled charges. The charges are launched onto the minefield and then detonated by the vehicle commander-operator from within the vehicle. The charge can be fired on land or in the water.

Russian Tracked Route-Clearing Vehicle BAT-M

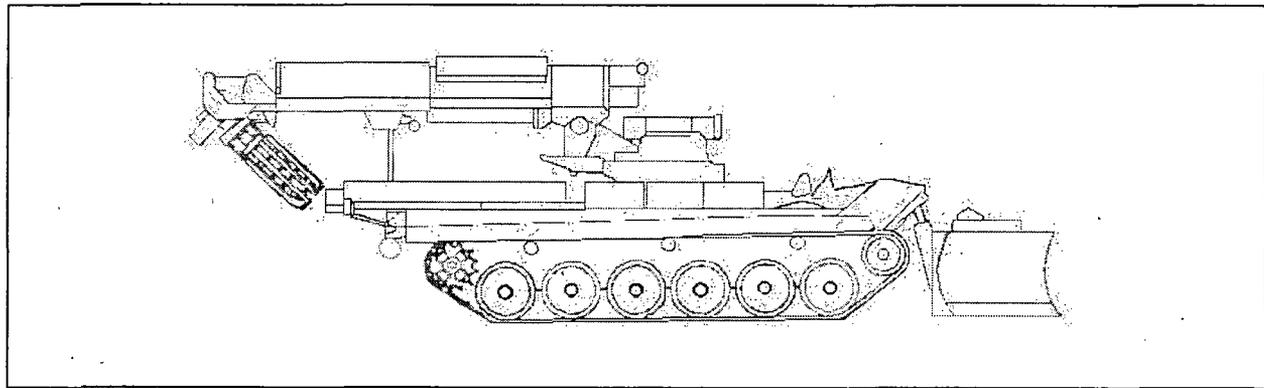


<p>SYSTEM</p> <p>Alternative Designations: Dozer Date of Introduction: 1967 Proliferation: Widespread</p> <p>Description: Crew: 2 Chassis: AT-T heavy tracked artillery tractor Weight (mt): 26 Length Overall (m): 10 Height Travel (m): 3.5 Width Overall (m): 4.7 Clearance (mm): 425 Gradient (°): 30 Trench Crossing (m): 1.57 Fording Depth (m): .7 Vertical Step (m): 1 Time from Travel to Operating Position (min): 5 to 7</p>	<p>AUTOMOTIVE</p> <p>Engine: V12, 415 hp, diesel Cruising Range (km): 500 Speed (km/h): 35 Navigation Equipment: No NBC Protection: Yes Radio: INA</p> <p>BLADE</p> <p>Width (m): 4.8 Blade Rate (m³/hr): 250 Operating Speed (km/h): 10</p> <p>ROTARY CRANE</p> <p>Capacity (mt): 2</p> <p>VARIANTS</p> <p>BAT BAT-2: Based on MT-T artillery tractor</p>
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NOTES

The BAT tractor dozer is a AT-T heavy tractor with a large dozer blade mounted at the front of the hull. It is designed for general engineer use, road and trail clearing and construction. The BAT-M is an improved model (over the BAT) and is electrohydraulic, whereas the BAT is electropneumatic. The BAT-M also has a hydraulic crane, and the dozer blade can be swung to the rear improving the vehicle's load distribution when in travelling mode.

Russian Obstacle Clearing Vehicle IMR-2M

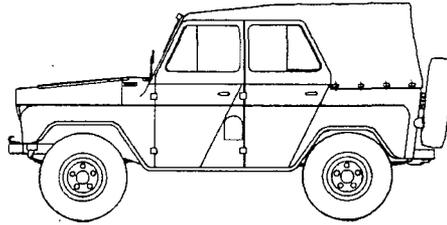


<p>SYSTEM Alternative Designations: N/A Date of Introduction: 1982 Proliferation: FSU and former Warsaw Pact armies</p> <p>Description: Crew: 2 Chassis: T-72A Weight (mt): 44.3 Length (traveling) (m): 9.55 Height (traveling) (m): 3.68 Width (traveling) (m): 3.73 Gradient (°): 25 Fording Depth (m): 1.2 System Components: Multipurpose dozer equipment, boom, treadway mine exploder</p> <p>AUTOMOTIVE</p> <p>Engine: 12 cyl, 840 hp, diesel Cruising Range (km): 500 Speed (km/h): 60 Night Driving Equipment: Yes Radio: R-173 radio, R-174 intercom NBC Protection System: Yes Smoke Screening System: INA</p>	<p>BLADE Can be used as a dozer, grader and V-blade, vertical plane skew ability.</p> <p>Operating Speed (bulldozer) (km/h): 8-12 Earth Displacement (m³/hr): 300 Lane Clearing Rate (km): .35</p> <p>ALL-PURPOSE TOOL:</p> <p>Trench Digging (1.1 to 1.3m deep)(m³/hr): 8-10 Pit Digging (up to 2.5m deep) (m³/hr): 12-16</p> <p>BOOM</p> <p>Capacity (mt): 2 Reach (m): 8.4</p> <p>MINE SWEEPING SPEED (km):</p> <p>AT pressure mines: 6-15 Tilt Rod mines: 7</p> <p>VARIANTS</p> <p>IMR: The IMR is a NBC-protected, combat engineer vehicle based on the T-54/55 tank chassis. It is fitted with an articulating dozer blade and a telescoping crane that fits a number of attachments. IMR-2: Equipped with mine sweepers and mine-clearing extended charges. Line drawing is of IMR-2.</p>
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NOTES

The IMR-2M differs from the IMR-2 in that the IMR-2M has no line-launched mineclearing charge. The IMR-2M has more armor, hydraulic equipment and a scraper-ripper.

Russian 0.6 mt 4 x 4 Utility Truck UAZ-469



SYSTEM

Alternative Designations: INA
Date of Introduction: 1973
Proliferation: Widespread

Description:

Troop Capacity: 2 in front, 5 in rear
 Weight (mt):
 Gross Vehicle Weight: 2.4
 Curb: 1.6
 Length Overall (m): 4
 Height Overall (m): 2
 Width Overall (m): 1.8
 Payload on/off Highway (kg): 600
 Number of Axles: 2
 Ground Clearance (mm): 300
 Turning Radius (m): 6.5
 Wheels:
 Size (in): 8.40x15
 Central Tire Pressure Regulation System: No
 Run Flat: No

AUTOMOTIVE

Engine: Inline 4, 70 hp, gasoline
Cooling: Water
Cruising Range (road) (km): 730
Speed (km/h): 100
Fuel Capacity (liters):
 Left Tank: 39
 Right Tank: 39
Towing Capability (kg):
 Off Highway: 850
 On Highway: 850
Gradient (loaded) (°): 60
Fording Depths (m): .58
Trench Crossing Width (mm): INA

CARGO SPACE

Height (mm): 400
Width (mm): 1,400
Length (mm): 1,000
Cargo Bed Area (m²): 1.6

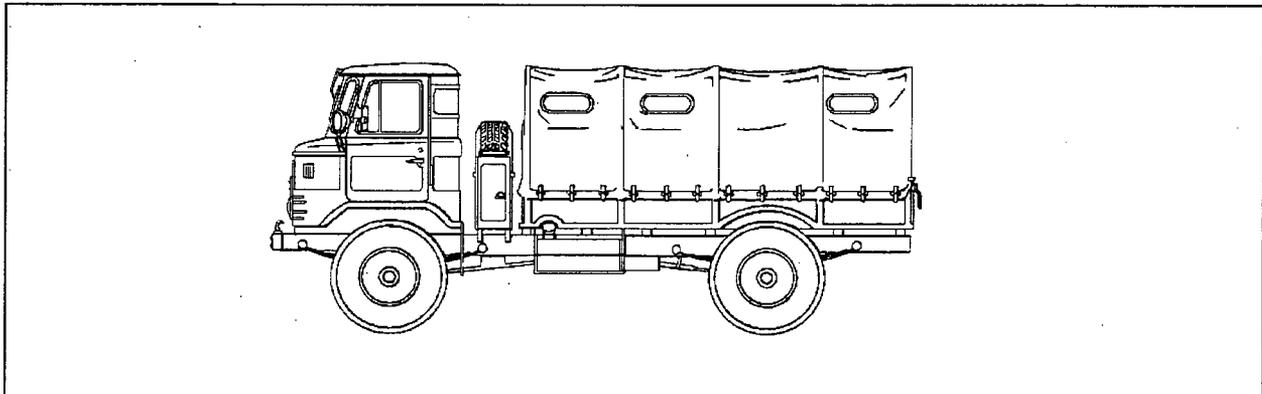
VARIANTS

UAZ-469B: Export; lower off-road performance
Ambulance: 1 stretcher patient and 1 attendant

NOTES

The UAZ-469 replaces the earlier UAZ-69.

Russian 2 mt 4 x 4 Cargo Truck GAZ-66

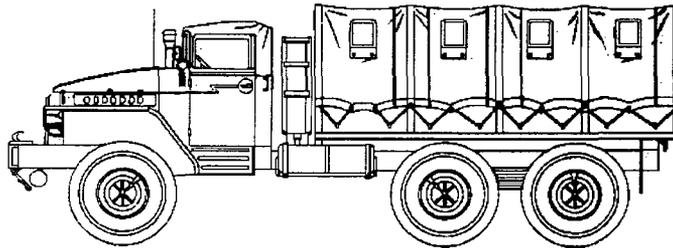


<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: 1964 Proliferation: Widespread</p> <p>Description: Troop Capacity: 3 in cab, 18 in rear Weight (mt): Gross Vehicle Weight: 5.8 Curb: 3.6 Length Overall (m): 5.65 Height Overall (m): 2.44 Width Overall (m): 2.32 Payload on/off Highway (kg): 2,000 Number of Axles: 2 Ground Clearance (mm): 315 Turning Radius (m): 10 Wheels: Size (in): 12x18 Central Tire Pressure Regulation System: Yes</p>	<p>AUTOMOTIVE</p> <p>Engine: V8, 115 hp, gasoline Cooling: Water Cruising Range (road) (km): 875 Speed (km/h): 95 Fuel Capacity (liters): Left Tank: 105 Right Tank: 105 Towing Capability (kg): Off Highway: 2,000 On Highway: 2,000 Gradient (loaded) (°): 39 Fording Depths (m): .8</p> <p>CARGO SPACE</p> <p>Height (mm): 890 Width (mm): 2,050 Length (mm): 3,330 Cargo Bed Area (m²): 6.8</p> <p>VARIANTS</p> <p>GAZ-66B: Canvas-top cab for air transport or airdrop GAZ-66A: Steelcab Numerous other variants for various duties.</p>
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NOTES

Besides functioning as a general cargo carrier, the GAZ-66 is used as a prime mover for 120-mm mortar. The DDA-66 variant is an NBC decontamination truck.

Russian 4.5 mt 6 x 6 Cargo Truck Ural-375D



SYSTEM

Alternative Designations: INA

Date of Introduction: 1965

Proliferation: Widespread

Description:

Troop Capacity: 3 in cab, 24 in rear

Weight (mt):

Gross Vehicle Weight: 13.2

Curb: 8.4

Length Overall (m): 7.36

Height Overall (m): 2.68

Width Overall (m): 2.67

Number of Axles: 3

Ground Clearance (mm): 410

Turning Radius (m): 10.8

Side Slope (°): 32

Vertical Step (mm): 800

Gradient (loaded) (°): 65

Fording Depths (m): 1.49

Trench Crossing Width (mm): 875

Wheels:

Size (in): 14x20

Central Tire Pressure Regulation System: Yes

Run Flat: INA

AUTOMOTIVE

Engine: V8, 180 hp, gasoline

Cooling: Liquid

Cruising Range (road) (km): 650

Speed (km/h): 75

Fuel Capacity (liters):

Main Tank: 300

Aux Tank: 60

Towing Capability (kg):

Off Highway: 5,000

On Highway: 10,000

CARGO SPACE

Height (mm): 872

Width (m): 2.43

Length (m): 3.9

Cargo Bed Area (m²): 9.5

VARIANTS

URAL-375: Observation hatch and unimproved powertrain

URAL-375E: Decontamination vehicle

URAL-375N: 2,000 kg additional payload

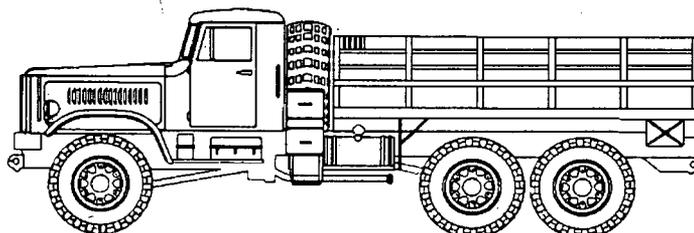
URAL-375S: Truck-tractor

URAL-375T: Equipped with winch

NOTES

Besides functioning as a general cargo carrier, the Ural-375D is used as a prime mover for light and medium artillery. The Ural-375 chassis also serves as a base for the BM-21 MRL, POL tankers, vans, and cranes. The Ural-4320 began to replace the Ural-375D around 1978.

Russian 7.5 mt 6 x 6 Cargo Truck KrAZ-255B



SYSTEM

Alternative Designations: INA

Date of Introduction: 1967

Proliferation: Widespread

Description:

Troop Capacity: 3 in cab, 16 in rear

Weight (mt):

Gross Vehicle Weight: 19.7

Curb: 12

Length Overall (m): 8.64

Height Overall (m): 2.94

Width Overall (m): 2.75

Payload (kg): 7,500

Number of Axles: 3

Ground Clearance (mm): 360

Turning Radius (m): 14

Wheels:

Size (in): 20x21

Central Tire Pressure Regulation System: Yes

Run Flat: INA

AUTOMOTIVE

Engine: V8, 265 hp, diesel

Cooling: Water

Cruising Range (road) (km): 850

Speed (km/h): 70

Fuel Capacity (liters):

Right Tank: 165

Left Tank: 165

Towing Capability (kg):

Off Highway: 10,000

On Highway: 50,000

Gradient (loaded) (°): 30

Fording Depths (m): 1

CARGO SPACE

Length (m): 4.56

Width (m): 2.5

Height (m): .92

Cargo Bed Area (m²): INA

VARIANTS

KrAZ-258: Tractor-truck

Numerous other variants for various duties.

NOTES

Primarily designed as a cargo truck, the KrAZ-255B is also used as a prime mover for various equipment including a tank-transporter trailer and PMP pontoon bridge.

Chapter 9 Rotary-Wing Aircraft

This chapter provides the basic characteristics of selected rotary-wing aircraft readily available to the OPFOR. Both FM 100-60, *Armor- and Mechanized-Based Opposing Force: Organization Guide* and FM 100-63, *Infantry-Based Opposing Force: Organization Guide*, use generic descriptors to indicate helicopter capabilities. This enables the trainer to structure OPFOR air support requirements by capability rather than specific equipment type. *Rotary-Wing Aircraft*, cover systems classified as light, attack, utility, and heavy aircraft systems. Some multi-role aircraft will be able to support missions across each of the categories. Therefore, they are listed in each of the above categories by their initial design, and their planned application. This chapter encompasses many aircraft which may have a dual civil/military history. It does not include however, aircraft designed and used primarily for civil aviation.

This initial sampling of systems was selected because of their wide proliferation across numerous countries or because of their already extensive use in training scenarios. Additional data sheets addressing other widely proliferated helicopter systems will be sent with further supplements to this guide.

Because of the increasingly large numbers of variants of each aircraft, only the most common variants produced in significant numbers were addressed. If older versions of helicopters have been upgraded in significant quantities to the standards of newer variants, the older versions were not addressed.

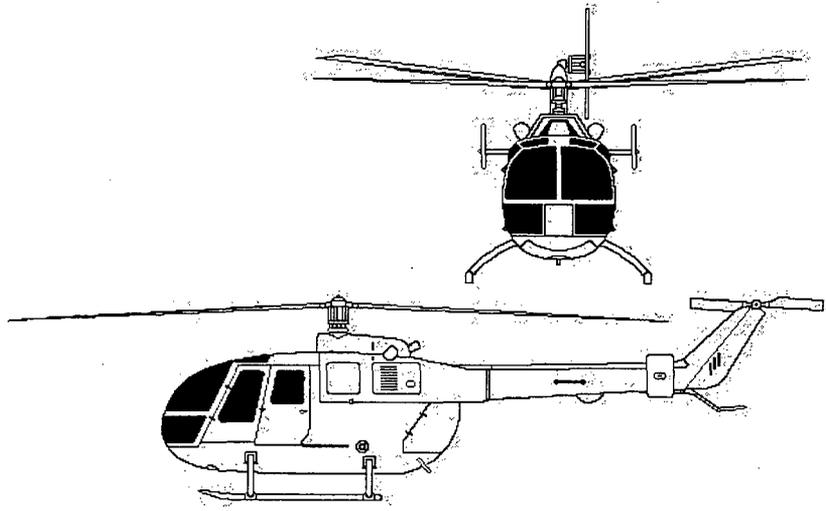
The munitions available to each aircraft are mentioned, but not all may be employed at the same time. The weapon systems inherent to the airframe are listed under armament. The most probable weapon loading options are also given, but assigned mission dictates actual weapon configuration. Therefore, any combination of the available munitions may be encountered.

Chapter 10, *Fixed-Wing Aircraft*, will be constructed with future supplements to this guide. It will provide the basic characteristics of selected fixed-wing aircraft readily available to the OPFOR. It will initially focus on the aircraft commonly employed by the OPFOR when in close proximity to enemy ground forces. Sample aircraft included will be categorized by the missions of reconnaissance, interdiction, strike, direct air support, and transport.

