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Monthly Letter Status Report

Reporting Period	September 2002
Name and Address	Organization 6141, Mail Stop 0718 Sandia National Laboratories P. O. Box 5800 Albuquerque, NM 87185-0718
JCN	J5412
Title	Vulnerability Assessments for Transportation and Storage of Radioactive Materials
Principal Investigator	Ken B. Sorenson
Project Period of Performance	March 2002 through September 2004

Technical Progress

Jetliner Crash Report. All project analysts performing jetliner crash analyses wrote preliminary drafts of report sections and supplied them to Jeff Smith or Jeremy Sprung who are incorporating these drafts into a full report on the vulnerability of spent fuel casks to jetliner crash scenarios. The preliminary draft, which will be a classified document, will be sent to NRC early next month.

Task 1.1: Jetliner Crash into an ISFSI.

CTH and Zapotec Analyses. Zapotec calculations were conducted that modeled the impact of the jetliner into the free-floating cask (i.e., cask without an underlying concrete pad). Comparisons with previous CTH calculations indicate that Zapotec tends to predict significantly higher cask velocities. For example, the predicted cask velocity at 150 msec with CTH and Zapotec were ( ) respectively. A number of EOS warnings were noted in the Zapotec calculation. This is currently under investigation and must be resolved before Zapotec is ready for production computing.

PRONTO Analyses. Work continued on the full 3-D representation of the Hi-Storm cask that is needed to support the modeling of the ( ) of the front landing gear strut onto the ( ) and (2) a ( ) of the landing gear strut onto the Incorporation of the contents of the Hi-Storm cask's canister into the PRONTO model of the cask continued. When completed the canister model will allow the resistance to overpack collapse during impact accidents to be treated during the PRONTO calculations.

Information in this record was deleted
in accordance with the Freedom of Information
Act, exemptions 2
FOIA- 2003-0184

Portions Ex 2

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Boeing Contract. The Boeing contract was signed by Boeing and a list of questions was sent to Boeing to serve as a basis for future discussions.

Computational Support. ARA contractor personnel are conducting 2D and 3D CTH calculations of jetliner engine impacts into reinforded concrete panels using the data of Sugano et al. When completed, these calculations, which are using a simple model of a jet engine, will help to validate the CTH and Zapotec codes for applications that examine more complicated problems

Jet Fuel Fire Modeling. MPEG movie files of some of the fire analysis runs were created. A problem-specific utility was coded that extracts data for a curved surface (i.e., in the gap between MPC and concrete shield) from the Vulcan dump files and writes the data to TECPLOT data files. Additional VULCAN fire analysis calculations for the standing Hi-Storm cask with a fuel pool fire on just one side of the cask, both with and without wind, were started.

Cask Response to Thermal Loads. Modeling of the response of a spent fuel truck cask to the thermal loads produced by an engulfing fire was begun. The development of correlations predicting cask response to thermal loads will be similar to the work done simulating the response of the NAC UMS rail cask. First a simple model will be constructed that will be calibrated based on the design basis accident presented in the SAR. Then the calibrated model will be extended to other boundary conditions to determine the response of the intact cask to a variety of fire boundary conditions.

The ABAQUS quasistatic analyses of the canister were rerun using high temperature tensile test data developed by Chavez et al. [1]. The stress results were combined using a parameter developed by Nix et al. [2] to allow the multiaxial stress state in the canister to be compared with data developed from uniaxial creep data. The Nix parameter, along with creep data developed by Chavez is combined with the Larson-Miller equation to determine the time to creep rupture failure of the canister for several different temperatures.

[1] Chavez,S.A., Korth, G.E., Harper, D.M. and Walker, T.J., "High-Temperature Tensile and Creep Data for Inconel 600, 304 Stainless Steel and SA106B Carbon Steel," Nuclear Eng. And Design,1994, 148, pp. 351-363.

[2] Nix W.D., Earthman, J.C., Eggeler, G. and Ilschner, b., "The Principal Facet Stress as a Parameter for Predicting Creep Rupture Under Multiaxila Stresses," Acta Metallurgica, 1989,37, pp. 1067-1077.

Fission Product Transport. Several MELCOR simulations of the effects of thermal transients on a failed NAC UMS canister were conducted and the results from these simulations were incorporated into a report entitled, "Analysis of Holtec HI-STORM and NAC Casks with air intrusion using MELCOR 1.8.5." During the performance of these calculations, both the default MELCOR Zr-O_2 oxidation correlations and a new set of low-temperature correlations were used. The results of these calculations indicate that air ingression into a failed NAC UMS canister may be able to initiate the highly exothermic oxidation of Zyrcaloy cladding by O_2, which would lead to large release fractions for the fission products in the pellets contained in affected rods.