Questions and comments on data listed in this chapter should be addressed to:

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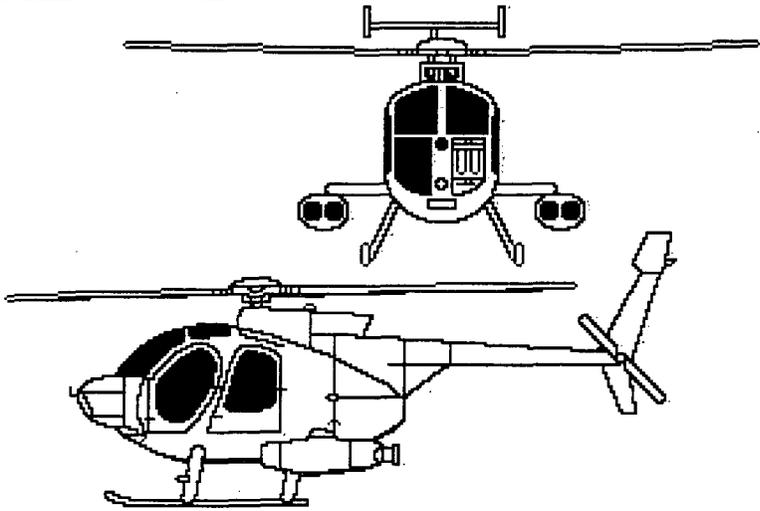
European Light Helicopter BO-105

		Weapon & Ammunition Types	Combat Load
		Other Loading Options 7.62-mm or 12.7-mm MG pods 2.75-in rocket pods (7 or 12 ea.) 68-mm SNEB rocket pods (12ea) 50-mm SNIA rockets (28 ea.) TOW ATGM pods (4 ea.) HOT ATGM AS-12 ASM pods (2 ea.) Stinger AAM pod (4 ea.)	2 2 2 2 6 2 1
SYSTEM Alternative Designations: INA Date of Introduction: 1972 Proliferation: At least 40 countries Description: Variants in “()” Crew: 1 or 2 (pilots) Blades: Main rotor: 4 Tail rotor: 2 Engines: 2x 420-shp Allison 250-C20B turboshaft Weight (kg): Maximum Gross: 2,500 Normal Takeoff: 2,000 Empty: 1,301, 1,913 (PAH1) Speed (km/h): Maximum (level): 242 Cruise: 205 Ceiling (m): Service: 3,050 Hover (out of ground effect): 457 Hover (in ground effect): 1,525 Vertical Climb Rate (m/s): 7.5 Fuel (liters): Internal: 570 Internal Aux Tank: 200 ea. (max 2x) Range (km): Normal Load: 555 With Aux Fuel: 961 Dimensions (m): Length (rotors turning): 11.9 Length (fuselage): 8.8 Width: 2.5	Dimensions continued (m): Height: 3.0 Main Rotor Diameter: 9.8 Tail Rotor Diameter: 1.9 Cargo Compartment Dimensions (m): Floor Length: 1.9 Width: 1.4 Height: 1.3 Standard Payload (kg): Internal load: 690 External on sling only: 1,200 Transports 3 troops or 2 litters, or cargo. Survivability/Countermeasures: Main and tail rotors electrically deiced. Infrared signature suppressors can be mounted on engine exhausts. Rotor brake. ARMAMENT Most Probable Armament: BO-105P/PAH1: Outriggers carry 6x HOT antitank missiles, or rocket pods. CASA BO-105/ATH: The Spanish produced variant rigidly mounts 1x Rh 202 20-mm cannon under the fuselage. AVIONICS/SENSOR/OPTICS The BO-105P has a roof-mounted direct-view, daylight-only sight to allow firing of HOT ATGMs. Options exist to fit a thermal imaging system for night operations, and a laser designator.	Night/Weather Capabilities: Available avionics include weather radar, Doppler and GPS navigation, and an autopilot. It is capable of operation in day, night, and instrument meteorological conditions. VARIANTS The BO 105 was developed initially by Messerschmitt-Bolkow-Blohm in Germany. Others are built in Chile, the Philippines, Indonesia (NBO-105), and Spain (CASA BO-105/ATH). BO-105CB: The standard production variant. BO-105CBS: VIP version with a slightly longer fuselage to accommodate 6 passengers, some used in a SAR role. BO-105LS: Upgraded to 2x 550-shp Allison 250-C28 turboshaft engines for extended capabilities in high altitudes and temperatures. Produced only in Canada. BO-105M/VBH: Standard reconnaissance version. BO-105P/PAH1: Standard antitank version.	

NOTES

Available munitions are shown above; not all will be employed at the same time, mission dictates weapons configuration. External stores are mounted on weapons “outriggers” or racks on each side of the fuselage. Each rack has one hardpoint. This helicopter is produced by the Eurocopter Company. It was formed as a joint venture between Aerospatiale of France, and Daimler-Benz Aerospace of Germany. Other missions include: direct air support, antitank, reconnaissance, search and rescue, and transport. Clamshell doors at rear of cabin area open to access cargo area. Cargo floor has tiedown rings throughout.

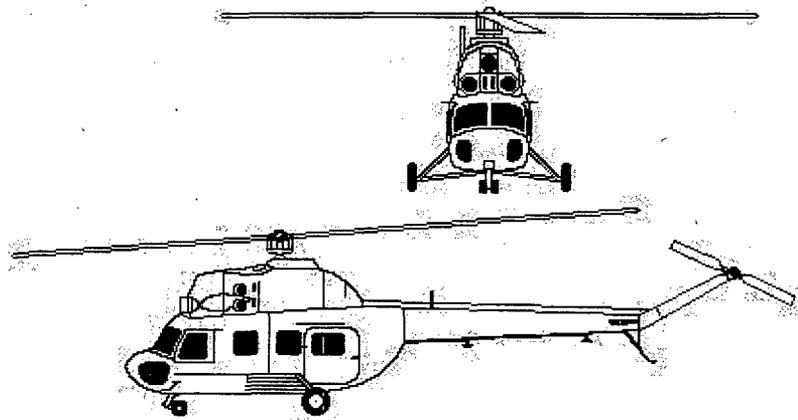
United States Light Helicopter MD-500/Defender

	<p>Weapon & Ammunition Types</p> <p>Other Loading Options</p> <p>M134 7.62-mm 6x barrel, Gatling type twin MG pods</p> <p>M260 2.75-in Hydra 70 rocket pods (7 or 12 each)</p> <p>.50 cal MG pods</p> <p>M75 40-mm grenade launchers</p> <p>MK19 40-mm grenade launcher</p> <p>TOW missile pods (2 each)</p> <p>Hellfire ATGM</p> <p>Stinger AAM</p>	<p>Combat Load</p> <p>2000</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p>
	<p>SYSTEM</p> <p>Alternative Designations: Hughes model 369, Cayuse, Loach</p> <p>Date of Introduction: 1977 (MD-500 MD)</p> <p>Proliferation: At least 22 countries</p> <p>Description: Variants in “()”</p> <p>Crew: 1 or 2 (pilots)</p> <p>Blades:</p> <p> Main rotor: 4 or 5 (see VARIANTS)</p> <p> Tail rotor: 2 or 4 (see VARIANTS)</p> <p>Engines: (see VARIANTS)</p> <p>Weight (kg):</p> <p> Maximum Gross: 1,361 (500), 1,610 (530)</p> <p> Normal Takeoff: 1,090</p> <p> Empty: 896</p> <p>Speed (km/h):</p> <p> Maximum (level): 241 (500), 282 (530)</p> <p> Cruise: 221 (500), 250 (530)</p> <p>Ceiling (m):</p> <p> Service: 4,635 (500), 4,875 (530)</p> <p> Hover (out of ground effect): 1,830 (500), 3,660 (530)</p> <p> Hover (in ground effect): 2,590 (500), 4,360 (530)</p> <p>Vertical Climb Rate (m/s): 8.4 (500), 10.5 (530)</p> <p>Fuel (liters):</p> <p> Internal: 240</p> <p> Internal Aux Tank: 80</p> <p>Range (km):</p> <p> Normal Load (est.): 485 (500), 430 (530)</p> <p>Dimensions (m):</p> <p> Length (rotors turning): 9.4 (500), 9.8 (530)</p> <p> Length (fuselage): 7.6 (500), 7.3 (530)</p> <p> Width: 1.9</p> <p> Height: 2.6 (500), 3.4 (530 over mast-mounted sight)</p>	<p>Dimensions continued (m):</p> <p> Main Rotor Diameter: 8.0 (500), 8.3 (530)</p> <p> Tail Rotor Diameter: 1.4</p> <p>Cargo Compartment Dimensions (m):</p> <p> Floor Length: 2.4</p> <p> Width: 1.3</p> <p> Height: 1.5</p> <p>Standard Payload (kg):</p> <p> Internal load: INA</p> <p> External load: 550</p> <p> Transports 2 or 3 troops or cargo internally, or 6 on external platforms in lieu of weapons.</p> <p>Survivability/Countermeasures:</p> <p>Some models have radar warning receivers. Chaff and flare systems available. Infrared signature suppressors can be mounted on engine exhausts.</p> <p>ARMAMENT</p> <p>Most Probable Armament: (MD-500D pictured)</p> <p>MD-500MD/Scout Defender: Fitted with guns, rockets, grenade launchers, or a combination on 2x fuselage hardpoints.</p> <p>MD-500MD/TOW Defender: Twin TOW missile pods on 2x fuselage hardpoints; mounts missile sight in lower-left front windshield.</p> <p>AVIONICS/SENSOR/OPTICS</p> <p>The MD-500 allows for the mounting of a stabilized, direct-view optical sight in the windshield. Options exist to fit a mast-mounted, multiple field of view optical sight, a target tracker, a laser rangefinder, thermal imager, a 16x FLIR for night navigation and targeting, and autopilot.</p>

NOTES

Available munitions are shown above; not all will be employed at the same time, mission dictates weapons configuration. External stores are mounted on weapons racks on each side of the fuselage. Each rack has one hardpoint. Other missions include: direct air support, antitank, reconnaissance, observation, and light utility.

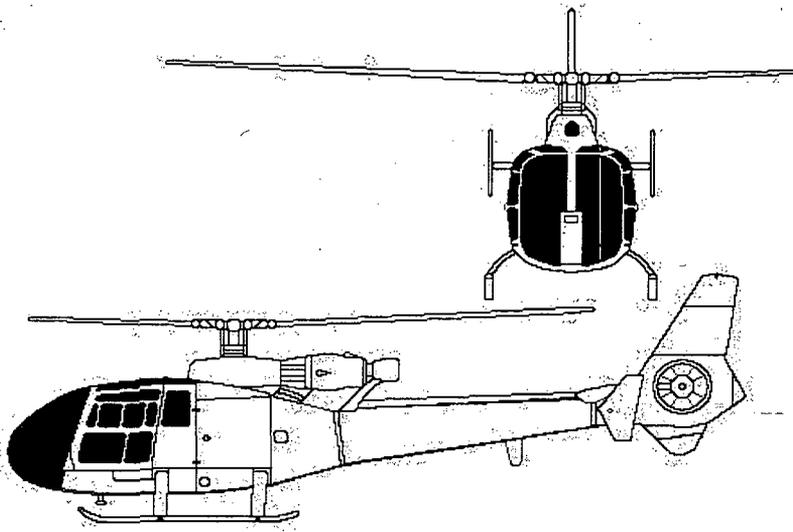
Russian Light Helicopter Mi-2/HOPLITE

		<table border="1"> <thead> <tr> <th>Weapon & Ammunition Types</th> <th>Combat Load</th> </tr> </thead> <tbody> <tr> <td>1x 23-mm automatic cannon</td> <td></td> </tr> <tr> <td>1x 7.62-mm or 12.7-mm MG</td> <td></td> </tr> <tr> <td colspan="2">Other Loading Options:</td> </tr> <tr> <td>AT-3c/SAGGER ATGM</td> <td>4</td> </tr> <tr> <td>57-mm Rocket pods (16 each)</td> <td>2</td> </tr> <tr> <td>Twin or single fixed 7.62-mm or 12.7-mm MG</td> <td></td> </tr> <tr> <td>External fuel tanks (liters)</td> <td>238</td> </tr> <tr> <td>SA-7b/GRAIL missile</td> <td>4</td> </tr> </tbody> </table>	Weapon & Ammunition Types	Combat Load	1x 23-mm automatic cannon		1x 7.62-mm or 12.7-mm MG		Other Loading Options:		AT-3c/SAGGER ATGM	4	57-mm Rocket pods (16 each)	2	Twin or single fixed 7.62-mm or 12.7-mm MG		External fuel tanks (liters)	238	SA-7b/GRAIL missile	4
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<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: 1965 Proliferation: Widespread</p> <p>Description: Crew: 1 (pilot) Blades: Main rotor: 3 Tail rotor: 2 Engines: 2x 400-shp PZL GTD-350 (series III and IV) turboshaft Weight (kg): Maximum Gross: 3,700 Normal Takeoff: 3,550 Empty: 2,372 Speed (km/h): Maximum (level): 220 Cruise: 194 Ceiling (m): Service: 4,000 Hover (out of ground effect): 1,000 Hover (in ground effect): 2,000 Vertical Climb Rate (m/s): 4.5 Fuel (liters): Internal: 600 Internal Aux Tank: N/A External Fuel Tank: 238 ea. Range (km): Maximum Load: 580 Normal Load: 340 With Aux Fuel: 790</p>	<p>Dimensions (m): Length (rotors turning): 17.4 Length (fuselage): 11.9 Width: 3.2 Height: 3.7 Main Rotor Diameter: 14.6 Tail Rotor Diameter: 2.7 Standard Payload: Transports 6-8 troops or 700 kg internal cargo or 800 kg external load on 4x external hardpoints.</p> <p>Survivability/Countermeasures: Main and tail rotor blades electrically deiced.</p> <p>ARMAMENT 23-mm Automatic Cannon, NS-23KM: Range: (practical) 2,500 m Elevation/Traverse: None (rigidly-mounted) Ammo type: HEFI, HEI, APT, APE, CC Rate of Fire (rpm): (practical) 550</p> <p>7.62-mm or Pintle-mounted Machinegun: (may be mounted in left-side cabin door) Range: (practical) 1,000 m Ammo type: HEFI, HEI, APT, APE, CC Rate of Fire (rpm): (practical) 250</p> <p style="text-align: center;">OR</p> <p>12.7-mm or Pintle-mounted Machinegun: (may be mounted in left-side cabin door) Range: (practical) 1,500 m Ammo type: API, API-T, IT, HEI Rate of Fire (rpm): (practical) 100</p>	<p>AVIONICS/SENSOR/OPTICS</p> <p>The cannon is pilot sighted, and fire is adjusted by controlling the attitude of the aircraft.</p> <p>Night/Weather Capabilities: The Mi-2 is primarily a daylight only aircraft.</p> <p>VARIANTS</p> <p>Mi-2R: Ambulance version that carries 4x litter patients.</p> <p>Mi-2T: Transport version that carries 8 personnel.</p> <p>Mi-2URN: Armed reconnaissance variant, employs 57-mm unguided rockets, and mounts a gunsight in the cockpit for aiming all weapons.</p> <p>Mi-2URP: The antitank variant. Carries 4x AT-3 Sagger wire-guided missiles on external weapons racks, and 4x additional missiles in the cargo compartment.</p> <p>Mi-2US: The gunship variant, employs an airframe modification that mounted a 23-mm NS-23KM cannon to the portside fuselage. Also employs 2x 7.62-mm gun pods on external racks, and 2x 7.62-mm pintle-mounted machineguns in the cabin.</p> <p>PZL Swidnik: A Polish-produced variant under license from Russia. Same performance, characteristics, and missions.</p>																		

NOTES

Available munitions are shown above; not all will be employed at the same time, mission dictates weapons configuration. External stores are mounted on weapons racks on each side of the fuselage. Each rack has two hardpoints for a total of four stations. Additional missions include; direct air support, antitank, armed reconnaissance, transport, medevac, airborne command post, smoke generating, minelaying, and training. The cabin door is hinged rather than sliding, which may limit operations. There is no armor protection for the cockpit or cabin. Ammo storage is in the aircraft cabin, so combat load varies by mission. Some Mi-2USs currently employ fuselage-mounted weapon racks rather than the 23-mm fuselage-mounted cannon which is removed. Some variants however, still employ the cannon.

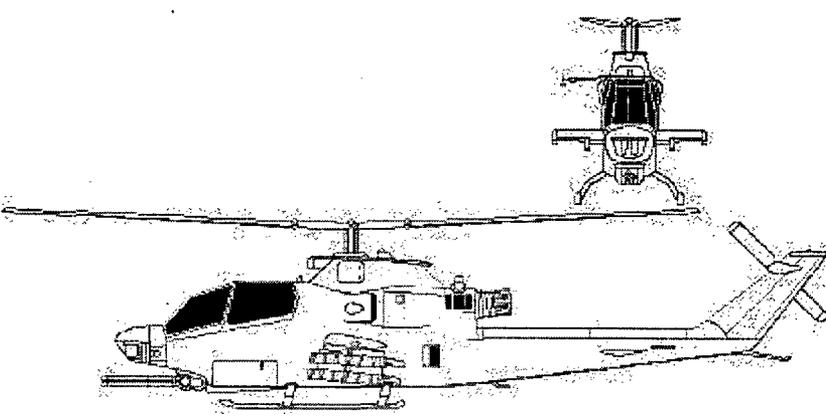
French Light Helicopter SA-341/GAZELLE

		<p>Weapon & Armament Types</p> <p>7.62-mm MG or</p> <p>20-mm GIAT M.621 cannon or</p> <p>2x 7.62-mm AA-52 FN MG pods</p> <p>Other Loading Options</p> <p>2.75-in rocket pods (7 ea.)</p> <p>68-mm SNEB rocket pods (12 ea)</p> <p>57-mm rockets (18 ea.)</p> <p>HOT ATGM</p> <p>AT-3 SAGGER ATGM</p> <p>AS-11 ASM, or AS-12 ASM</p> <p>SA-7 GRAIL AAM</p> <p>MISTRAL AAM</p>	<p>Combat Load:</p> <p>100</p> <p>1,000</p> <p>2</p> <p>2</p> <p>2</p> <p>4-6</p> <p>4</p> <p>4 or 2</p> <p>2</p> <p>2</p>
		<p>SYSTEM</p> <p>Alternative Designations: SA-342</p> <p>Date of Introduction: 1973</p> <p>Proliferation: At least 23 countries</p> <p>Description: Variants in “()”</p> <p>Crew: 1 or 2 (pilots)</p> <p>Blades:</p> <p>Main rotor: 3</p> <p>Tail rotor: 13 (fenestron enclosed in tail)</p> <p>Engines: 1x 590-shp Turbomeca Astazou IIIB turboshaft</p> <p>Weight (kg):</p> <p>Maximum Gross: 1,800 (SA 341), 1,900 (SA 342K), 2,000 (SA 342L/M)</p> <p>Normal Takeoff: 1,800</p> <p>Empty: 998</p> <p>Speed (km/h):</p> <p>Maximum (level): 310</p> <p>Cruise: 270</p> <p>Ceiling (m):</p> <p>Service: 4,100 (SA 341), 5,000 (SA 342)</p> <p>Hover (out of ground effect): 2,000 (SA 341), 2,370 (SA 342)</p> <p>Hover (in ground effect): 2,850 (SA 341), 3,040 (SA 342)</p> <p>Vertical Climb Rate (m/s): 12.2</p> <p>Fuel (liters):</p> <p>Internal: 445</p> <p>Internal Aux Tank: 90</p> <p>Additional Internal Aux Tank: 200</p> <p>Range (km):</p> <p>Normal Load: 670 (SA 341), 735 (SA 342)</p>	
<p>Dimensions (m):</p> <p>Length (rotors turning): 11.9</p> <p>Length (fuselage): 9.5</p> <p>Width: 2.0</p> <p>Height: 3.1</p> <p>Main Rotor Diameter: 10.5</p> <p>Tail Rotor Diameter: 0.7</p> <p>Cargo Compartment Dimensions (m):</p> <p>Floor Length: 2.2</p> <p>Width: 1.3</p> <p>Height: 1.2</p> <p>Standard Payload (kg):</p> <p>Internal load: 750</p> <p>External on sling only: 700</p> <p>Transports 3 troops or 1 litter, or cargo.</p> <p>Survivability/Countermeasures:</p> <p>IR signature suppressor on engine exhaust.</p> <p>ARMAMENT</p> <p>Most Probable Armament:</p> <p>SA 341F: A GIAT M.621 20-mm cannon is installed on starboard side of some aircraft. Rate of fire is selectable at 300 or 740 rpm.</p> <p>SA 341H: Can carry 4x AT-3 ATGMs, and 2x SA-7, or 128-mm or 57-mm rockets, and 7.62-mm machinegun in cabin.</p> <p>SA 342K: Armed antitank version with 4-6x HOT ATGMs.</p> <p>SA 342L: Either rocket pods or machineguns.</p> <p>SA 342M: Armed with 4-6x HOT antitank missiles, and possibly fitted with Mistral air to air missiles.</p>		<p>AVIONICS/SENSOR/OPTICS</p> <p>The SA 342M has a roof-mounted stabilized direct view/infrared/laser sight to allow night firing of HOT ATGMs.</p> <p>Night/Weather Capabilities:</p> <p>The aircraft is NVG compatible; and by its instruments, avionics, autopilot, and nav computer, is capable of flight in day, night, and instrument meteorological conditions.</p> <p>VARIANTS</p> <p>SA 341 Gazelle: Developed by Aerospatiale in France. Others were built in the UK by Westland, and in Yugoslavia.</p> <p>SA 341B/C/D/E: Production versions for the British military. Used in training and communications roles.</p> <p>SA 341F: Production version for the French Army. Upgraded engine to Astazou IIIC.</p> <p>SA 341H: Export variant.</p> <p>SA 342K: Armed SA 341F with upgraded 870-shp Astazou XIVH engine, mostly exported to the Middle East.</p> <p>SA 342L: Export light attack variant with Astazou XIVM engine.</p> <p>SA 342M: Improved ground attack variant for the French Army. Similar to SA 342L, but with improved instrument panel, engine exhaust baffles to reduce IR signature, navigational systems, Doppler radar, and other night flying equipment.</p>	

NOTES

Available munitions are shown above; not all will be employed at the same time, mission dictates weapons configuration. External stores are mounted on weapons “outriggers” or racks on each side of the fuselage. Each rack has one hardpoint. Other missions include: attack, antitank, antihelicopter, reconnaissance, utility, transport, and training. The bench seat in the cabin area can be folded down to leave a completely open cargo area. Cargo floor has tiedown rings throughout.

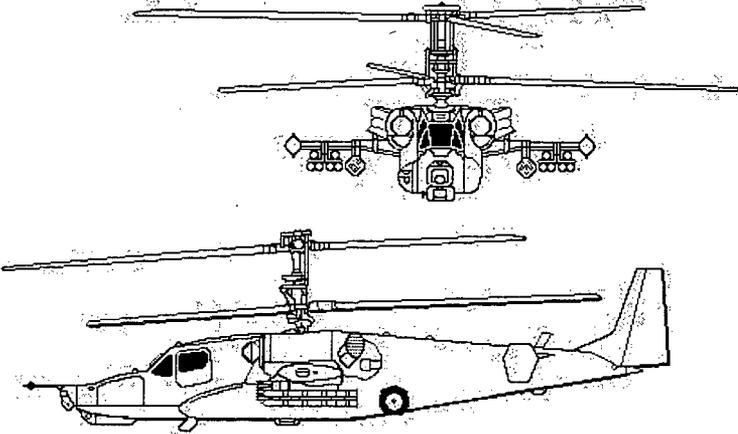
United States Attack Helicopter AH-1F/COBRA

		<table border="1"> <thead> <tr> <th style="text-align: left;">Weapon & Ammunition Types</th> <th style="text-align: left;">Combat Load</th> </tr> </thead> <tbody> <tr> <td>20-mm 3x barrel Gatling gun</td> <td>750</td> </tr> <tr> <td colspan="2">Other Loading Options</td> </tr> <tr> <td>TOW missile pods (4 each)</td> <td>0-2</td> </tr> <tr> <td>2.75-in Hydra 70 rocket pods (19 each)</td> <td>2-4</td> </tr> <tr> <td>7.62-mm 6x barrel rotary MG pods</td> <td>0-2</td> </tr> </tbody> </table>	Weapon & Ammunition Types	Combat Load	20-mm 3x barrel Gatling gun	750	Other Loading Options		TOW missile pods (4 each)	0-2	2.75-in Hydra 70 rocket pods (19 each)	2-4	7.62-mm 6x barrel rotary MG pods	0-2
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<p>SYSTEM</p> <p>Alternative Designations: Hueycobra, Bell 209</p> <p>Date of Introduction: 1986 (AH-1S)</p> <p>Proliferation: At least 11 countries</p> <p>Description: Crew: 2 (pilots in tandem seats) Blades: Main rotor: 2 Tail rotor: 2 Engines: 1x 1,800-shp AlliedSignal Engines T-53-L-703 turboshaft Weight (kg): Maximum Gross: 4,535 Normal Takeoff: 4,524 Empty: 2,993 Speed (km/h): Maximum (level): 315 Cruise: 227 Max "G" Force: INA Ceiling (m): Service: 3,720 Hover (out of ground effect): INA Hover (in ground effect): 3,720 Vertical Climb Rate (m/s): 8.5 Internal Fuel (liters): 991 Range (km): Normal Load: 610 With Aux Fuel: N/A Dimensions (m): Length (rotors turning): 16.3 Length (fuselage): 13.6 Width (including wing): 3.2 Height: 4.1 Main Rotor Diameter: 13.4 Tail Rotor Diameter: 2.6 Cargo Compartment Dimensions: negligible Standard Payload (kg): 1,544</p>	<p>Survivability/Countermeasures: Infrared signature suppressors mounted on engine exhaust. Radar warning receivers, IFF, Infrared jammer, chaff and flares. Armored cockpit.</p> <p>ARMAMENT The chin-mounted turret accepts Gatling-type guns ranging from 7.62-mm to 30-mm. Some aircraft have been modified to accept Stinger missiles (air-to-air Stinger or ATAS).</p> <p>20-mm 3x barrel Gatling gun, M197: Range: (practical) 1,500 m Elevation: 21° up to 50° down Traverse: 220° Ammo Type: AP, HE Rate of Fire: burst 16±4, continuous 730±50</p> <p>Most Probable Armament: AH-1G: Either 2x 7.62-mm miniguns with 4,000 rounds or 2x 40-mm grenade launchers with 300 rounds (one each is possible) in chin turret. Also on underwing hardpoints, 2.75-in. FFAR, minigun pods, or 20-mm automatic cannons. AH-1S: M197, 3x barrel 20-mm Gatling gun in chin turret. Also on underwing hardpoints, 8x BMG71 TOW antitank missiles, and 2x 2.75-in FFAR rocket pods.</p> <p>AVIONICS/SENSOR/OPTICS The TOW missile targeting system uses a telescopic sight unit (traverse 110°, elevation -60°/+30°), a laser augmented tracking capability, thermal sights and a FLIR to allow for acquisition, launch, and tracking of all types of TOW missiles in all weather conditions.</p>	<p>The Cobra also uses a digital ballistic computer, a HUD, Doppler nav, and a low speed air data sensor on the starboard side for firing, and has in-flight boresighting. Available Israeli-made upgrades include an integrated FLIR with laser rangefinder, GPS, automatic boresighting, and the ability to fire both TOW II and Hellfire missiles.</p> <p>Night/Weather Capabilities: The AH-1 is fully capable of performing its attack mission in all weather conditions.</p> <p>VARIANTS Most older Cobra variants still in operation have been upgraded to the AH-1F standard. Also produced in Romania and Japan under license from Bell Textron in the U.S.</p> <p>AH-1G: Initial production model in 1966</p> <p>AH-1S: Upgraded 1960s produced aircraft in late 1980s to the standard TOW carrying version.</p> <p>AH-1P: A set of AH-1S aircraft fitted with composite rotors, flat plate glass cockpits, and NVG capabilities.</p> <p>AH-1E: A set of AH-1S aircraft upgraded with the Enhanced Cobra Armament System incorporating the universal turret, 20-mm gun, automatic compensation for off-axis gun firing, and weapon management system.</p> <p>AH-1F: Current standard Cobra. Also referred to as the "Modernized Cobra". Incorporated all past upgrades.</p> <p>AH-1J/-1T/-1W: See separate AH-1W entry.</p>												

NOTES

Available munitions are shown above; not all may be employed at one time. Mission dictates weapon configuration. External stores are mounted on underwing external stores points. Each wing has two hardpoints for a total of four stations. A representative mix when targeting armor formations would be eight TOW missiles, two 2.75-in rocket pods, and 750x 20-mm rounds. The gun must be centered before firing underwing stores. Additional missions include direct air support, antitank, armed escort, and air to air combat. Armored cockpit can withstand small arms fire, and composite blades and tailboom are able withstand damage from 23-mm cannon hits. small arms fire, and composite blades and tailboom able to withstand damage from 23-mm cannon hits.

Russian Attack Helicopter Ka-50/HOKUM

	Weapon & Ammunition Types	Combat Load
	1x 2A42 30-mm cannon HE-Frag AP Total	 250 250 500
Other Loading Options		
AT-16 VIKhR ATGM (6 each)		2
80-mm rockets (20 each)		2
Twin 23-mm gun pods		940
500-kg bombs		4
AA-11/ARCHER AAM		2
External fuel tanks (liters)		500

<p>SYSTEM</p> <p>Alternative Designations: Black Shark, Werewolf</p> <p>Date of Introduction: N/A</p> <p>Proliferation: Preproduction. An initial fielding plan is for 2 per year for 14 years.</p> <p>Description: Crew: 1 (pilots, 2 in Ka-52) Blades: Main rotor: 6 (2 heads, 3 blades each) Tail rotor: None Engines: 2x 2,200-shp Klimov TV3-117VK turboshaft Weight (kg): Maximum Gross: 10,800 Normal Takeoff: 9,800 Empty: 7,692 Speed (km/h): Maximum (level): 340 (est.) Cruise: 270 Sideward: 100+, Rearward: 100+ Turn Rate: unlimited Max "G" Force: +3 to +3.5 g Ceiling (m): Service: 5,500 Hover (out of ground effect): 4,000 Hover (in ground effect): 5,500 Vertical Climb Rate (m/s): 10 Fuel (liters): Internal: INA External Fuel Tank: 500 ea. (max 4x) Range (km): Maximum Load: INA Normal Load: 460 With Aux Fuel: INA Dimensions (m): Length (rotors turning): 16 Length (fuselage): 15.0 Width (including wing): 7.34 Height (gear extended): 4.93 Height (gear retracted): 4 Main Rotor Diameter: 14.5</p>	<p>Cargo Compartment Dimensions: Negligible Standard Payload: External weapons load: 2,500 kg on 4 underwing stores points.</p> <p>Survivability/Countermeasures: Main rotors and engines electrically deiced. Infrared signature suppressors can be mounted on engine exhausts. Radar warning receivers, IFF, chaff and flares. Armored cockpit and self-sealing fuel tanks. Pilot ejection system. (see NOTES)</p> <p>ARMAMENT 30-mm Automatic Cannon, 2A42: Range: effective 3,000 m Elevation: -45° to +10° Traverse: ±15° Ammo type and rate of fire is selectable by pilot (HE or AP, 350 or 600)</p> <p>Most Probable Armament: (shown above) HOKUM A/N: Fuselage-mounted 30-mm cannon on right side, 80-mm rockets, AT-16 VIKhR ATGMs.</p> <p>HOKUM B: Same as above.</p> <p>ATGM, AT-16/VIKhr: Guidance: Laser Beam Rider SACLOS Range: 10,000 m Warhead: HEAT Penetration: 900 mm Effective against ground & air targets at converging speeds to 800 km/h. ATGM racks can depress to 12°.</p>	<p>AVIONICS/SENSOR/OPTICS</p> <p>The HOKUM uses a low-light level TV or thermal sighting, a laser range-finder (10 km), FLIR, air data sensor, and digital data-link which interface with a fire control computer, an autopilot, a helmet sighting system and HUD for target location, acquisition, designation, and firing.</p> <p>Night/Weather Capabilities: This aircraft's avionics package ensuring a full day/night, all weather capability. If it is to be employed at night in an attack role, it must be fitted with a night targeting pod. This pod includes a FLIR, a millimeter wave radar, and an electro-optical sight takes up one of the underwing pylons. The Ka-50N, and Ka-52 are capable of performing attack missions in day/night, and all-weather conditions. The French companies Thomson-CSF, and Sextant Avionique offer nav/attack systems, which can be fitted to export variants.</p> <p>VARIANTS</p> <p>Ka-50A/HOKUM A: Standard direct air support variant.</p> <p>Ka-50N/HOKUM N: Night attack variant fitted with a nose-mounted FLIR. The cockpit is fitted with an additional TV display, and is NVG compatible.</p> <p>Ka-52/HOKUM B: The "Alligator" is a side-by-side, two-seat cockpit variant of the Ka-50. The gross weight of the aircraft is greater, so the performance is marginally degraded. But airframe characteristics, dimensions, and armaments are relatively similar. It includes a mast-mounted millimeter wave radar covering the front quadrant only. It is used as an attack aircraft, and as a trainer for the Ka-50.</p>
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Russian Attack Helicopter Ka-50/HOKUM continued

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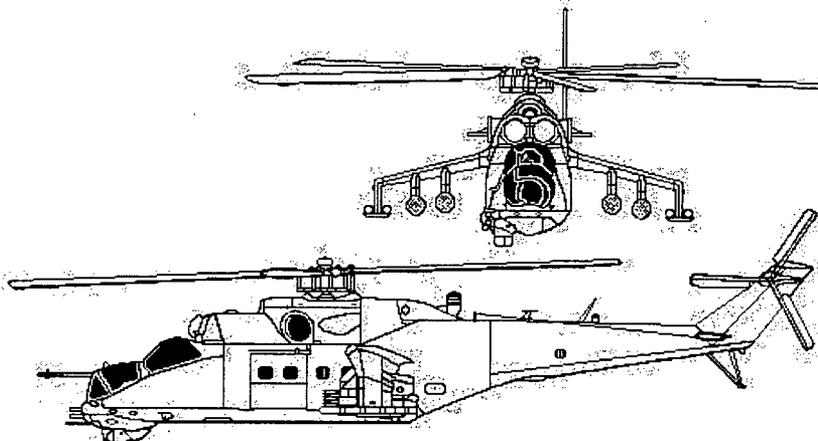
NOTES

This aircraft is not fielded. Only a handful of prototypes exist, and it has not yet been approved for full-scale production.

The fully armored pilot's cabin can withstand 23-mm gunfire, and the cockpit glass 12.7-mm MG gunfire. The Zvezda K-37-800 pilot ejection system functions at any altitude. Available munitions are shown above; not all may be employed at one time. Mission dictates weapons configuration. External stores are mounted on underwing external hardpoints. Each wing has two hardpoints for a total of four stations. A typical mix for targeting armor formations is 12x AT-16 ATGMs, 500x 30-mm cannon rounds, and 2x 20-round pods of 80-mm folding fin unguided rockets. It was designed for remote operations, and not to need ground maintenance facilities for 2 weeks. The 30-mm cannon is the same as on the BMP-2. The firing computer will turn the aircraft to keep the gun on target. A coaxial counter-rotating rotor system negates the need for a tail rotor and its drive system. Because of this, this aircraft is unaffected by wind strength and direction, has an unlimited hovering turn rate, and gives a smaller profile and acoustic signature, while allowing a 10-15% greater power margin. The airframe is 35% composite materials with a structural central 1 m² keel beam of kevlar/nomex that protects critical systems and ammunition. The HOKUM is fully aerobatic. It can perform loops, roll, and "the funnel", where the aircraft will maintain a concentrated point of fire while flying circles of varying altitude, elevation, and airspeed around the target.