Consequence Modeling.

Plume data for very large pool fires from experiments conducted in France during the early 1970's were obtained and reviewed. These data provide an excellent validation for the plume model in general. The data also illustrate the substantial impact of inversion layers on plume trajectories.

Stephanie Bush-Goddard of NRC came to SNL for a 2-day visit during September to receive hands-on training with the MACCS2 code; she was also given a demonstration of the RADTRAN code. Review of recent documents describing the federal response procedure after a terrorist act continued.

Task 1.2: Small Plane Crash into an ISFSI.

Small Plane Survey. A proposed final draft of the survey of small planes that might be used in a terrorist attack on a spent fuel cask was completed. The draft examines the threats posed by the mass of the small plane, the possibility that the [redacted] during [redacted] and the possibility that the plane's propeller can damage a cask. Each of these threats was found to be [redacted] The report also proposes a representative small plane for further study. A copy of the draft report is appended to this monthly technical report.

Task 1.3: ANSYS/LS-DYNA Jetliner Model. No work done this month.

Task 1.4: Jetliner Crash into a Spent Fuel Rail Cask. No work done this month.

Task 1.5: Small Plane Crash into a Spent Fuel Rail Cask. No work done this month.

Task 1.6: Small Plane Crash into Other Radioactive Material Packages. No work done this month.

Task 2.0: Weapons, Radioactive Materials, Consequences.

Weapons Versus Consequences Spreadsheet. No work done this month.

Expert Panel - Source Term Guidance Document. The NRC sent SNL a revised version of the Expert Panel Charter. The revised charter contained significant changes in the organizational structure of the expert panel and its supporting personnel and also contained a request for a FACA by NRC that was published in the Federal Register. In response to these changes, Sandia will organize a Sandia Expert Task Group (SETG) to perform a preliminary analysis of package vulnerabilities and the modeling of source terms using the initial set of scenarios and packages specified by the NRC. The SETG will have expertise in the areas of vulnerability analysis; structural, thermal, and chemical engineering; fuel performance and source term evaluations; properties and behavior of materials; weapons and [redacted] transportation and storage of radioactive materials; and consequence analysis. The results from the SETG will be reviewed by the members of the expert Peer Review Panel, who will mainly be individuals from outside

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Small Aircraft Survey

Introduction

The Nuclear Regulatory Commission (NRC) is the cognizant authority responsible for the licensing and operation of commercial nuclear facilities within the United States. Since the terrorist attacks of September 11 2001, there has been an increased concern regarding the vulnerability of nuclear facilities with respect to sabotage or terrorist attack, and the NRC has quickly responded by instituting enhanced security measures and procedures, while concurrently investigating potential improvements.

Across the United States the spent fuel pools of commercial nuclear power plants are becoming filled with spent fuel assemblies. To avoid having to cease operations when the pools are full, many utilities have been removing older fuel and storing it in dry casks on concrete pads on site in an area termed an Independent Spent Fuel Storage Installation (ISFSI). Further, it has been proposed to license and construct a commercial dry storage site, referred to as a Private Fuel Storage Facility (PFSF), to provide extended period interim storage pending permanent disposal in a geologic repository.

As a new nuclear facility with no commercially operating PFSF currently licensed, the NRC has commissioned several studies to investigate the vulnerability and potential consequences of surface dry storage facilities to sabotage or terrorist attack. The study herein investigates the potential vulnerability of the primary nuclear component of a PFSF, a representative dry storage cask filled with spent fuel assemblies, with respect to attack by a small aircraft, arbitrarily defined as carrying as a result of impact, sustained fire, and Ex 2

Dry Storage Cask

Depicted in Figure 1, the representative dry storage cask selected by the NRC for the purposes of the study is the HI-STORM 100 overpack of the Holtec International integrated system of transportation, transfer, and storages containers. HI-STAR 100 is an acronym for Holtec International Storage, Transport, and Repository System with the annex 100 indicating a system weight in excess of 100 tons, and is a high-capacity, multi-purpose canister (MPC) used for both storing spent nuclear fuel on an ISFSI pad, or conveying the highly radioactive payload over land or water. The HI-STAR 100 is designed to accept one multi-purpose canister containing a 68-cell fuel basket for BWR assemblies, or either a 24-cell flux-trap or a 32-cell non-flux trap fuel basket for PWR fuel.