Russian Attack Helicopter Mi-24/HIND

	Weapon & Ammunition Types	Combat Load
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		<p>1x twin 30-mm gun or 12.7-mm 4 barrel turret gun: 750 1,470</p> <p>Other Loading Options</p> <p>AT-2C or AT-6C ATGMs: 2-12</p> <p>80-mm S-8 rocket pods (20 ea.): 2-4</p> <p>57-mm S-5 rocket pods (32 ea.): 2-4</p> <p>GSh-23L twin 23-mm MG pods: 940</p> <p>250-kg bombs: 4</p> <p>500-kg bombs: 2</p> <p>External fuel tanks (liters): 500</p>
<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: 1976 (HIND D) Proliferation: At least 34 countries</p> <p>Description: Crew: 2 (pilots in tandem cockpits) Blades: Main rotor: 5 Tail rotor: 3 Engines: 2x 2,200-shp Klimov TV3-117VMA turboshaft Weight (kg): Maximum Gross: 11,500 Normal Takeoff: 11,100 Empty: 8,500 Speed (km/h): Maximum (level): 335 Cruise: 295 Max "G" Force: 1.75 g Ceiling (m): Service: 4,500 Hover (out of ground effect): 1,500 Hover (in ground effect): 2,200 Vertical Climb Rate (m/s): 15 Fuel (liters): Internal: 1,840 Internal Aux Tank (in cabin): 1,227 External Fuel Tank: 500 ea. Range (km): Normal Load: 450 With Aux Fuel: 950 Dimensions (m): Length (rotors turning): 21.6 Length (fuselage): 17.5 Width (including wing): 6.5 Height (gear extended): 6.5 Main Rotor Diameter: 17.3 Tail Rotor Diameter: 3.9 Cargo Compartment Dimensions (m): Floor Length: 2.5 Width: 1.5 Height: 1.2</p>	<p>Standard Payload: Internal load: 8 combat troops or 4 litters External weapons load: 1,500 kg External load (no weapons): 2,500 kg</p> <p>Survivability/Countermeasures: Main and tail rotors electrically deiced. Infrared signature suppressors can be mounted on engine exhausts. Radar warning receivers, IFF, Infrared jammer, rotor brake, chaff and flares. Armored cockpit.</p> <p>ARMAMENT Loaded combat troops can fire personal weapons through cabin windows.</p> <p>12.7-mm 4x Barrel Machinegun, YaKB-12.7: Range (m): (practical) 1,500 Elevation/Traverse: 20° up to 60° down/ 120° Ammo Type: HEFI, APT, Duplex, DuplexT Rate of Fire (rpm): up to 4,500 (pilot selectable)</p> <p style="text-align: center;">OR</p> <p>30-mm Twin Barrel Cannon, GSh-30K: Range (m): (practical) 4,000 Elevation/Traverse: None (rigidly mounted) Ammo Type: HEFI, HEI, APT, APE, CC Rate of Fire (rpm): 300, or 2,000 to 2,600</p> <p>Most Probable Armament: (HIND F pictured) HIND D: Turret-mounted 4-barrel 12.7-mm Gatling type machinegun, 57-mm rockets, AT-2C/SWATTER ATGMs. HIND E: Turret-mounted 4-barrel 12.7-mm Gatling type machinegun or twin barrel 23-mm turret gun, 57-mm rockets, AT-6C/ SPIRAL ATGMs. HIND F: Fixed 30-mm twin gun on the right fuselage side, 57-mm rockets, AT-6C/ SPIRAL ATGMs.</p>	<p>AVIONICS/SENSOR/OPTICS The ATGM targeting system uses a low-level light TV, a laser designator, FLIR, air data sensor, and a missile guidance transmitter.</p> <p>Night/Weather Capabilities: HIND D versions are primarily daytime aircraft only. Some HIND E and Mi-35 series export versions have upgraded night and weather capabilities, better avionics, weather radar, autopilot, HUD, GPS, NVG compatibility, more armor, and an increased weapons load provided by the French company Sextant Avionique.</p> <p>VARIANTS Nearly all of the older HIND A, B and C variants have been upgraded or modified to the HIND D or E standard.</p> <p>Mi-24D/HIND D: Direct air support.</p> <p>Mi-24V/HIND E: Direct air support. Most proliferated version.</p> <p>Mi-24P/HIND F: Direct air support. The fixed twin gun cut the turret profile, and empty weight to 8,200 kg, while boosting maximum gross weight to 12,000 kg.</p> <p>Mi-24R/HIND G-1: NBC sampling. It has mechanisms to obtain soil and air samples, filter air, and place marker flares.</p> <p>Mi-24K/HIND G-2: Photo-recon, and artillery spotting. Has a camera in cabin, gun, rocket pods, but no targeting system.</p> <p>Mi-25: Export version of the HIND D.</p> <p>Mi-35: Export version of the HIND E. The Mi-35M has a twin barrel 23-mm gun.</p> <p>Mi-35P: Export version of the HIND F.</p>

Russian Attack Helicopter Mi-24/HIND continued

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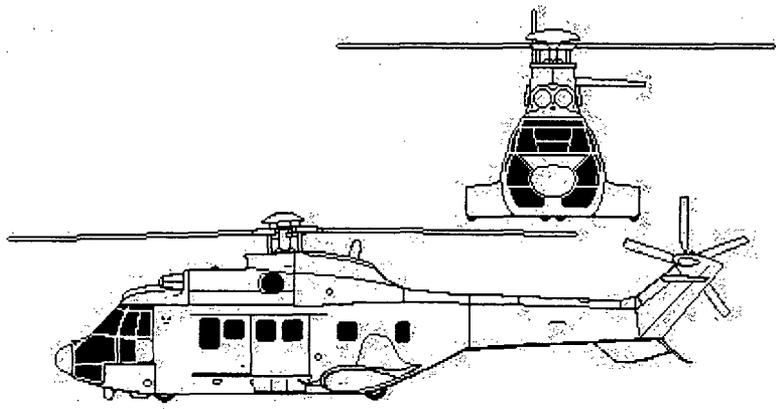
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escort, and air to air combat. The aircraft can store an additional ammunition basic load in the cargo compartment in lieu of carrying troops. Armored cockpits and titanium rotor head able to withstand 20-mm cannon hits. Every aircraft has an overpressurization system for operation in a NBC environment.

The HIND's wings provide 22% to 28% of its lift in forward flight. In a steep banking turn at slower airspeeds, the low wing can lose lift while it is maintained on the upper wing, resulting in an excessive roll. This is countered by increasing forward airspeed to increase lift on the lower wing. Because of this characteristic, and the aircraft's size and weight, it is not easily maneuverable. Therefore they usually attack in pairs or multiple pairs, and from various directions.

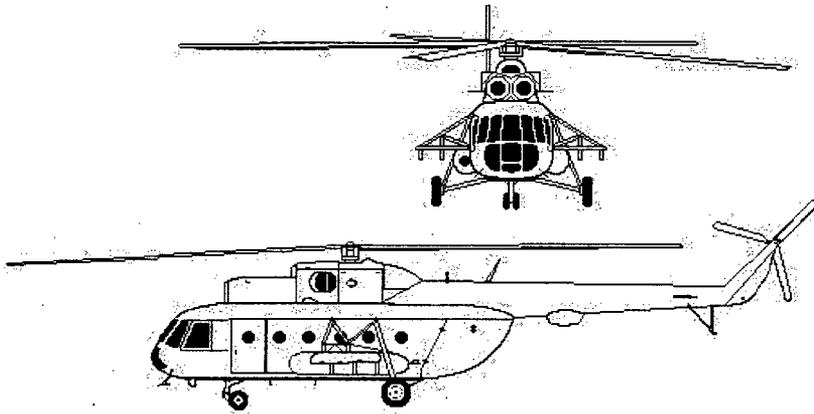
European Utility Helicopter AS-532/COUGAR

	<p>Weapon & Ammunition Types</p> <p>7.65-mm MG</p> <p>Other Loading Options</p> <p>20-mm twin gun pods</p> <p>68-mm rocket pods (22 each)</p> <p>2.75-in rocket pods (19 each)</p> <p>External fuel tanks (liters)</p>	<p>Combat Load</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>600</p>
	<p>VARIANTS</p> <p>SA 330 Puma: Developed in the late 1960s by Aerospatiale in France. Others were built in the UK, Indonesia, Romania.</p> <p>AS 332 Super Puma: Differs from the SA 330 Puma through an improved rotor system, upgraded engines, stretched fuselage, and a modified nose shape.</p> <p>The Cougar name was adopted for all military variants, and in 1990, all Super Puma designations were changed from AS 332 to AS 532 to distinguish between civil and military variants. The "S" denotes military, "A" is armed, "C" is armed-antitank, and "U" is utility. The second letter represents the level of "upgrading".</p> <p>AS-532 Cougar UC/AC Mk I: The basic version with a short fuselage to carry 20 troops.</p> <p>AS-532 Cougar UL/AL Mk I: This version has an extended fuselage, which allows it to carry 25 troops and more fuel. It is also capable of carrying an external load of 4,500 kg.</p> <p>AS-532 Cougar U2/A2 Mk II: This 1992 version is the longest variant of the Cougar line. It has an improved Spheriflex rotor system with only 4x tail rotor blades, and 2x 2,100-shp Turbomeca Makila 1A2 turboshaft engines that allow an increased cargo carrying capability. It can transport 29 troops or 12 liters, or an external load of 5,000 kg. Primarily used for combat search and rescue, and as an armed version. It may be armed additionally with a 20-mm cannon or pintle-mounted .50 caliber machine guns.</p>	
<p>SYSTEM</p> <p>Alternative Designations: AS 332 Super Puma, SA 330 Puma</p> <p>Date of Introduction: 1981</p> <p>Proliferation: At least 38 countries</p> <p>Description: Variants in "()"</p> <p>Crew: 2 (pilots)</p> <p>Blades:</p> <p>Main rotor: 4</p> <p>Tail rotor: 5, 4 (U2/A2)</p> <p>Engines: 2x 1,877-shp Turbomeca Makila 1A1 turboshaft</p> <p>Weight (kg):</p> <p>Maximum Gross: 9,000 (Mk I), 9,750 (Mk II)</p> <p>Normal Takeoff: 8,600 (Mk I), 9,300 (Mk II)</p> <p>Empty: 4,330 (UC/AC), 4,460 (UL/AL), 4,760 (U2/A2)</p> <p>Speed (km/h):</p> <p>Maximum (level): 275 (Mk I), 325 (Mk II)</p> <p>Cruise: 270</p> <p>Ceiling (m):</p> <p>Service: 4,100</p> <p>Hover (out of ground effect): 1,650 (Mk I), 1,900 (Mk II)</p> <p>Hover (in ground effect): 2,800 (Mk I), 2,540 (Mk II)</p> <p>Vertical Climb Rate (m/s): 7</p> <p>Fuel (liters):</p> <p>Internal: 1,497 (UC/AC), 2,000 (UL/AL), 2,020 (U2/A2)</p> <p>Internal Aux Tank: 475 ea. (4x Mk I, 5x Mk II)</p> <p>Range (km):</p> <p>Normal Load: 620 (UC/AC), 840 (UL/AL), 800 (U2/A2)</p> <p>With Aux Fuel: 1,017 (UC/AC), 1, 245 (UL/AL), 1,176 (U2/A2)</p> <p>Dimensions (m):</p> <p>Length (rotors turning): 18.7-19.5 (U2/A2)</p>	<p>Dimensions continued (m):</p> <p>Length (fuselage): 15.5 (UC/AC), 16.3 (UL/AL), 16.8 (U2/A2)</p> <p>Width: 3.6-3.8 (U2/A2)</p> <p>Height: 4.6</p> <p>Main Rotor Diameter: 15.6-16.2 (U2/A2)</p> <p>Tail Rotor Diameter: 3.1-3.2 (U2/A2)</p> <p>Cargo Compartment Dimensions (m):</p> <p>Floor Length: 6.5 (AC/UC), 6.8 (UL/AL), 7.9 (U2/A2)</p> <p>Width: 1.8</p> <p>Height: 1.5</p> <p>Standard Payload (kg):</p> <p>Internal load: 3,000</p> <p>External on sling only: 4,500</p> <p>Transports 20-29 troops or 6-12 liters (variant dependant), or cargo.</p> <p>Survivability/Countermeasures:</p> <p>Main and tail rotor blades electrically deiced. A radar warning receiver is standard, while a laser warning receiver, missile launch detector, missile approach detector, infrared jammer, decoy launcher, and flare/chaff dispensers are optionally available.</p> <p>ARMAMENT</p> <p>The Mk I variants may employ 2x 7.65-mm machine guns on pintle-mounts in the cabin doors when employed in a transport role.</p> <p>Most Probable Armament</p> <p>The armed versions have side-mounted 20-mm machineguns and/or axial pods fitted with 68-mm rocket launchers.</p> <p>AVIONICS/SENSOR/OPTICS</p> <p>Night/Weather Capabilities:</p> <p>The aircraft is NVG compatible, and through its instruments, avionics, full autopilot, and nav computer, is capable of operation in day, night, and instrument meteorological conditions.</p>	

NOTES

This helicopter is produced by the Eurocopter company. It was formed as a joint venture between Aerospatiale of France, and Daimler-Benz Aerospace of Germany. Additional missions include: VIP transport, electronic warfare, and anti-submarine warfare.

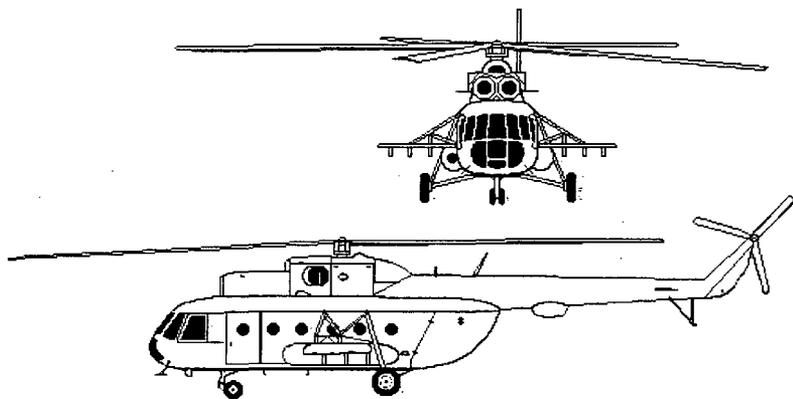
Russian Utility Helicopter Mi-8/HIP

		Weapon & Ammunition Types 2x 7.62-mm or 1x 12.7-mm MG	Combat Load
		Other Loading Options AT-2C or AT-3 ATGMs 4-6 57-mm rocket pods (16 each) 4-6 80-mm rocket pods (20 each) 2 250-kg bombs 4 500-kg bombs 2 12.7-mm MG pod 2 Twin 23-mm gun pods 2 Additional fuel tanks (liters) 1,830	
SYSTEM Alternative Designations: INA Date of Introduction: 1967 Proliferation: At least 54 countries Description: Crew: 3 (2x pilots, 1x flight engineer) Blades: Main rotor: 5 Tail rotor: 3 Engines: 2x 1,700-shp Isotov TV2-117A turboshaft Weight (kg): Maximum Gross: 12,000 Normal Takeoff: 11,100 Empty: 6,990 Speed (km/h): Maximum (level): 250 Cruise: 225 Ceiling (m): Service: 4,500 Hover (out of ground effect): 800 Hover (in ground effect): 1,900 Vertical Climb Rate (m/s): 9 Fuel (liters): Internal: 445 Internal Aux Tank: 915 ea. External Fuel Tank: 745 in port tank, 680 in starboard tank Range (km): Maximum Load: INA Normal Load: 460 With Aux Fuel: 950	Dimensions (m): Length (rotors turning): 25.2 Length (fuselage): 18.2 Width: 2.5 Height: 5.6 Main Rotor Diameter: 21.3 Tail Rotor Diameter: 3.9 Cargo Compartment Dimensions (m): Floor Length: 5.3 Width: 2.3 Height: 1.8 Standard Payload: HIP C: 24 troops, or 3,000 kg internal or external loads on 4x hardpoints. HIP E: 24 troops, or 4,000 kg internal or 3,000 kg external on 6x hardpoints. HIP J/K: antennas on aft section of fuselage. Survivability/Countermeasures: Main and tail rotor blades electrically deiced. Infrared jammer, chaff and flares. ARMAMENT Loaded combat troops can fire personal weapons through windows from inside cabin. The HIP E mounts a flexible 12.7-mm machinegun in the nose. AVIONICS/SENSOR/OPTICS Night/Weather Capabilities: The Mi-8 is equipped with instruments and avionics allowing operation in day, night, and instrument meteorological conditions.	VARIANTS Mi-8T: The HIP C is a medium assault/transport version. The probable armament is 57-mm-rockets, bombs, or AT-2C/SWATTER ATGMs. Mi-8VPK: The HIP D is an airborne communications platform with rectangular communication canisters mounted on weapons racks. Mi-8TVK: The HIP E is used as a gunship or direct air support platform. Airframe modifications add 2x external hardpoints for a total of 6, and mount a flexible 12.7-mm machinegun in the nose. The probable armament is 57-mm rockets, bombs, or AT-2/SWATTER ATGMs. Mi-8MT/MTV/MTB/-171-17: The HIP H is an upgraded medium assault/transport version. See separate Mi-17 entry. Mi-8SMV: The HIP J is an airborne jamming platform characterized by small boxes on the left side of the fuselage. Mi-8PPA: The HIP K is an airborne jamming platform characterized by 6x "X"-shaped antennas on the aft fuselage. Mi-9: The HIP G is an airborne command post characterized by antennas, and Doppler radar on tailboom.	

NOTES

Available munitions are shown above; not all may be employed at one time, mission dictates weapon configuration. External stores are mounted on weapons racks on each side of the fuselage. The HIP C has four external hardpoints; the HIP E, HIP H, have six; other variants have none. Interior seats are removable for cargo carrying. The rear clamshell doors open, an internal winch facilitates loading of heavy freight. Floor has tiedown rings throughout. The aircraft carries a rescue hoist capable to 150 kg, and a cargo sling system capable to 3,000 kg. The Mi-8 is capable of single-engine flight in the event of loss of power by one engine (depending on aircraft mission weight) because of an engine load sharing system. If one engine fails, the other engine's output is automatically increased to allow continued flight. See also Mi-17.

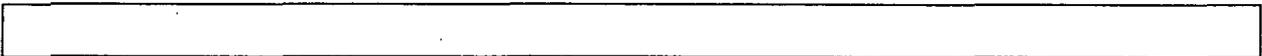
Russian Utility Helicopter Mi-17/HIP

		Weapon & Ammunition Types 2x 7.62-mm or 1x 12.7-mm MG	Combat Load:
		Other Loading Options AT-2C or AT-3 ATGMs 57-mm rocket pods (16 each) 80-mm rocket pods (20 each) 250-kg bombs 500-kg bombs 12.7-mm MG pod Twin 23-mm gun pods Additional fuel tanks (liters)	4-6 4-6 2 4 2 2 1,830
SYSTEM Alternative Designations: Mi-8MT HIP H Date of Introduction: 1981 (as Mi-17) Proliferation: At least 22 countries Description: Crew: 3 (2x pilots, 1x flight engineer) Blades: Main rotor: 5 Tail rotor: 3 Engines: 2x 1,950-shp Isotov TV3-117MT turboshaft Weight (kg): Maximum Gross: 13,000 Normal Takeoff: 11,100 Empty: 7,100-7,370 (variant dependant) Speed (km/h): Maximum (level): 250 Cruise: 240 Ceiling (m): Service: 5,000-5,700 (variant dependant) Hover (out of ground effect): 1,760 Hover (in ground effect): 1,900-3,980 (variant dependant) Vertical Climb Rate (m/s): 9 Fuel (liters): Internal: 445 Internal Aux Tank: 915 ea. External Fuel Tank: Port Tank: 745 Starboard Tank: 680 Range (km): Normal Load: 495 With Aux Fuel: 1,065	Dimensions (m): Length (rotors turning): 25.4 Length (fuselage): 18.4 Width: 2.5 Height: 5.7 Main Rotor Diameter: 21.3 Tail Rotor Diameter: 3.9 Cargo Compartment Dimensions (m): Floor Length: 5.3 Width: 2.3 Height: 1.8 Standard Payload (kg): Internal load: 4,000 External on sling only: 3,000 Transports 24 troops and cargo, or armaments on 6x external hardpoints. Survivability/Countermeasures: Main and tail rotor blades electrically deiced. Infrared jammer, chaff and flares. ARMAMENT Loaded combat troops can fire personal weapons through cabin windows from inside cabin. Most Probable Armament: HIP H: Fitted with 2x 7.62-mm machineguns or possibly 2x 23-mm GSh-23 gun packs in cabin, 57-mm rockets, and AT3/SAGGER ATGMs.	AVIONICS/SENSOR/OPTICS Night/Weather Capabilities: The Mi-17 is equipped with instruments, avionics, Doppler radar, and a fully functioning autopilot for operation in day, night, and instrument meteorological conditions. VARIANTS Mi-17: A mid-life upgrade of the widely proliferated Mi-8 HIP H medium assault/transport helicopter. Initially, only the export version was known as the Mi-17. The only visible differences between this variant and the older Mi-8s is that the tail rotor is on the portside rather than the starboard side, and crew armor plating. Mi-17P: A descendent of the HIP K airborne jamming platform characterized by large rectangular antennas along the aft fuselage. Mi-171/-17M/-17V: Also known as Mi-8MTV , and a descendent of the HIP H. The engines are upgraded to 2x 2,070-shp Klimov TV3-117VMAs to allow greater rates of climb and hover ceilings, yet performance characteristics remain virtually unchanged from the baseline Mi-17. Mi-8: See separate entry.	

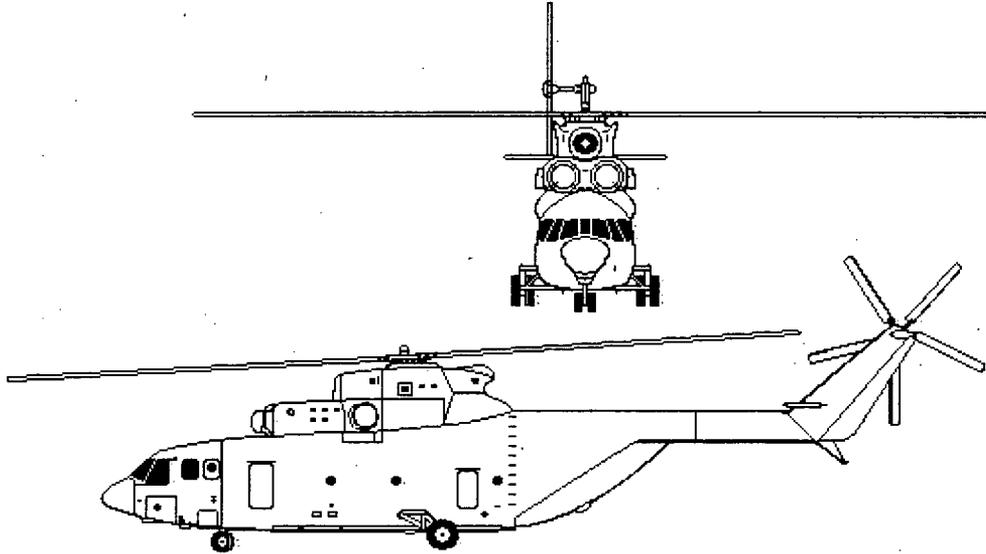
NOTES

Available munitions are shown above; not all may be employed at one time, mission dictates weapon configuration. External stores are mounted on weapons racks on each side of the fuselage. The Mi-17 has six external hardpoints. Additional missions include; attack, direct air support, electronic warfare, airborne early warning, medevac, search and rescue, and minelaying. Interior seats are removable for cargo carrying. The rear clamshell doors open, an internal winch facilitates loading of heavy freight. Floor has tiedown rings throughout. The aircraft carries a rescue hoist capable to 150 kg. The Mi-17 is capable of single-engine flight in the event of loss of power by one engine (depending on aircraft mission weight) because of an engine load sharing system. If one engine fails, the other engine's output is automatically increased to allow continued flight. See also Mi-8.

Russian Transport Helicopter Mi-26/HALO



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<p>SYSTEM</p> <p>Alternative Designations: INA Date of Introduction: 1983 Proliferation: At least 5 countries</p> <p>Description: Crew: 5 (2x pilots, 1x navigator, 1x flight engineer, 1x loadmaster) Blades: Main rotor: 8 Tail rotor: 5 Engines: 2x 11,400-shp Lotarev D-136 turboshaft Weight (kg): Maximum Gross: 56,000 Normal Takeoff: 49,500 Empty: 28,240 Speed (km/h): Maximum (level): 295 Cruise: 255 Ceiling (m): Service: 4,500 Hover (out of ground effect): 1,800 Hover (in ground effect): 4,500 Vertical Climb Rate: INA</p>	<p>Fuel (liters): Internal: 11,900 Range (km): Maximum Load: 800 Normal Load: INA With Aux Fuel: 1200 km Dimensions (m): Length (rotors turning): 40 Length (fuselage): 33.5 Width: 8.2 Height: 8.1 Main Rotor Diameter: 32 Tail Rotor Diameter: 7.6 Cargo Compartment Dimensions (m): Floor Length: 12 Width: 3.3 Height: variable from 2.9 to 3.2 Standard Payload: Internal or external load: 20,000 kg Transports over 80 troops, 60 litters, or 2x BRDM-2 scout cars, or 2x BMDs, or 1x BMP or, 1x BTR-60/70/80 or, 1x MT-LB.</p> <p>Survivability/Countermeasures: Main and tail rotor blades electrically deiced. Infrared signature suppressors on engines. Infrared jammers and decoys; flares. Self-sealing fuel tanks.</p>	<p>ARMAMENT</p> <p>None</p> <p>AVIONICS/SENSOR/OPTICS</p> <p>Night/Weather Capabilities: The avionics and navigational package, a Doppler weather radar, and a fully functioning autopilot allow for day/night all-weather operation.</p> <p>VARIANTS</p> <p>Mi-26MS: Medical evacuation version.</p> <p>Mi0-26T: Freight transport.</p> <p>Mi-26TZ: Fuel tanker with an additional 14,040 liters of fuel in 4x internal tanks and 1,040 liters of lubricants, pumped through 4x 60-meter long refueling nozzles for refueling aircraft, and 10x 20-meter long hoses for refueling ground vehicles. Fuel transfer rate is 300 liters/minute for aviation fuel, and 75-150 liters/minute for diesel fuel. The refueling system can easily be removed to allow the aircraft to perform transport missions.</p>

NOTES

The HALO A has no armament. The load and lift capabilities of the aircraft are comparable to the U.S. C-130 Hercules transport aircraft. The length of the landing gear struts can be hydraulically adjusted to facilitate loading through the rear doors. The tailskid is retractable to allow unrestricted approach to the rear clamshell doors and loading ramp. The cargo compartment has two electric winches (each with 2,500 kg capacity) on overhead rails can move loads along the length of the cabin. The cabin floor has rollers and tie-down rings throughout. The HALO has a closed-circuit television system to observe positioning over a sling load, and load operations. The Mi-26 is capable of single-engine flight in the event of loss of power by one engine (depending on aircraft mission weight) because of an engine load sharing system. If one engine fails, the other engine's output is automatically increased to allow continued flight.

Glossary

AA - antiaircraft

acquisition range - sensor range against a category of targets. Targets are usually categorized as infantry, armored vehicles, or aircraft. Acquisition includes four types (or levels of clarity, in ascending order of clarity): detection, classification, recognition, and identification. Where the type of acquisition is not specified, the acquisition range will be regarded as sufficient for accurate targeting. This range is comparable to the former Soviet term *sighting range*.

AAM - air-to-air missile

AGL - automatic grenade launcher

AIFV - airborne infantry fighting vehicle

aka - also known as

antitank - functional area and class of weapons characterized by destruction of tanks. In the modern context, used in this guide, the role has expanded to the larger one of "antiarmor". Systems and munitions employed against light armored vehicles may be included within the category of antitank.

AP - antipersonnel

APE - armor-piercing explosive (ammunition)

APC - armored personnel carrier

APC-T - armor-piercing capped tracer (ammunition)

AP HE - armor-piercing high explosive (ammunition)

API-T - armor-piercing incendiary tracer (ammunition)

APERS-T - antipersonnel tracer (ammunition)

APT - armor-piercing tracer (ammunition)

APU - auxiliary power unit; auxiliary propulsion unit

ASM - air-to-surface missile

AT - antitank

ATGL - antitank grenade launcher

ATGM - antitank guided missile

average cross-country (speed) - vehicle speed (km/hr) on unimproved terrain without a road.

burst (rate of fire) - artillery term: the greatest number of rounds that can be fired in 1 minute.

caliber - munition diameter (mm or inches), used to classify munition sizes; barrel length of a cannon (howitzer or gun), measured from the face of the breech recess to the muzzle.

canister - close-range direct-fire ammunition which dispenses a fan of flechettes forward

CC - cargo-carrying (ammunition)

CCM - counter-countermeasure

CE - chemical energy: the class of ammunition which employs a shaped charge for the lethal mechanism. Ammunition types which employ CE include HEAT and HESH (see below).

CM - countermeasure

coax - coaxial

CRV - combat reconnaissance vehicle

cyclic (rate of fire) - maximum rate of fire for an automatic weapon (in rd/min)

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decon - decontamination

direct-fire range - maximum range of a weapon, operated in the direct-fire mode, at which the bullet's trajectory will not rise above the height of the intended point of impact on the target. At this range, the gunner is not required to adjust for range in order to aim the weapon. The comparable Russian term is *point blank range*.

DPICM - dual-purpose improved conventional munitions (ammunition)

DPICM-BB - dual-purpose improved conventional munitions, base-bleed (ammunition)

DU - depleted uranium (ammunition)

DVO - direct-view optics

ECM - electronic countermeasures

EO - electro-optic, electro-optical

ERA - explosive reactive armor

ERFB - extended range full-bore (ammunition)

ERFB-BB - extended range full-bore, base-bleed (ammunition)

est - estimate

ET - electronic timing (ammunition fuze type)

European - from a consortium of firms located or headquartered in several European countries

FAE - fuel-air explosive (ammunition). This munition technology is employed in aerial bombs and artillery munitions, and uses a dispersing explosive fill to produce intense heat, a long-duration high-pressure wave, and increased HE blast area

FCS - fire control system

FFAR - folding-fin aerial rockets

flechette - former-Soviet artillery ammunition which dispenses flechettes forward over a wide area. Unlike **canister rounds**, these rounds use a time fuze, which permits close-in direct fire, long-range direct fire, and indirect fire.

FLIR - forward-looking infrared (thermal sensor)

FLOT - forward line of own troops

FOV - field of view

frag-HE - fragmentation-high explosive (ammunition)

FSU - former Soviet Union

gen - generation. Equipment such as APS and (thermal and II) night sights are often categorized in terms of 1st, 2nd or 3rd generation of development, with different capabilities for each.

GP MG - general purpose machinegun

GPS - global positioning system

HE - high explosive (ammunition)

HEAT - high-explosive antitank (also referred to as shaped-charge ammunition)

HEAT-FS - high-explosive antitank, fin-stabilized (ammunition)

HEAT-MP - high-explosive antitank, multi-purpose

HEFI - high-explosive fragmentation incendiary (ammunition)

HEI - high-explosive incendiary (ammunition)

HEP-T - high explosive plastic-tracer (ammunition)

HESH - high-explosive squash head (ammunition)
HUD - head-up display
HVAP-T - hypervelocity, armor-piercing tracer (ammunition)

I-T - incendiary - tracer (ammunition)
IFF - identification friend-or-foe
IFV - infantry fighting vehicle
II - image intensification (night sighting system)
ILS - instrument landing system
INA - information not available
IR - infrared

K-kill - catastrophic kill (simulation lethality data)
KE - kinetic energy: class of ammunition which transfers energy to the target for the lethal mechanism. Ammunition types which employ KE include AP, APFSDS-T, and HVAP-T.

LAFV - light armored fighting vehicle
LLLTV - low-light-level television
LMG - light machinegun
LRF - laser rangefinder

max - maximum

maximum aimed range - maximum range of a weapon (based on firing system, mount, and sights) for a given round of ammunition, while aiming at a ground target or target set with sights in the direct-fire mode. The range is not based on single-shot hit probability on a point target, rather on tactical guidance for firing multiple rounds if necessary to achieve a desired lethality effect. One writer referred to this as *range with the direct laying sight*. Even greater ranges were cited for *salvo fire*, wherein multiple weapons (e.g., tank platoon) will fire a salvo against a point target.

max effective range - maximum range at which a weapon may be expected to achieve a high single-shot probability of hit (50%) and a required level of destruction against assigned targets. This figure may vary for each specific munition and by type of target (such as infantry, armored vehicles, or aircraft).

max off-road (speed) - vehicle speed (km/hr) on dirt roads.

MCLOS - manual command-to-line-of-sight

MG - machinegun

Mk - Mark

MRL - multiple rocket launcher

N/A - not applicable

NBC - nuclear, biological, and chemical

Nd - neodymium, type of laser rangefinder

NFI - no further information

normal (rate of fire) - artillery term: rate (in rd/min) for fires over a 5-minute period.

NVG - night-vision goggle

NVS - night-vision system

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PD - point-detonating (ammunition fuze type)

Ph - probability of hit (simulation lethality data)

PIBD - point-initiating base-detonating (ammunition fuze type)

pintel - post attached to a firing point or vehicle, used to replace the base for a weapon mount

Pk - probability of kill (simulation lethality data)

practical (rate of fire) - maximum rate of fire for sustained aimed weapon fire against point targets. The rate includes reload time and reduced rate to avoid damage from overuse.

Former Soviet writings also refer to this as the **technical rate of fire**.

recon - reconnaissance

Rd - round

ready rounds - rounds available for use on a weapon, whether in autoloader or in nearby stowage, which can be loaded within the weapon's stated rate of fire.

RF - radio frequency

RHA - rolled homogeneous armor, often used as a standard armor hardness for measuring penetration of anti-tank munitions.

RHAe - RHA equivalent, a standard used for measuring penetrations against various type armors

SACLOS - semiautomatic command-to-line-of-sight

SAM - surface-to-air missile

SP - self-propelled

stadimetric - in this guide, a method of range-finding using stadia line intervals in sights and target size within those lines to estimate target range.

stowed rounds - rounds available for use on a weapon, but stowed and requiring a delay greater than that for ready rounds (and cannot be loaded within the weapon's stated rate of fire).

sustained (rate of fire) - artillery term: rate (in rd/min) for fires over the duration of an hour.

tactical AA range - maximum targeting range against aerial targets, aka: **slant range**.

TAR - target acquisition radar

TELAR - transporter-erector-launcher and radar

thermobaric - HEI volumetric (blast effect) explosive technology similar to fuel-air explosive and used in shoulder-fired infantry weapons and ATGMs.

TLAR - transporter-launcher and radar

TOF - time of flight (seconds)

TTP - tactics, techniques, and procedures

TTR - target tracking radar

UI - unidentified

VEESS - vehicle engine exhaust smoke system

vs - versus

w/ - with (followed by associated item)

WP - white phosphorus (ammunition)

EXHIBIT RR

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1.0 PURPOSE

[P-33641 - P-33643], [P-33645], [P-33714 – P-33719], [P-33730], [P-35351], [JAFP-87-0737], [JPN-89-051], [IP3-87-055Z], [IPN-89-044], [BEC0-89-107], [FVY-89-66], [FVY-87-94], [FVY-87-121], [P-1079], [P-35269], [P-24444], [P-15802], [P-15803], [P-16557], [P-20303], [P-22888]

- [1] The purpose of this procedure is to provide requirements for establishing and maintaining an effective Flow Accelerated Corrosion (FAC) Program that will standardize Entergy Nuclear Fleet's approach towards mitigating FAC damage.
- [2] This procedure uses a systematic approach for long term monitoring to enhance the reliability of the affected FAC components by reducing the probability of failures and reduces maintenance costs associated with unplanned or unnecessary repairs.
- [3] This procedure provides criteria and methodology for selecting components for inspection, performing inspections, evaluating inspection data, disposition of results, sample expansion requirements, piping repair /replacement criteria, program responsibilities and documentation requirements.
- [4] This program is applicable to carbon steel plant piping systems and includes feed water heater and moisture separator re-heater (MSR) shells susceptible to FAC. It includes inspections of single-phase and two-phase piping components for both safety and non-safety related systems.
- [5] This procedure may be used as a guide for evaluating systems and components that are not included in the FAC program.

2.0 REFERENCES

- [1] NRC Generic Letter 89-08, Erosion/Corrosion Induced Pipe Wall Thinning.
- [2] NUREG-1344, "Erosion/Corrosion-Induced Pipe Wall Thinning in U.S. Nuclear Power Plants."
- [3] NSAC 202L, latest revision, EPRI Document, "Recommendations for an Effective Flow Accelerated Corrosion Program"
- [4] EPRI Technical Report, TR-106611, "Flow-Accelerated Corrosion in Power Plants"
- [5] NRC Bulletin No. 87-01, "Pipe Wall Thinning."
- [6] EN-LI-102, "Corrective Action Process."
- [7] Erosion/Corrosion in Nuclear Power Plant Steam Piping: Causes and inspection Program Guidelines. EPRI, April 1985. NP-3944.

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2.0 cont.