Portions Ex2

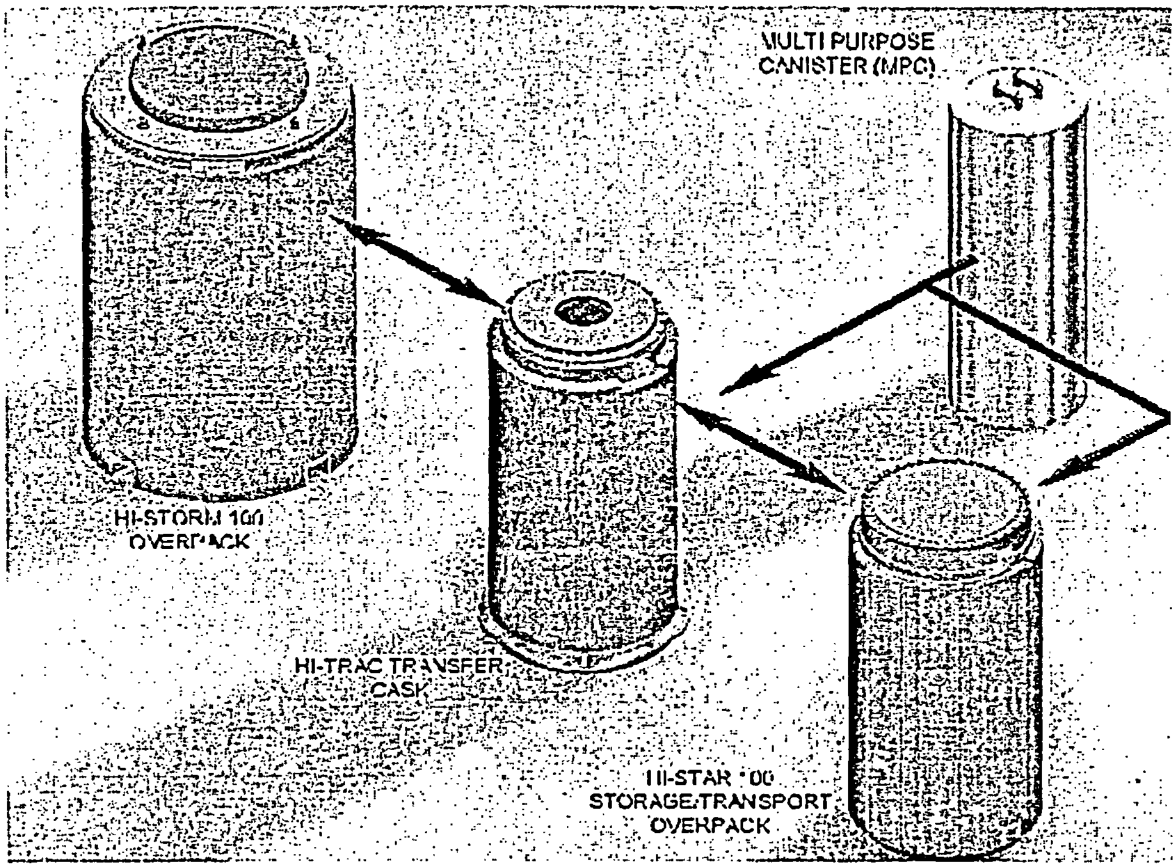

Figure 1: HI-STAR 100 and HI-STORM 100 System Family

In contrast to the HI-STAR 100, the HI-STORM 100 (Holtec International Storage and Transfer Operation Reinforced Module) is strictly a storage device, consisting of an upright robust metal and concrete ventilated structure to promote passive air-cooling of the stored MPC. The HI-STORM is engineered for maximum shielding, with an all-structural steel skeleton and twenty-six inches of concrete enclosed in the annular space between two concentric ductile metallic shells.

The design bases of the HI-STORM 100 and HI-STAR 100 systems bound all spent nuclear fuel characteristics, site design conditions and interfaces existing in the vast majority of power reactor sites in the US and abroad, and both can be anchored to the ISFSI for enhanced protection against seismic events. Table 1 presents a compilation of the HI-STORM 100 overpack physical design attributes. Clearly, with physical dimensions of approximately 11 feet in diameter and 20 feet high, a loaded weight in excess of 350,000 pounds, construction of structural and ductile steel reinforced with more than 2 feet of concrete, the HI-STORM 100 represents a very large, robust and formidable target.