- [8] ENN-NDE-9.05, "Ultrasonic Thickness Examination"
- [9] ANSI B31.1 "Power Piping", (For applicable code year see individual plant FSAR).
- [10] ENN-DC-126, "Calculations".
- [11] ENS-DC-126, "Engineering Calculation Process".
- [12] ENS-DC-126-01, "Engineering Calculation Process".
- [13] ENN-CS-S-008, "Pipe Wall Thinning Structural Evaluation".
- [14] ENS-PS-S-001, "Pipe Wall Thinning and Crack-like Flaw Evaluation Standard".
- [15] Site ASME XI Repair / Replacement Program as applicable.
- [16] ENN-EP-S-005 "Flow Accelerated Corrosion Component Scanning and Gridding Standard".
- [17] EPRI Paper, "Single-Phase Erosion/Corrosion of Carbon Steel Piping", February 1987.
- [18] EPRI Paper - "Practical Consideration for the Repair of Piping Systems Damaged by Erosion/Corrosion", dated 10/5/87
- [19] Acceptance Criteria for Structural Evaluation of Erosion/Corrosion Thinning in Carbon Steel Piping. EPRI, April 1988. NP-5911.
- [20] NRC Generic Letter 90-05, "Guidance for Performing Temporary Non-Code Repairs of ASME Code Class 1, 2 & 3 Piping".
- [21] INPO SOER 87-3, "Piping Failures in High-Energy Systems Due to Erosion/Corrosion", March 1987.
- [22] INPO Significant Operating Experience Report (SOER) 82-11, "Erosion of Steam Piping and Resulting Failure", February 1982.
- [23] IN 93-21, Summary of NRC Staff Observations compiled during Engineering Audits on inspections of Licensee E/C Programs", dated March 25, 1993.
- [24] EPRI CHUG Position Paper #3, "A Summary of Tasks and Resources Required to Implement an Effective Flow Accelerated Corrosion Program."

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- [25] EPRI CHUG Position Paper #4, "Recommendations for inspecting Feedwater Heater Shells for Flow-Accelerated Corrosion Damage", February 2000.
- [26] CHECWORKS Steam /Feedwater Application, "Guidelines for Plant Modeling and Evaluation of Component Inspection Data", EPRI No. 1009599, Final Report, September 2004.
- [27] Entergy Quality Assurance Manual
- [28] ENN FAC Qualification Card ENN-TK-ESPG-042, "Implementing the Flow Accelerated Corrosion Program".
- [29] ENN/ENS-DC-115, "Engineering Response Development".
- [30] EN-DC-115, "Engineering Change Development"
- [31] EOI-C-QC-ESPP-PFAC- "Qualification card for Flow Accelerated Corrosion Engineers".
- [32] EN-DC-202, "NEI 03-08 Materials Initiative".
- [33] JAF-SPEC-MISC-03290 Rev.0, "Specification for Evaluation and Acceptance of Local Areas of material, parts and components that are less than the specified thickness." By REEDY Engineering.
- [34] IP3-SPEC-UNSPEC-02996 Rev.0, "Specification for Evaluation and Acceptance of Local Areas of material, parts and components that are less than the specified thickness." By REEDY Engineering.
- [35] CHECWORKS Steam /Feedwater Application, Version 2.1, EPRI No. 1009600; Final Report, October 2004.
- [36] CHECWORKS Steam /Feedwater Application, latest version.
- [37] Institute of Nuclear Plant Operations, "Engineering Program Guide, Flow Accelerated Corrosion", EPG-06 (Pending).

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3.0 DEFINITIONS

- [1] Base Line Inspection – An initial wall thickness measurement of a component taken prior to being placed in service.
- [2] Basis Document - Program documents that define the scope, attributes, commitments, evaluation reports and predictive models that forms the basis of the FAC program (i.e., System Susceptibility Evaluation reports). These documents contain the basis for the plant piping in the CHECWORKS model, the susceptible-not-modeled (SNM) piping and those that are non-susceptible.
- [3] Code Minimum Thickness (t_{min} , $t_{codemin}$) – The minimum required global wall thickness based on hoop stress.
- [4] Critical Thickness (t_{crit}) -The minimum required wall thickness per code of construction required to meet all design-loading conditions.
- [5] Deficient Component - A component identified by examination to be below t_{accept} wall thickness or projected to be below t_{accept} wall thickness by the next refueling outage.
- [6] Degraded component – A component identified as being below the screening criteria that is acceptable for continued operation.
- [7] EPRI CHUG – EPRI CHECWORKS USERS GROUP.
- [8] Examination - Denotes the performance of all visual observation and nondestructive testing, such as radiography, ultrasonic, eddy current, liquid penetrant and magnetic particle methods.
- [9] Examination Checklist/ Traveler – A data sheet developed for the components being inspected and may contain but is not limited to the following: t_{nom} , t_{meas} , T_{min} , Screening criteria, components name, system number, previous data, inspection datasheet number, grid size, examination extent, work order and affiliated minimum wall calculation.
- [10] Flow Accelerated Corrosion (FAC) - Degradation and consequent wall thinning of a component by a dissolution phenomenon, which is affected by variables such as temperature, steam quality, steam/fluid velocity, water chemistry, component material composition and component geometry. Previously known as Erosion/Corrosion.

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- [11] Grid - A pattern of points or lines on a piping component, where UT thickness measurements will be made. Grid may be permanently marked with circumferential and longitudinal grid lines.
- [12] Grid Point – A Specific location on a piping component, where a UT thickness measurement will be made. Grid points are at the intersections of the circumferential and longitudinal grid lines.
- [13] Grid Point Reading – UT reading taken at the intersection of the grid location.
- [14] Grid Scan– 100% scans of the area between the grid lines. The lowest measurement in each area to be recorded as the measured thickness.
- [15] Full Scan – scans of 100% of an area, circumference, nozzle, heater segments etc, measuring minimum, maximum and averages thicknesses and approximate location of minimum measured thickness.
- [16] Grid Size - The distance between grid points in the circumferential or longitudinal direction. Also called grid space or grid spacing.
- [17] Initial Thickness (t_{init}): The thickness determined by ultrasonic examination prior to the component being placed into service (baseline) or the first ultrasonic examination during its service life. If an examination has not previously been performed on the component, the initial thickness shall be determined by reviewing the initial ultrasonic data for that component. The area of maximum wall thickness within the same region as the worn area (based on the method selected for evaluating wear) shall be identified and compared to t_{nom} . If the thickness is greater than t_{nom} , the maximum wall thickness within that region shall be used as t_{init} . If that thickness is less than t_{nom} , t_{nom} shall be used as t_{init} .
- [18] Inspection Location - A specific component (i.e., elbow, tee, reducer, straight pipe section).
- [19] Inspection Outage - the outage during which the component was inspected.
- [20] Large-bore Piping - Piping generally greater than 2" nominal pipe size with butt-weld fittings.
- [21] Line Scans– piping segments broken into one-foot lengths (Small-Bore pipe).

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- [22] Minimum acceptable wall thickness (t_{accpt}) – Maximum value of axial stress, hoop stress, and or critical thickness and the piping replacement values of $0.3 t_{nom}$ for Class1 piping or $0.2 t_{nom}$ for Class 2, Class 3 and non-safety related piping.
- [23] Minimum Measured Thickness - (t_{meas} or t_{mm}) as identified by ultrasonic thickness examination, the present thickness at the thinnest point on a component.
- [24] Local minimum required thickness – (t_{aloc}) Minimum acceptable local wall thickness as calculated by ENN-CS-S-008 or ENS-PS-S-001.
- [25] Minimum required thickness – (t_{min}^a) Minimum required pipe wall thickness based on axial stress (See ENN-CS-S-008) .
- [26] Next Scheduled Inspection (NSI) -The outage at which an inspection will be performed on a given component.
- [27] Nominal Thickness (t_{nom}) - Wall thickness equal to ANSI standard thickness.
- [28] PASS 1 Analysis - Runs modeled in CHECWORKS that either have no inspection data, an insufficient number of inspections to provide a proper calibration, or where there is no expectation of ever developing a proper calibration.
- [29] PASS 2 Analysis - The process of utilizing UT inspection data thickness measurements in CHECWORKS to predict wear and wear rates for components.
- [30] Piping Segment - A run of piping that consists of inspection locations which have common operating parameters (i.e., temperature, pressure, flow rate, Oxygen content and pH level).
- [31] Predicted /Projected Thickness (t_p , t_{pred}) -The calculated thickness of a component based upon a rate of wear to some point in time (e.g., next refueling, next scheduled examination).
- [32] Quadrant Scan– Piping segments divided in quadrants A, B, C, D that are 90 degrees apart and broken into one-foot lengths, or as specified by the FAC engineer.

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- [33] Qualified FAC Engineer- Individual who has completed the FAC Qualification Card, who participates in the Engineering Support Personnel (ESP) training program and demonstrates knowledge required for the use of the CHECWORKS computer program.
- [34] Reference Point - The point on a piping component where the longitudinal and circumferential grid lines originate.
- [35] Remaining Service Life (RSL) - The amount of time remaining based upon an established rate of wear at which the component is anticipated to thin to t_{accpt} .
- [36] Safety Factor – A Margin of Safety used to account for inaccuracies in wear rate evaluation.
- [37] Sample Expansion - The addition of inspection locations based on significant or unexpected wall thinning during planned inspection(s).
- [38] Significant wall thinning - Wall thinning to a thickness which is the largest of:
- (a) a thickness less than 60% of pipe nominal wall thickness
 - (b) Wall thinning to a thickness that is half the remaining margin of the piping/ component which is above t_{accpt} . [$\frac{1}{2} (0.875 t_{nom} + t_{accpt})$]
 - (c) $(t_{accpt} + 0.020)$ inch.
- [39] Small-bore Piping - Piping that is generally 2" or less nominal diameter and that typically uses socket welded fittings.
- [40] Subsequent Inspection - Inspection of components that have had a baseline inspection and/or an initial operational inspection.
- [41] Susceptible Line - Piping determined to be susceptible to FAC using the EPRI susceptibility criteria in NSAC 202L, industry experience and as documented in the System Susceptible Evaluation.
- [42] Susceptible Non-Modeled (SNM) Piping - A subset of the FAC susceptible lines that cannot be modeled using the EPRI CHECWORKS software.
- [43] Time - Time in service shall be actual hours on line or of operation and/ or hours critical. Calendar hours may be used for conservatism.

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- [44] Train – Loops within subsystems that have similar geometries, flow rates and temperatures and which have similar FAC risk.
- [45] UT Datasheets - Paperwork that documents the results of the ultrasonic thickness inspections.
- [46] Wear (W) - The amount of material removed or lost from a components wall thickness since baseline or subsequent to being placed in service.
- [47] Wear Rate (WR) - Wall loss per unit time.

4.0 RESPONSIBILITIES

4.1 MANAGER, ENGINEERING PROGRAMS

- [1] Providing a single point of accountability and is responsible for the overall health and direction of the FAC programs.
- [2] Ensuring that the FAC programs are effectively developed and implemented.
- [3] Providing oversight for implementing the FAC programs.
- [4] Co-ordinate ENN or ENS FAC working group meetings.
- [5] Co-ordinate ENN or ENS FAC Self-Assessments.

4.2 SUPERVISOR, CODE PROGRAMS

- [1] Designate responsible engineer/Personnel from the Code Programs Engineering Group for the implementation and maintenance of the Flow Accelerated Corrosion Program.
- [2] Ensure that the Flow Accelerated Corrosion Program activities are conducted in accordance with this procedure.
- [3] Shall ensure that repair procedures are in place to support any planned repairs or replacements.
- [4] Ensure audits and surveillance of selected Flow Accelerated Corrosion (FAC) activities is performed to verify compliance with applicable codes, procedures and drawings.

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- [5] Provides personnel to perform NDE during normal plant operation and unscheduled outages.
- [6] Shall provide qualified Non-Destructive Examination personnel to perform flow accelerated corrosion inspections during scheduled refueling and maintenance outages.
- [7] Provides personnel to perform reviews of all final FAC UT data sheets.
- [8] Provides personnel to review vendor procedures, personnel certifications and equipment certifications.
- [9] Assuring adequate technical personnel are available to provide required support services prior to the outage.
- [10] Allocation of resources to execute the requirements of the program.
- [11] Provide funding and resources to address control and configuration requirements for FAC drawings.
- [12] Having bench strength and back up personnel for the FAC program.

4.3 NDE LEVEL III OR DESIGNEE

- [1] Reviews and approves FAC personnel and equipment certifications, and NDE procedures including revisions.
- [2] NDE Level II or Level III reviews and signs all final NDE/UT data sheets to ensure appropriate NDE examinations have been completed in accordance with the FAC program. The NDE level III review of Risk Informed examination shall be performed in accordance with the site ISI program requirements.
- [3] Resolution of anomalies found in inspection data.
- [4] Identify discrepancies or deficiencies and initiates condition report in accordance with FAC program or site protocols as appropriate.
- [5] Performs oversight of selected FAC examinations to verify vendor procedure compliance.
- [6] Performs functions in accordance with applicable procedures including the Entergy Quality Assurance Program.

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4.4 FLOW ACCELERATED CORROSION ENGINEER

- [1] Shall determine scope of inspections. The FAC Engineer shall develop a list of components/piping segments to be inspected prior to each outage using the criteria of NSAC-202L and CHECWORKS Pass1 and Pass 2 output as a guide. Previous outage inspection results shall be reviewed prior to development of the inspection list. This list shall be based on the susceptibility to flow accelerated corrosion and the severities of wear identified from previous inspection results.
- [2] Review and/or perform an engineering evaluation for all Flow Accelerated Corrosion inspections where pipe wall thinning has been identified and concur on any recommended action. Calculations shall be done in accordance with applicable procedures.
- [3] Shall ensure that appropriate inspections are performed in accordance with the scope of the Flow Accelerated Corrosion Program.
- [4] Shall review and may sign all inspection data and make recommendations for repair/replacement of piping materials in accordance with applicable site protocols.
- [5] Shall provide NDE data for review and signature to the ANII, if requested by the ANII.
- [6] Shall provide Risk Informed Inspection data sheet (s) to the ANII for review and signature, if applicable.
- [7] Develops or reviews program basis documents.
- [8] Shall revise and/or expand the scope of the Flow Accelerated Corrosion inspection program to incorporate industry and in-house operating experiences and track/trend inspection results.
- [9] Shall maintain records of all inspection results and inspection database.
- [10] Develop a FAC examination checklist/traveler that contains t_{nom} , screening criteria, t_{accpt} , line number, etc. for the components being inspected.
- [11] Shall initiate request for engineering services in accordance with the MAXIMO/Indus Asset Suite or site specific work control system for piping replacement or engineering evaluations as required. This request should include recommended materials for replacement and configuration changes, if applicable, to reduce the effects of flow accelerated corrosion.
- [12] Shall periodically review completed plant modifications to assess their effect on the scope of the flow accelerated corrosion program.

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- [13] Shall assist in vendor oversight as required.
- [14] Maintaining control of the predictive models (e.g. CHECWORCS), which includes any development, updates or revisions to the models.
- [15] Developing, revising, and issuing FAC program documents.
- [16] Initiating and/or responding to Condition Reports and Engineering Requests for evaluating degraded and deficient components or other discrepancies or deficiencies within the scope of the FAC program.
- [17] Developing post outage inspection summary reports.
- [18] Review and disposition Operating Event (OE) notices for applicability to the FAC program.
- [19] Analyzing inspection data to determine component acceptability for continued service and to determine the need for sample expansion.
- [20] Prioritizing and ranking inspection in terms of susceptibility and consequence of failure.
- [21] Develop and maintain the System Susceptibility Evaluation report.

4.5 DESIGN ENGINEERING/RESPONSIBLE ENGINEER

- [1] Provide minimum acceptable wall thickness (t_{accpt}) to the FAC Engineer. Responsibility may be delegated to another department or qualified personnel.
- [2] Perform local wall thinning evaluations for components having UT measurements that are below or are projected to go below the minimum acceptable wall thickness (t_{accpt}) or administrative wall thickness requirement. Responsibility may be delegated to another department or qualified personnel.
- [3] Prepare and issue engineering response packages for component requiring replacement. Responsibility may be delegated to another department or qualified personnel.
- [4] Perform remaining service life evaluation for components in the FAC program as required. Responsibility may be delegated to another department or qualified personnel.

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4.6 MAINTENANCE SUPERVISOR/DESIGNEE

- [1] The maintenance supervisor or designee will ensure that adequate craft personnel are available to support the FAC program. The supervisor shall ensure that scaffolding is erected, when needed, and insulation removed from components/piping segments that will be inspected and that the piping is prepared for inspection. Scaffolding erection in safety related areas should be in accordance with site procedures.
- [2] The maintenance supervisor or designee shall inform the FAC engineer when it is necessary to remove a pipe support for inspection. An engineering evaluation is required if a pipe support requires removal.
- [3] The maintenance supervisor must ensure that surfaces to be inspected are free from all foreign materials that would interfere with the inspections, i.e., dirt, rust, paint, etc. If cleaning is required, this may be accomplished by power sanding, flapper wheel only) hand wire brushing, or hand sanding in accordance with site procedures/protocols.
- [4] The maintenance supervisor shall ensure restoration of lines, i.e. insulation replaced, scaffolding removed, upon completion of the FAC inspection.

4.7 FAC/ISI PROJECT COORDINATOR

- [1] A FAC/ISI project coordinator may be chosen to Implement the activities of the inspection plan, the duties, if applicable, may include but is not limited to the following activities:
 - (a) Performing component walk downs
 - (b) Generating NDE inspection packages
 - (c) Defining NDE staffing as required
 - (d) Scheduling of inspections
 - (e) Acquiring data as required
 - (f) Providing field coordination to ensure timely inspection are accomplished
 - (g) Tracking progress of the FAC inspection project
 - (h) Transmitting inspection results to the FAC Engineer

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5.0 DETAILS

5.1 PRECAUTIONS AND LIMITATIONS

None.

5.2 ANALYSIS/PRE-EXAMINATION

- [1] The criteria contained in NSAC-202L, latest revision, shall be used to perform the System Susceptibility Evaluation (SSE).
- [2] The System Susceptibility Evaluation report shall be developed and peer checked in accordance with ENN or ENS procedures.
- [3] Non-typical operation of systems should be taken into consideration and if necessary factored into the FAC program.
- [4] The susceptible small-bore piping inspection priority ranking should consider personnel safety, consequence of failure and plant unavailability.
- [5] Industry and plant experiences relating to FAC will be factored into the program.
- [6] The CHECWORKS model should be used for guidance in determining inspection priority based on relative ranking for specific locations to be examined for FAC damage.

5.3 PREPARATION OF OUTAGE INSPECTION PLAN

- [1] The FAC Program Engineer shall prepare an Outage Inspection Plan prior to the outage to meet site milestones.
- [2] The Outage Inspection Plan should consider the cost of repair/replacement versus inspection.
- [3] The Outage Inspection Plan should consider inspection priority based on relative ranking for specific locations to be examined for FAC damage.
- [4] Each identified location shall be documented in the inspection plan, along with the component number and reason for selection.
- [5] The inspection plan shall be reviewed by qualified FAC personnel.

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[6] Component Selection

- (a) The FAC engineer shall prepare a FAC Outage Inspection scope as directed by plant milestones or as directed by Station management.
- (b) Inspection selections shall be made in accordance with the requirements of this procedure and shall be identified based on CHECWORKS results, industry/station/utility experience, required re-inspections, the non-modeled program piping and engineering judgment.
- (c) If a selected inspection location is determined to be excessively difficult, impractical or costly to examine due to inaccessibility, temperature, ALARA concerns, scaffolding requirements, or other factors, then an equivalent alternate inspection location may be selected.
- (d) Components selected shall be formally documented.
- (e) The criteria for component selection should consider the following:
 - (1) Components selected from measured or apparent wear found in previous inspection results.
 - (2) Components ranked high for susceptibility from current CHECWORKS evaluation.
 - (3) Components identified by industry events/experience via the Nuclear Network or through the EPRI CHUG.
 - (4) Components selected to calibrate the CHECWORKS models.
 - (5) Components subjected to off normal flow conditions. Primarily isolated lines to the condenser in which leakage is indicated from the turbine performance monitoring system.
 - (6) Engineering judgment / Other
 - (7) Piping identified from Work Orders (malfunctioning equipment, downstream of leaking valves, etc.).
 - (8) Susceptible piping locations (groups of components) contained in the Small Bore Piping database, which have not received an initial inspection.

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- (9) Piping identified from Condition Reports/ Corrective action, Work Orders (malfunctioning equip, downstream of leaking valves, etc.).
- (10) Vessel Shells – Feed-water heaters, moisture separator re-heaters, drain tanks etc.

[7] Inspection schedule

- (a) Inspection sequence and schedule should be developed based on priority established by the FAC engineer considering repair/scope expansion potential. Consideration will also be incorporated based on other outage work priorities, job conflict and system window duration.
- (b) The FAC outage schedule should contain sufficient time for analysis and evaluations of the components being inspected.

[8] Drawing Preparation

- (a) For each component scheduled for inspection, an isometric or other acceptable location drawing should be prepared prior to the outage that identifies the component to be examined. When applicable ensure the component number is shown on the drawing.

[9] Obtain Minimum Acceptable Wall Thickness (t_{accpt})

- (a) Obtain t_{accpt} values for each component to be inspected.
- (b) The minimum acceptable wall thickness, t_{accpt} , values should be obtained from ENN-CS-S-008 or ENS-PS-S-001 as applicable or from an approved site method (e.g. FAC Manager).
- (c) Values for t_{accpt} should be obtained from design engineering or it may be delegated to another department or qualified personnel. These values may be ascertained prior to or during an outage.

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[10] Component Identification

- (a) Inspected components should have a unique identifier to allow for the tracking of inspection data.
- (b) Component identifiers may allow for the identification of the Unit, system, sub-system, line number and corresponding location of that component within a sub-system.
- (c) Components in the CHECWORKS non-modeled piping may be identified by using line numbers.

[11] Pre-inspection Activities

- (a) Review inspection schedule, inspection requirements and sequence with appropriate plant personnel to ensure requirements for the completion of the FAC inspection are understood.
- (b) The FAC engineer should participate in the preparation of FAC inspection work packages as required.

5.4 GRIDDING

- [1] Gridding of components shall be performed in accordance with recommendation of NSAC 202L, ENN-EP-S-005 (for ENN plants only), and applicable site approved procedures or as specified by the FAC engineer.
- [2] Gridding information shall be documented on the appropriate NDE UT data sheet either by a sketch or digital photo.

5.5 NDE TEST METHODS AND DOCUMENTATION

- [1] Components can be inspected for FAC wear using ultrasonic testing (UT), radiography testing (RT), visual observation or other approved methods. The inspection technique used shall be at the discretion of the FAC engineer.

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[2] UT thickness measurement is the primary method of determining pipe wall thickness.

(a) Inspections will be performed by using one of the following techniques:

- (1) Grid Point Reading
- (2) Grid Scan
- (3) Quadrant Scan
- (4) Line Scan
- (5) Full Scan

(b) Ultrasonic Thickness measurement shall be performed in accordance with approved NDE, site or vendor procedures.

(c) A data sheet for components inspected shall be prepared. The information included in the sheet should contain but is not limited to the following:

- (1) Plant's name/unit
- (2) Components name
- (3) Component sketch
- (4) NDE technician signature/ date
- (5) Grid size
- (6) Axial and radial grid boundaries
- (7) Calibration information
- (8) Level II or Level III signature/date
- (9) Work order information
- (10) Nominal & Measured thickness
- (11) 87.5% nominal thickness screening criteria
- (12) Scanning method

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[3] Radiograph Testing

- (a) RT (digital or conventional) is the preferred method for inspecting socket welded fittings. The method used is at the discretion of the FAC engineer.
- (b) RT can be performed during plant operations without removing insulation

[4] Visual Observation

- (a) Visual observation/techniques may be used for examination of large components such as tanks, cross-around piping, cross-under piping, pump casings, shell walls, valves etc. (visual techniques is only applicable to two phase flow).
- (b) Follow-up UT examinations, at the discretion of the FAC engineer, may be required of areas where significant damage is observed or suspected.

5.6 EVALUATION OF UT INSPECTION DATA

NOTE

Historically, typical manufacturing practice has been to supply fittings (especially tees, elbows and reducers) with wall thickness significantly larger than the piping nominal thickness.

- [1] The data review should consider screening for further evaluation. Factors that should be considered when reviewing the inspection data include unknown initial thickness (especially fittings), counter-bore, obstructions, and manufacturing wall thickness variations.
- [2] For each component that is examined and is below the screening criteria of 87.5% of nominal wall, the wear, wear rate, remaining service life shall be calculated.
- [3] The FAC Program Engineer or designee shall review the UT data to ensure that the data is complete and corresponds to the requirements specified on the inspection data sheet (i.e., grid size, spacing, flow direction, starting and ending locations, obstructions, missing data, suspect readings and orientation).
- [4] If low readings are encountered from repeat inspections that are due to counter-bore, then those areas shall be noted and additional inspections are not required.

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[5] Grid Refinement

- (a) A grid reduction / refinement may be used if the minimum measured thickness is less than the minimum required wall thickness, severe wall thinning is detected, engineering judgment, or the projected thickness is less than the minimum required wall thickness or as directed by the FAC engineer.
- (b) The results of the grid refinement or scan shall be documented on an inspection data sheet.

[6] Grid Extension

- (a) If measurement indicates wall loss at any edge of the grid, then the grid should be extended until the entire wear pattern is mapped.

[7] Determination of Initial Wall Thickness

- (a) Initial Thickness (t_{init}): The thickness determined by ultrasonic examination prior to the component being placed into service (baseline) or the first ultrasonic examination during its service life. If an examination has not previously been performed on the component, the initial thickness shall be determined by reviewing the initial ultrasonic data for that component. The area of maximum wall thickness within the same region as the worn area (based on the method selected for evaluating wear) shall be identified and compared to t_{nom} . If the thickness is greater than t_{nom} , the maximum wall thickness within that region shall be used as t_{init} . If that thickness is less than t_{nom} , t_{nom} shall be used as t_{init} .

[8] Determination of Wear

- (a) Wear of piping components may be evaluated using the band, area, and blanket or point-to-point method as defined in NSAC-202 L, latest revision or any other approved method.
- (b) Evaluation of inspection data that is determined to require wear evaluation shall be documented and reviewed.

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5.6 cont.

[9] Wear rate Determination

- (a) Wear rate is determined by wear/ unit time (Units to be consistent with thickness evaluation).
- (b) A reasonable safety factor should be applied to the wear rates to account for inaccuracies in the FAC wear rate calculations.
- (c) Wear rate evaluation should be evaluated on a component evaluation sheet.

[10] Predicted Thickness (t_p , t_{pred})

- (a) The projected or predicted thickness to the next schedule refueling outage.

$$t_{pred} = t_{meas} - \text{Safety factor} \times \text{Wear Rate} \times \text{Time}$$

A safety factor of 1.1 should be applied to all Entergy nuclear plants. If a value less than 1.1 is used the reason shall be documented.

[11] Determination of Remaining Service Life (RSL)

- (a) Remaining service life (RSL) shall be evaluated as follows, units to be consistent with thickness evaluation:

$$\text{RSL} = (t_{meas} - t_{accpt}) / (\text{Safety Factor} \times \text{Wear Rate})$$

5.7 EVALUATION OF RT INSPECTION DATA

- [1] Qualified NDE personnel shall interpret the film and report the examination result to the FAC engineer.
- [2] Appropriate conservatism should be used to determine if a component requires replacement or re-inspection as a consequence of qualitative nature of RT.
- [3] RT inspection shall be recorded on a data sheet.

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5.8 EVALUATION OF VISUAL INSPECTION DATA

- [1] Where accessible, visual inspections may be performed on two-phase flow lines.
- [2] Follow-up UT inspection is required for locations where significant damage is observed or suspected.
- [3] Due to the qualitative nature of visual inspections, appropriate conservatism should be used when determining whether a component is acceptable to return to service and when establishing a re-inspection frequency.

5.9 DISPOSITION OF INSPECTION RESULTS

- [1] The following are used to disposition component inspection results. Reference attachment 9.3 for logic diagram

NOTE

Certain components may have very little margin remaining as a consequence of high stresses in the line even though $t_{pred} \geq 0.875 t_{nom}$ and therefore may require evaluation, for example Feedwater, Condensate, RHR, etc.

- [2] If t_{pred} is $\geq 0.875 t_{nom}$, the component is acceptable as is and may be returned to service.
- [3] If t_{pred} is $< 0.875 t_{nom}$, evaluate for sample expansion (Reference section 5.12).
- [4] If t_{pred} is $\leq 0.3 t_{nom}$, for ISI Class 1 piping repair or replacement is required in accordance with the requirements of ASME Section XI Repair and Replacement Program.
- [5] If t_{pred} is $\leq 0.2 t_{nom}$, for ISI Class 2, Class 3 and non-safety related, repair, replace or evaluate as warranted in accordance with applicable site programs or as directed by the FAC engineer.
- [6] If t_{pred} is $\geq t_{accpt}$, the component is acceptable for continued operations, however monitoring is required in accordance with program requirements.

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5.9 cont.

- [7] If t_{pred} is $< t_{accpt}$, a structural evaluation is required in accordance with site approved procedures or engineering standards. Also a sample expansion evaluation is required. Repair or replacement in accordance with the requirements of ASME Section XI Repair and Replacement Program or other site approved process may also be required.
- [8] If t_{meas} is $< t_{accpt}$, **generate a condition report**. A structural evaluation is also required in accordance with applicable site procedures or engineering standards.

5.10 RE-INSPECTION REQUIREMENT

- [1] If the remaining service life (RSL) of a component is greater than or equal to the number of hours in the next operating cycle, then the component may be returned to service.
- [2] If the component's remaining service life (RSL) is greater than the number of hours in the next operating cycle but is less than the number of hours in the next two operating cycles, then the component should be considered for re-inspection, repair or replacement during the next scheduled outage.
- [3] If the component is acceptable for continued service, then it shall be re-examined before or during the outage immediately prior to the cycle during which it is projected to wear to the minimum allowable wall thickness.

5.11 COMPONENTS FAILING TO MEET INITIAL SCREENING CRITERIA

- [1] If the results of the remaining life evaluation are shorter than the amount of time until the next scheduled inspection, there are several options for disposition of the component, as follows:
- (a) Shorten the inspection interval (for components that can be inspected online)
 - (b) Refine the t_{accpt} value through a detailed stress analysis, which should be provided by Design Engineering or designee.
 - (c) Repair or replace the component
 - (d) ISI Class1 components that are less than or equal to $0.3 t_{nom}$ must be repaired or replaced unless further structural evaluation permits continued service.
- [2] Wall thinning resulting in less than t_{accpt} shall be reported immediately to the FAC engineer by verbal or written communications.

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5.11 cont:

- [3] A condition report shall be generated when significant wall thinning or unexpected wear is detected in a system or component.
- [4] A condition report shall be generated for wall thinning below t_{accpt} or other site established limit and a subsequent structural evaluation performed to disposition the line for continued service.
- [5] If a previous condition report was generated for a component with wall thinning then no new condition report is required provided that the associated structural evaluation is current and applicable.

5.12 SAMPLE EXPANSION

- [1] If a component is discovered that has a current or projected wall thickness less than the minimum acceptable wall thickness (t_{accpt}), then additional inspections of identical or similar piping components in a parallel or alternate train shall be performed to bound the extent of thinning except as provided below. Reference section 5.12.2.
- [2] When inspections of components detects significant wall thinning and it is determined that sample expansion is required, the sample size for that line should be increased to include the following:
 - (a) Components within two diameters downstream of the component displaying significant wear or within two diameters upstream if the component is an expander or expanding elbow.
 - (b) A minimum of the next two most susceptible components from the relative wear ranking in the same train as the piping component displaying significant wall thinning.
 - (c) Corresponding components in each other train of a multi-train line with a configuration similar to that of the piping component displaying significant wall thinning.
- [3] If the expanded inspection scope detects additional degradation, the sample expansion should continue until no additional components with significant wear are detected.
- [4] Sample expansion is not required if the thinning was expected or if the thinning is unique to that component (e.g., degradation downstream of a leaking valve).

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5.12 cont.

- [5] Inspections of components from the current or past outages may satisfy the sample expansion criteria, therefore, some of the sample expansion requirements can be met without performing additional inspections.
- [6] Sample expansion is not required for components that are being re-inspected if normal or expected wear is detected or wear unique to that component. All other wear patterns encountered shall be evaluated by the FAC Engineer to determine if sample expansion is required.

5.13 REPAIR / REPLACEMENT OF DEGRADED COMPONENTS
[NRC Generic Letter 90-05]

- [1] The FAC engineer shall generate applicable documents to facilitate repair or replacement of degraded or deficient components.
- [2] Components experiencing severe or unacceptable wear should be replaced with corrosion resistant material. However like in kind replacement may be appropriate if procurement of a resistant material would delay plant restart.
- [3] Replacing components or fitting-by-fitting that have experienced significant wear is a satisfactory approach to reducing wear if the wear is very localized (i.e., wear is concentrated downstream of a flow control valve or orifice).
- [4] Repairs and replacements to piping and components within the scope of Class 1, 2, 3 shall be performed in accordance with the requirements of ASME Section XI Repair and Replacement Program.
- [5] All temporary non-code repairs to ISI Class 1, 2, 3 shall comply with NRC Generic Letter 90-05.

5.14 COMPONENT EVALUATION PACKAGES

- [1] The FAC Engineer or designee shall assemble a component evaluation package for each examined component which may contain some of, but is not limited to the following:
 - (a) UT DATA Sheet
 - (b) Isometric drawing(s), sketches, flow diagram and digital photo.
 - (c) Reference to Structural /Minimum wall evaluation
 - (d) Component evaluation data sheet.

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5.15 POST- INSPECTION ACTIVITIES

- [1] The FAC Program Engineer shall prepare an Outage Summary report to document the outage FAC activities and submit to Records for retention in accordance with applicable procedures.
- [2] Update CHECWORKS models with inspection data.
- [3] Update small bore susceptible report as applicable
- [4] Update all applicable FAC reports.
- [5] Update FAC System Susceptible Report as required.

5.16 LONG TERM STRATEGY

- [1] Entergy's fleet long-term strategy shall focus on reducing the plants FAC susceptibility. Optimization of the inspection planning process is an important factor. However, the reduction of FAC wear rates is necessary if both the number of inspections and the probability of failure are to be reduced. Subsequently the fleet's long term strategy will include the following elements:
 - (a) The use of improved materials for replaced components or proactive replacement of piping with corrosion resistant material.
 - (b) Utilization of improved water chemistry
 - (c) Incorporation of local design changes.
 - (d) Optimization of the inspection planning process,
 - (e) Industry participation in meetings for technology and information transfer (e.g. EPRI CHUG).
 - (f) Maintaining up-to-date predictive software and incorporating the latest inspection data in the models.

5.17 METHODS OF DETERMINING PLANT PERFORMANCE

- [1] Program performance indicators, self- assessments and bench marking are utilized as methods for monitoring program and plant performance.

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6.0 INTERFACES

- [1] ENN-CS-S-008, "Pipe Wall Thinning Structural Evaluation".
- [2] ENN-EP-S-005 "Flow Accelerated Corrosion Component Scanning and Gridding Standard".
- [3] ENS-PS-S-001, "Pipe Wall Thinning and Crack-like Flaw Evaluation Standard".
- [4] EN-DC-202, "NEI 03-08 Materials Initiative".

7.0 RECORDS

- [1] Record retention shall be in accordance with site procedures.

8.0 OBLIGATION AND COMMITMENTS IMPLEMENTED BY THIS PROCEDURE

8.1 OBLIGATIONS AND COMMITMENTS IMPLEMENTED OVERALL

None

8.2 SECTION/STEP SPECIFIC OBLIGATIONS AND COMMITMENTS

Step	Document	Document Section/Step	Commitment Number
[1]	QAPM	A.6a, A.6b, A.6c, A.6e	P33641-P33643, P-33645
[2]	QAPM	B.12a, B.12b, B.12c, B.12d, B.12e, B12f	P-33714 - P-33719
[3]	QAPM	B.15a, B.15c	P-33730, P-35351
[4]	NRC Generic Letter 90-05		None

8.3 SITE SPECIFIC COMMITMENTS

Step	Site	Document	Commitment Number or Reference
[1]	JAF	Response to NRC IE Bulletin 87-01	JAFP 87-0737
[2]	JAF	Response to NRC Generic Letter 89-08	JPN-89-051
[3]	IPEC Unit 3	Response to NRC IE Bulletin 87-01	IP3-87-055Z
[4]	IPEC Unit 3	Response to NRC Generic Letter 89-08	IPN-89-044
[5]	IPEC Unit 2	Response to NRC IE Bulletin 87-01	Mr. Murray Selman (Con Edison) to Mr. William Russell (NRC), Letter dated September 11, 1987.