HI-STORM Overpack Data	
Height (approximate)	240 inches
Shell Outside Diameter	132.5 inches
Shell Inside Diameter	73.5 inches
Weight, empty	269,000 lbs
Weight loaded with heaviest MPC	358,000 lbs
Number of bottom ducts	4
Bottom duct size	15 x 10 inches
Number of top ducts	4
Top duct size	25 x 6 inches

Table 1: HI-STORM 100 Physical Design Data

In 1999, Holtec International received a Certificate of Compliance (COC) from the Nuclear Regulatory Commission for the HI-STAR 100 System both under 10CFR Part 71 (transport) and under 10CFR Part 72 (storage), representing the first certified dual-purpose system with multi-purpose canister technology. The combined Certificate of Compliance and Safety Evaluation Report (COC/SER) for the HI-STORM 100 storage cask was issued on May 1, 2000 with an effective date of May 31, 2000.

Aircraft Survey

As the NRC currently has both completed and on-going studies investigating the vulnerability of nuclear facilities to sabotage and terrorist attack by large aircraft, the focus of the present analysis was on "small" aircraft, arbitrarily defined as capable of carrying([redacted]) A detailed literature search was conducted in which all certificated aircraft presently in production have been tabulated including associated physical, mission, and operational characteristics. The study was limited to only aircraft currently in production and with a valid airworthiness certificate issued by the Federal Aviation Administration (FAA) for flight legally within the United States. Although such action neglects the population of previously produced aircraft, over time any built in large numbers will be removed from service through attrition, or more commonly, as operations and maintenance costs become prohibitive, with any remaining fleet being comprised of a very small number of aircraft deemed historically interesting by aviation enthusiasts.

Ex 2

Results of the survey, of which the primary contents have been excerpted and included as Appendix A, has been compiled into a very large database of 70 aircraft, each potentially having 57 possible characteristics for a total of nearly 4000 data entries. Due to the dimensions of the database therefore, for brevity only the fields relevant to the analysis have been included in Appendix A, of which portions have been directly excerpted for particular discussions within the document.

Portion Ex 2

Adherence to a [redacted] criterion while incorporating maximum flying speeds and carrying capacities results in a very restrictive definition of a "small" aircraft, as the aviation industry produces aircraft not by easily categorized classes but rather based upon mission and associated life-cycle operational costs. With respect to commercial aircraft operations, for example, the bottom line is the bottom line. High acquisition and operational costs precludes the use of fanjet aircraft in the [redacted] Ex 2 mission regime. With the exception of small charter operations, commuter airlines serving the [redacted] market almost exclusively use turboprop (gas turbine/propeller-driven) aircraft. Whereas large corporations may justify the utilization of jet aircraft for executive transport, such operational and mission profile economics indicate selection of a single or multi-engine turboprop for the [redacted] operational regime.

As presently the category of "small" aircraft has been limited to single or multi-engine turboprop aircraft, an additional scoping measure was applied to identify candidate aircraft, which numerically dominate the domestic and foreign flying fleets. Appendix B contains a distillation of world and domestic commercial fleet statistics compiled by the Aerospace Industries Association (AIA), a trade industry association representing the major manufacturers of commercial, military and business aircraft, helicopters, aircraft engines, missiles, spacecraft, materials, and related components within the United States.

According to 1999 Federal Aviation Administration figures, of the 1,759 twin-engine turboprop carrier aircraft registered in the United States, 239 were of the [redacted] model with another 38 of the [redacted] variant, comprising approximately 16% of the total active fleet. Further, also in 1999, the latest year for which statistics were available, of the total world airline fleet of 7,226 turboprop aircraft, 469 were of the [redacted] model with an additional 110 of the [redacted] version, constituting approximately 8% of the global Ex 2 turboprop fleet. By restricting consideration of candidate aircraft to adherence to the [redacted] or less criterion, no other aircraft exceeds the number of [redacted] aircraft operating as a carrier aircraft within the United States, and is only surpassed by the Cessna 208 Caravan I from an international perspective. Considering the [redacted] has a maximum speed half again higher and useful load two-thirds larger versus the [redacted] and represents a significant constituent of both the US and foreign fleets, provides a solid rationale to select the [redacted] as the representative "small" aircraft for the study.