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8.3 cont.

[6]	Pilgrim	Response to NRC Generic Letter 89-08	BEC0 89-107
[7]	VY	Response to NRC Generic Letter 89-08	Vermont Yankee letter to USNRC, FVY-89-66
[8]	VY	Response to NRC IE Bulletin 87-01	Vermont Yankee letter to USNRC, FVY-87-94
[9]	VY	Supplemental Response to NRC IE Bulletin 87-01.	Vermont Yankee letter to USNRC, FVY-87-121
[10]	ANO	OCAN108914	P-1079
[11]	GGNS	GGNS Appendix K, Power Uprate	P-35269
[12]	GGNS	Response to NRC Generic Letter 89-08	P-24444
[13]	RBS	Response to NRC IE Bulletin 93-02	P-15802
[14]	RBS	Response to NRC IE Bulletin 93-02, Supp. 1	P-15803
[15]	WF3	Response to INPO SOER 87-03	P-16557
[16]	WF3	Response to IEN 89-001	P-20303
[17]	WF3	Response to IEN 93-021	P-22888

(a)

9.0 ATTACHMENTS

- 9.1 Guidance on Parameters affecting FAC.
- 9.2 Flow Accelerated Corrosion Program Attributes.
- 9.3 Wall Thinning Evaluation Process Map.

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GUIDANCE ON PARAMETERS AFFECTING FAC

Listed below are factors to be considered when reviewing work requests, component replacements and modification packages for possible impact on the content of the FAC Program governed by DC-315. All Design Change Packages (DCP's) are required to be evaluated for impact to the FAC Program. This list is not intended to be all-inclusive or to limit the number of items an individual would consider when performing this impact assessment. It is intended as a reasonable list of items to consider for potential program content updates.

1. Water Chemistry. Many water chemistry parameters have been shown to contribute to FAC.
 - a. pH Control Amine – pH is the primary chemistry parameter affecting FAC rates in PWRs. However, the amine used to control pH also plays an important role. Amines such as ammonia tend to separate more into the steam phase in two-phase flow conditions, and therefore provide less protection in the drains. Amines such as morpholine and especially ethanolamine have better partitioning characteristics for FAC.
 - b. In a BWR, pH has much less of a role since the pH is stable and there are no amine's added to control the pH. FAC rates decrease as pH level increases. FAC rates seem to drop considerably at pH values of greater than 9.3 - 9.5.
 - c. Oxygen Content - FAC rates decrease as oxygen concentration increases. Values that typically result in minimum FAC rates are approximately 15 to 20 ppb.
 - d. Hydrogen Water Chemistry – BWR Plants that do not have hydrogen addition normally have a main steam oxygen content near 18 ppm. Plants with hydrogen water chemistry typically have an oxygen content from 3 to 12 ppm. This has a potential to impact the corrosion rates in the LP steam systems; mainly the first and second stage reheater drains based on industry experience.
 - e. Hydrazine Injection - Hydrazine is added to the feed train of PWRs as an oxygen scavenger and to maintain a reducing environment in the steam generators. From zero to approximately 150 ppb, an increase in hydrazine concentrations seems to increase rates of FAC. Higher concentrations seem to result in no further increase in FAC rates. EPRI recommends the use of high levels of hydrazine (>100 ppb) to protect steam generator tubes; however, this can result in accelerated rates of FAC in the feed train. Although CHECWORKS does not currently model high hydrazine conditions, any model updates performed after the release of version 1.0F should carefully consider hydrazine concentrations.
 - f. Zinc Injection - Industry experience has shown that zinc injection decreases corrosion and FAC wear rates due to the concentration of zinc at the oxide surface. The amount of reduction depends on the amount of zinc at the surface.

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2. Piping Geometry - Piping geometry is one of the most important factors in FAC. Generally, geometries that produce the greatest turbulence also produce the highest FAC rates. Listed below are examples of obvious items that should be considered in any assessment:
 - a. Addition or replacement of fittings, bends and branch connections.
 - b. Like for like replacement of any fitting in a system that is susceptible to FAC damage or is part of system that is already part of the FAC Program.
 - c. Alterations or repairs encountered in the nozzles or walls of FW heaters, MSR, Drain Tanks, FW Pumps, HD Pumps or CD/CB Pumps.
 - d. Throttled Valves.

3. Piping Material Composition - Alloying elements improve the resistance of piping systems to FAC. In ascending order of resistance, the following table presents the degree of improvement over carbon steel:

Material	Nominal Composition	Rate (carbon steel) / Rate (alloy)
P11	1.25% Cr, 0.50% Mo	34
P22	2.25% Cr, 1.00% Mo	65
304	18% Cr	>250

4. In-Line Components - Addition or replacement of such components as thermowells, flow elements and pressure-reducing orifices should be evaluated. The local effects caused by these components can generate FAC damage in areas where overall conditions don't indicate the need for inspections.

5. Component Supports - Additions or deletions of components supports which could result in the need for a review of the existing code minimum wall value or a new code minimum wall calculation.

6. Operational Changes - System operational changes such as the normal operation of emergency heater drains, switching of spare components, extended use of normal start-up or by-pass lines, etc.

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7. Component Replacements – Records should be updated for like for like replacement of fittings already in the program including new baseline data, changing next scheduled inspection due date, etc. Note and track whether the replacement components have had surface preparation and a UT grid applied for future outage planning.
8. External Sources – Information concerning FAC Inspection results from other stations and Nuclear Plants operated by others. General information distributed by EPRI Reports, INPO & NRC Bulletins, etc. should also be considered.
9. Maintenance History – A review of the maintenance performed on valves, orifices, steam traps, etc. should be considered. Valves that have had seat leakage can cause very localized wear in systems normally exempted. Plugged traps create water pockets in steam systems that accelerate metal loss. Eroded orifices can cause increased metal loss due to decrease in back pressure and increase in flow rates.

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PROGRAM ATTRIBUTES

Attributes:

Program Infrastructure

- (a) Program Structure: Roles & Responsibilities, Program Ownership, Organizational Interfaces, etc.
- (b) Configuration management
- (c) Program Bases
- (d) Engineering Documentation
- (e) Flow Accelerated Corrosion System Susceptibility Evaluation, Latest Revision.
- (f) CHECWORKS models
- (g) Change processes

Program Staffing and Experience

- (a) Background and Expertise.
- (b) Qualification and training.
- (c) Bench Strength
- (d) Time Allotment
- (e) Industry Participation

Program Implementation

- (a) Work control
- (b) Inspections
- (c) Maintenance and Repairs
- (d) Control of Changes and Deferrals
- (e) Review of INPO Operating Experience documents, CHUG operating experience, NRC notices.

Health Monitoring:

- (a) System Engineering Health reports.
- (b) FAC Quarterly Health Reports.

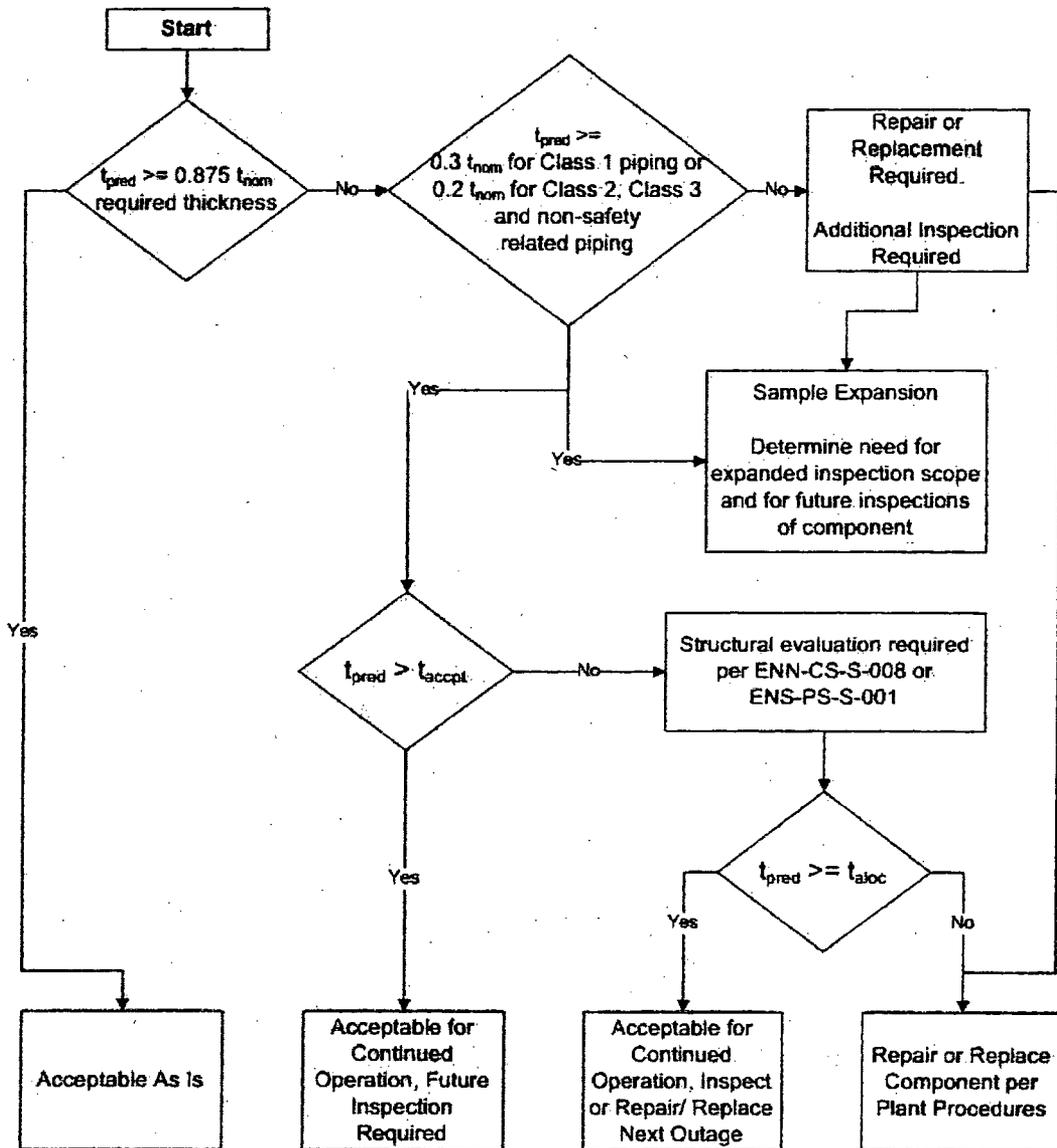
Effective Assessment:

- (a) Perform FAC Self-Assessment on a periodic basis or as defined by applicable procedures.

Oversight:

- (b) Effective assessment, Benchmarking or Audits.

Logic Diagram - Evaluation of Pipe Wall Thinning



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UNITED STATES NUCLEAR REGULATORY COMMISSION

ABOUT NRC

Home > Nuclear Reactors > Operating Reactors > Oversight > Reactor Oversight Process

Indian Point 3 2Q/2007 Plant Inspection Findings

Nuclear Reactors

Nuclear Materials

Initiating Events

Waste

Nuclear Security

Significance: [REDACTED] Mar 31, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

FAILURE TO INCLUDE THE INTAKE STRUCTURE TRASH RACKS WITHIN THE SCOPE OF THE MAINTENANCE RULE MONITORING PROGRAM

The inspectors identified a Green non-cited violation (NCV) of 10 CFR 50.65(b), in that, Entergy did not include the Indian Point Unit 3 trash rack structures within the scope of the maintenance rule monitoring program. Additionally, Entergy did not demonstrate the performance or condition of the trash racks was being effectively controlled through the performance of appropriate preventive maintenance such that the structure remained capable of performing its intended function. Entergy performed a cleaning of the trash racks to immediately address the lowered service water intake bay level, and they timed service water bay level monitoring to coincide with river low tide cycles. Entergy also entered this issue into the corrective action program as CR-IP3-2007-00453, and developed corrective actions to: modify the requirements for inspection and cleaning of trash racks based on component history and condition monitoring; modify guidance for service water bay level monitoring to be more effective; evaluate maintenance rule system scoping; develop procedural guidance for managing low service water bay levels; and implement a method for monitoring debris fouling of the trash racks.

The inspectors determined that this finding affected the Initiating Events cornerstone and was more than minor because it was similar to Example 7.d in Inspection Manual Chapter (IMC) 0612, Appendix E, "Examples of Minor Issues." Specifically, equipment performance problems were such that Entergy was unable to demonstrate effective control of the performance or condition of the trash racks through appropriate preventive maintenance as specified by 10CFR50.65 (a)(2). The inspectors evaluated the significance of this finding using Phase 1 of IMC 0609, Appendix A, "Significance Determination of Reactor Inspection Findings for At-Power Situations," and determined that the finding was of very low safety significance (Green) because it did not contribute to both the likelihood of a reactor trip and the likelihood that mitigation equipment or functions would not be available. (Section 1R12)

Inspection Report# : 2007002 ([pdf](#))

Significance: [REDACTED] Mar 31, 2007

Identified By: Self-Revealing

Item Type: NCV NonCited Violation

INADEQUATE PROCEDURE FOR RECIRCULATION SUMP INTERFERENCE REMOVAL

A Green, self-revealing, non-cited violation of 10 CFR 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," was identified, in that, Entergy's work package failed to ensure that piping interference was correctly planned for and removed during modifications to the vapor containment and recirculation sumps. On March 9, 2007, during the sump modifications, a section of pipe was cut for interference removal which was different from the piping specified in the work package. This resulted in approximately 385 - 500 gallons of reactor coolant being discharged from the reactor loops into the recirculation sump where personnel were working. The cause of the improper pipe being cut was misidentification of the piping by work planners, followed by a failure of workers to follow steps in the work package that should have identified the work package inadequacy. Immediate corrective actions included a revision to the work package that subsequently welded a cap on the open piping leading from the reactor coolant drain tank to the work site, and plant configuration tags were placed on the residual heat removal interface valves (SI-864E and 864F) to isolate the work area. Entergy entered this issue into the corrective action program as CR-IP3-2007-01059, performed a root cause analysis, and conducted a human performance error review.

The inspectors determined that this finding was more than minor because it was associated with the Procedure Quality attribute of the Initiating Events cornerstone; and, it affected the cornerstone objective of limiting the likelihood of those events that upset plant stability and challenge critical safety functions during shutdown as well as power operations. Specifically, cutting the wrong pipe resulted in the inadvertent draining of reactor coolant system inventory and increased the likelihood of a loss of inventory control. This finding was evaluated using Phase 1 of IMC 0609, Appendix G, "Shutdown Operations Significance Determination Process." The inspectors evaluated the plant conditions (cold shutdown, reactor coolant system open, refueling cavity less than 23 feet) in accordance with Checklist 3 of Appendix G, Attachment 1, and determined that the finding was of very low safety significance because it did not satisfy the criteria of Table 1 for a "Loss of Control," and the Checklist 3 criteria for maintaining adequate mitigation capability (Core Heat Removal Guidelines, Inventory Control Guidelines, Power Availability Guidelines, Containment Control Guidelines, and Reactivity Guidelines) were met.

The inspectors determined that this finding had a cross-cutting aspect in the area of human performance because the work package used for interference removal was not accurate and did not ensure the correct section of piping was identified and appropriately controlled. (Section 1R17)

Inspection Report# : 2007002 (*pdf*)

Significance: [REDACTED] Mar 31, 2007

Identified By: Self-Revealing

Item Type: NCV NonCited Violation

INADEQUATE PROCEDURE FOR CONDUCT OF RTD CROSS CALIBRATIONS

A Green, self-revealing, non-cited violation of 10 CFR 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," was identified, in that, Entergy failed to ensure that appropriate procedures existed to prevent conflicting activities which led to the opening of the pressurizer power operated relief valves (PORVs) when plant conditions did not require them to be open, leading to a partial plant depressurization during plant heat-up. Entergy entered this issue into their corrective action program as CR-IP3-2007-01691. Entergy took immediate corrective action to stop the reactor coolant system pressure transient, and they generated corrective actions to clarify the applicable procedure pre-requisites.

The inspectors determined that this finding was more than minor because it was associated with the Procedure Quality attribute of the Initiating Events cornerstone; and, it affected the cornerstone objective of limiting the likelihood of those events that upset plant stability and challenge critical safety functions during shutdown as well as power operations. Specifically, the lack of procedure clarity and poor interpretation of a procedure pre-requisite led to a loss of reactor coolant system pressure as a result of the pressurizer PORV actuation. This finding was evaluated using Phase 1 of IMC 0609, Appendix A, "Determining the Significance of Reactor Inspection Findings for At Power Situations." The inspectors determined that the finding was of very low safety significance because assuming the worst case degradation, the loss of inventory did not exceed the Technical Specification limit for identified reactor coolant system (RCS) leakage, and the finding would not have caused a total loss of another mitigating system safety function.

The inspectors determined that this finding had a cross-cutting aspect in the area of human performance because the applicable procedure prerequisites were not adequate as written to prevent a plant transient. (Section 1R20)

Inspection Report# : 2007002 (*pdf*)

Mitigating Systems

Significance: [REDACTED] Mar 31, 2007

Identified By: NRC

Item Type: NCV NonCited Violation

INADEQUATE PROCEDURE FOR CONTROL OF TEMPORARY MODIFICATION

The inspectors identified a Green, non-cited violation of 10 CFR 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," because Entergy failed to generate a procedure of a type appropriate to the circumstances associated with the implementation of a temporary modification to normal control room lighting power. The procedure that was generated lacked precautions, limitations, and prerequisites to prevent a low lighting condition in the control room from existing during implementation of the temporary modification. Consequently, during implementation of this temporary modification there were several control panels that did not have adequate lighting for operators to conduct control board manipulations. Entergy entered this issue into the corrective action program as CR-IP3-2007-00821, took immediate corrective action to add additional lighting to the control room, and generated a contingency procedure to allow backup lighting to be energized, if needed.

The inspectors determined that this finding was more than minor because it caused an actual condition to exist in the control room where lighting at selected control panels was not adequate, and contingency plans were not developed for