As depicted in Figure 2, the [redacted] is listed in the aircraft database contained in Appendix A under the heading of "Multi Turboprops >12500 lb MTOW", which refers to multi-engine gas turbine/propeller-driven aircraft having a Maximum Take-Off Weight greater than 12,500 pounds. Formerly known as the Ex 2 [redacted] the [redacted] is categorized as Category B (Commuters/Regional Aircraft) aircraft by the International Civil Aviation Organization (ICAO), and as Group B under the FAA Air Traffic Control (ATC) speed classification. The [redacted] has a maximum useful load of approximately 6,545 pounds, a cabin volume of 640 ft^3 readily configurable for either passengers or cargo, and a maximum

Portions Ex 2

cruising speed of 327 mph, highest of any twin-engine turboprop commuter airliner operating capable of carrying up to [redacted] Ex2

[redacted]

Ex2

Many [redacted] are pressed into service both day and night, 7 days a week by operators seeking to maximize utilization and return on investment, once again deferring to the economics of commercial aviation operations. The [redacted] was specifically designed to be easily reconfigured from carrying passengers to cargo in one hour, and routinely operates as a day/night passenger/cargo conversion aircraft, as illustrated in Figure 3. Such a design attribute would potentially be a positive decision factor to an adversary contemplating an aircraft for a terrorist attack, for the valuable flexibility to be readily converted for a variety of mission profiles, including the study concern of directly impacting a dry storage cask with the cabin filled with [redacted]

Ex2

Portions Ex2

[redacted] Ex2

Figure 3: Raytheon [redacted] Cargo Configuration

Analysis

The analysis for the small aircraft study centered on the calculation of 3 quantities;

- Impact Energy
- Fuel Energy
- [redacted] Ex2

Impact Energy is the kinetic energy applied to the dry storage cask target as a result of the aircraft acting as a [redacted] based upon the maximum total aircraft mass, defined as any combination of fuel, crew and passengers, and cargo, and the maximum structural cruising velocity. Fuel Energy is the thermal energy resulting from deflagration or ignition and sustained fire, based upon the maximum fuel capacity of the aircraft. [redacted] is the energy released resulting from the [redacted] as a function of the aircraft being fully laden with [redacted] and operated by a minimum crew. The three energies have been calculated and are tabulated within Appendix C, where appropriate conversion factors have been applied to yield energy in the unit of calories, providing a relative comparison of the magnitudes of the three quantities. Although the impact energy, fuel energy and [redacted] were calculated via spreadsheet for all 70 aircraft within the database, only the [redacted] reference small aircraft is considered during discussion developments. Ex 2

Portions Ex2

[redacted]

The [redacted] is based upon the classical mechanics of kinetic energy, $KE = \frac{1}{2} mv^2$, and is calculated using the aircraft maximum take-off weight and maximum cruising speed as parameters, with appropriate dimensional conversion factors applied to yield the energy in calories. For the [redacted] reference small aircraft, a maximum take-off weight of [redacted] with a maximum cruising speed of [redacted] yields a kinetic energy of 18,836,147 calories (78,845,322 kg-m^2/s^2). It should be noted event though 79 million Joules represents a significant quantity, the aircraft acting as a missile is imparting the kinetic energy to a target of mass nearly 21 times greater and much harder, 358,00 pounds of steel with concrete for the dry storage cask, versus the [redacted] pounds of aluminum for the [redacted]

Ex 2

- **Flyer Plate**

During the course of the study, concerns were raised as to the possible threat of a knowledgeable adversary potentially utilizing an aircraft with a centerline-mounted engine as a flyer plate during an attack. A flyer plate is a mass, typically a small steel plate, accelerated to hypervelocity speeds ranging from several to tens of kilometers per second, which is used to induce deformation, impact, spallation, or plasma ablation effects on targets. Although an [redacted] driven [redacted] for the duration normally associated with flyer plate devices, the very large and metallurgically hard mass of the engine rotor shaft would acquire substantial energy.

[redacted]

Ex 2

Depicted in Figure 4 are the only centerline-thrust single-engine turboprop aircraft currently in production, corresponding to the previously developed definition of small

Portions Ex 2

aircraft for the purposes of the current investigation, for which the associated descriptive characteristics excerpted from the database are presented in Table 2. The category of aircraft which includes the Caravan I variant subsumed herein by the Grand Caravan, is distinguishable by having a single turbine/propeller engine which burns kerosene-type fuel known as Jet A, and generally operated by a single pilot. All four aircraft are powered by the same Pratt & Whitney PT6A turboprop, a family of turbines differing only with respect to scaleable size and power output, and which is very tightly shrouded within a cowling to provide an effective flow of cooling air.

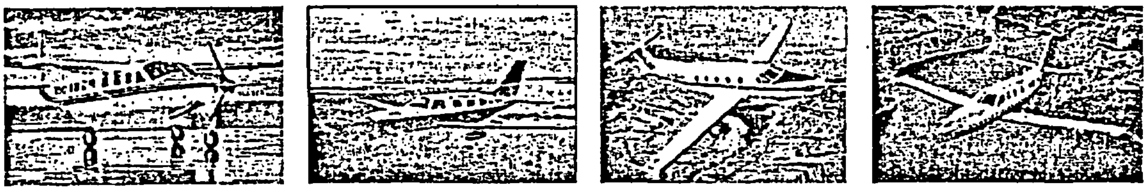

Figure 4: Cessna Grand Caravan, New Piper Meridian, Pilatus PC-12, Socata TBM 700

Manufacturer	Model	Seating (Crew + Passenger)	Ramp Weight (lb)	Useful Load (lb)	Maximum Fuel (lb)	Maximum Speed (kt)	Maximum Speed (mph)	Altitude (ft)
Cessna	Caravan	1 + 9	8,785	3,708	2,224	182	209	10,000
New Piper	Meridian	1 + 5	4,893	1,271	1,139	262	301	30,000
Pilatus	PC-12	1 + 10	9,965	3,745	2,704	270	311	24,000
Socata	TBM700	1 + 6	6,614	2,314	1,887	300	345	26,000

Table 2: Single-Engine Centerline-Thrust Turboprop Aircraft

Figure 5 contains two images of the Pratt & Whitney PT6A-42A turbine, one external devoid of the associated propeller, and the other internal as installed in the New Piper Meridian, of which the upper half of the cowling has been removed. As is readily discernable, space within the cowling is very limited with essentially none existing at the intersection of the turbine and firewall, the fireproof compartment separating the engine from the aircraft cabin cockpit section. Further, very little space also exists between the firewall and cockpit occupied by the flight crew, an area dedicated to the instrumentation panel and flight controls, which is almost totally occupied by avionics, associated wiring and control linkages. The only available area in which a restricted amount of/ materials might possibly be accommodated is around the turbine within the cowling

Ex 2

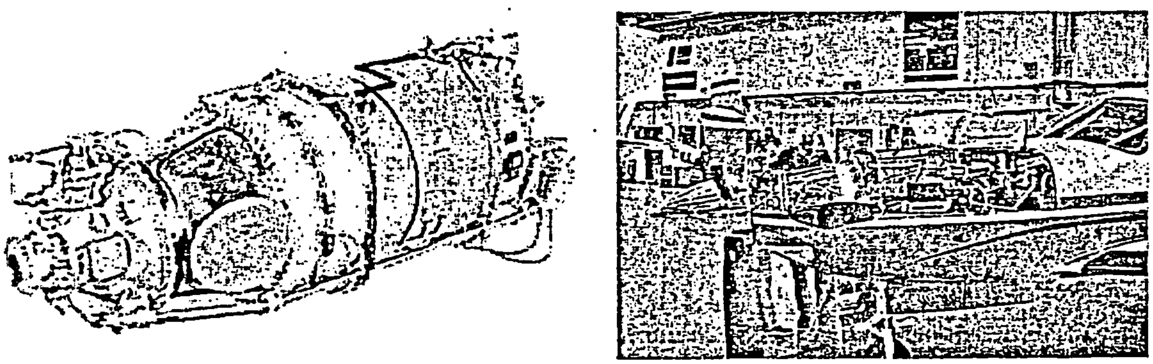

Figure 5: Pratt & Whitney PT6A-42A Turbine, New Piper Meridian Aircraft

Portions Ex 2

[redacted]

Ex2

- Propeller

Another concern identified during the investigation is the potential for damage posed by the rotating propellers of the aircraft to the cask. The [redacted] reference small aircraft is powered by two [redacted] turboprop engines each rated at 1,279 shaft horsepower (SHP), and equipped with four-bladed, composite, constant speed and full feathering reversible-pitch propellers manufactured by Hartzell.

Ex 2

Although composite materials characteristically have a high strength-to-weight ratio, should the propellers impact the dry storage cask 2-inch thick outer steel liner rotating generally in excess of 2,000 revolutions per minute (RPM), the blades would instantly disintegrate. For the case of turboprop aircraft equipped with propellers constructed of aluminum, although not likely to shatter as composite materials, the blades would shear due to the relative strength of aluminum versus steel.

Fuel Energy

Jet fuels, or more generally, turbine fuels, are one of the primary fuels for internal combustion engines worldwide and are the most widely available aviation fuel. Due to much greater availability compared to gasoline during wartime, commercial illuminating kerosene was the fuel chosen for early jet engines. Consequently, the development of commercial jet aircraft following World War II centered primarily on the use of kerosene-type fuels. Jet A fuel, the primary operational fuel for commercial and military turboprop and turbojet aircraft in the United States, is a kerosene-based product meeting

Portions Ex2

American Society for Testing and Materials (ASTM) and Military Specifications, and has a thermal energy content of 5.670 Million British Thermal Units (BTU) per barrel.

The quantity of fuel energy is based upon the thermal content of Kerosene-type Jet A aviation fuel, and is calculated using the heat capacity and again applying appropriate dimensional conversion factors to yield the energy in calories. There are 2 potential scenarios with respect to fuel on board an aircraft, one considering the internal tanks only, and the other consists of outfitting the cabin with either an inflatable bladder or solid tank to nearly double the carrying capacity. With respect to the reference small aircraft, the [redacted] has a maximum fuel capacity of [redacted] within the internal tanks, and can accommodate a maximum payload of [redacted] within the cargo bay. Manufacturers typically express both the maximum useful load and fuel capacities in terms of pounds or kilograms, as generally aircraft are weight rather than volume limited, which enables operators and pilots to quickly determine if the airplane is within the center of gravity envelope.

Ex 2

Noting one gallon of Jet A fuel weighs 6.70 pounds, the [redacted] maximum fuel capacity of [redacted] yields a thermal energy of 22,635,994,030 calories. Should an adversary opt to outfit the aircraft cabin with an expandable bladder or solid wall tank up to the maximum load of [redacted] the additional fuel would contribute another 20,437,388,060 calories. Considering the Kerosene-type Jet A fuel within the aircraft wings and the outfitted cargo bay as a single entity yields a total of [redacted] for an associated combined fuel energy of 43,073,382,090 calories.

Ex 2

Once again, it is to be noted even though 23 and 43 billion calories for the internal and combined wing/cargo scenarios, respectively, represent significant quantities of energy, the results are the full thermal content as obtained from perfect combustion of the fuel. A Fuel-Air Explosion (FAE) event is not credible, as no scenario can be postulated to enable complete atomization, referred as aerosolization, of the fuel to support deflagration. The most likely outcome would be a fire, however, in the case of an aircraft impacting the dry storage cask as a missile, fuel would be dispersed over a large area precluding pool formation of sufficient depth to result in immersion.

[redacted]

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[redacted] Ex 2

Summary/Conclusions

The representative dry storage cask selected by the NRC as the target of interest for the purposes of the study is the Holtec International Storage and Transfer Operation Reinforced Module 100 ton (HI-STORM 100) storage overpack, a robust metal and concrete passive air-ventilated multi-purpose canister used for storing spent nuclear fuel.

Based upon a three-tier rationale of; 1) adherence to a [redacted], 2) selecting the highest flying speeds and carrying capacities possible, and 3) preferring candidates numerically dominating both current US and international flying fleets, the [redacted] was selected as the reference small aircraft. Ex 2

The results of the small aircraft survey and analysis are summarized in Appendix C, a tabulation of the three quantities of [redacted] fuel energy, and [redacted] and which although determined for all 70 aircraft in the database are developed in detail for the [redacted] reference small aircraft. Ex 2

For the [redacted] reference small aircraft acting as a missile, approximately 19 million calories of kinetic energy would be imparted to the dry storage cask, a target of nearly 21 times greater mass and much harder steel and concrete construction with respect to the lighter and softer aluminum [redacted] Ex 2

An attempt to use an aircraft as a flyer plate weapon imposes severe limitations and requires careful consideration, as any of the parameters of geometry, coupling and range either independently or synergistically can combine to nullify transfer of the kinetic energy, subsequently resulting in little or no damage to the dry storage cask.

The composite material propellers of the [redacted] reference small aircraft would quickly shatter upon impacting the very robust storage cask, and for the case of other turboprop aircraft equipped with propellers constructed of aluminum, the blades would shear due to the relative strength of the steel outer shell. Ex 2

Calculations of the fuel energy considered 2 scenarios, the baseline case of the maximum fuel capacity normally carried within the wings, and the case in which an adversary augments the aircraft internal fuel with the cabin area fitted with a tank nearly doubling the total capacity. The [redacted] maximum fuel capacity of [redacted] pounds yields a thermal energy of 22,635,994,030 calories, and the second scenario of a tank within the cargo bay could be filled with up to an additional [redacted] of Jet A, and potentially contribute another 20,437,388,060 calories. However, in the case of an aircraft impacting the dry storage cask as a missile, fuel would be dispersed over a large area precluding formation of a pool of sufficient depth to result in immersion a sustained fire. Ex 2

Portions Ex 2

Ex 2

Glossary

AFATL	Air Force Armament Testing Laboratory
AFSC	Air Force Systems Command
AIA	Aerospace Industries Association
AOPA	Aircraft Owners and Pilots Association
ASTM	American Society for Testing and Materials
ATC	Air Traffic Control
BBL	British Barrel
BTU	British Thermal Unit
CFR	Code of Federal Regulations
COC	Certificate of Compliance
COC/SER	Certificate of Compliance/Safety Evaluation Report
FAA	Federal Aviation Administration
FAE	Fuel-Air Explosion
HI-STAR	Holtec International Storage, Transport, and Repository
HI-STORM	Holtec International Storage and Transfer Operation Reinforced Module
ICAO	International Civil Aviation Organization
ISFSI	Independent Spent Fuel Storage Installation
MPC	Multi-Purpose Canister
NRC	Nuclear Regulatory Commission
PBX	Plastic-Bonded Explosive
PFSF	Private Fuel Storage Facility
RPM	Revolutions Per Minute
SHP	Shaft Horsepower
TNT	Trinitrotoluene
US	United States

References

[AFATL, 1968] *Oxidizer Incendiaries (U)*, Dr. James W. Dale, Gerald J. O'Neill, and Carl A. Olson, Monsanto Research Corporation, Technical Report No. AFATL-TR-68-6, Air Force Armament Laboratory, Air Force Systems Command, Eglin Air Force Base, Florida, January 1968

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Appendix A: Aircraft Database (abridged)

	Type	Manufacturer	Model	Characteristics (Crew + Passengers)	Maximum Ramp Weight (lb)	Maximum Useful Load (lb)	Maximum Fuel Load (lb)	Maximum Speed (kt)
1	**Ultra Long Range Jets**	Gulfstream	Gulfstream V G-V	4+15/19	90,900	42,500	40,994	488
2	Ultra Long Range Jets	Bombardier	Global Express BD-700	4+13/19	95,250	44,950	43,170	499
3	Ultra Long Range Jets	Airbus	A319 Corporate Jetliner	4+12/48	167,380	73,135	71,815	486
4	Ultra Long Range Jets	Boeing	737-700-IGW BBJ1	4+8/149	171,500	76,930	71,657	470
5	Ultra Long Range Jets	Boeing	737-800 BBJ2	4+8/189	174,700	74,385	69,968	470
6	**Jet >20000 lb MTOW**	Bombardier	Learjet 45 LR-45	2+8/9	20,750	7,055	6,062	456
7	Jet >20000 lb MTOW	Cessna	Citation Excel CE-560-XL	2+8/11	20,200	7,500	6,740	423
8	Jet >20000 lb MTOW	Bombardier	Learjet 60 LR-60	2+6/10	23,750	9,050	7,910	453
9	Jet >20000 lb MTOW	Raytheon	Hawker 800XP	2+8/15	28,120	11,720	10,000	447
10	Jet >20000 lb MTOW	Israel Aircraft	Astra SPX IA-1125A	2+7/9	24,800	10,700	9,365	455
11	Jet >20000 lb MTOW	Fairchild Dornier	Envoy 3 Corporate Do328-310	2+18/32	34,789	13,941	11,154	387
12	Jet >20000 lb MTOW	Fairchild Dornier	Envoy 3 Executive Do328-310	2+10/12	34,789	11,420	11,154	387
13	Jet >20000 lb MTOW	Embraer	Legacy Shuttle EMB-145	2+19/37	44,246	16,667	11,321	457
14	Jet >20000 lb MTOW	Cessna	Citation X CE-750	2+8/12	36,400	14,400	12,931	506
15	Jet >20000 lb MTOW	Israel Aircraft	Galaxy	2+8/18	35,600	15,800	15,000	476
16	Jet >20000 lb MTOW	Dassault	Falcon 50EX DA-50	2+9/19	39,900	17,650	15,520	481
17	Jet >20000 lb MTOW	Embraer	Legacy Executive EMB-145	2+12/15	48,633	19,996	17,702	459
18	Jet >20000 lb MTOW	Dassault	Falcon 2000 DA-2000	2+8/19	36,000	13,250	12,154	479
19	Jet >20000 lb MTOW	Bombardier	Corporate Jetliner CL-601RJ	2+18/30	51,250	19,590	14,305	460
20	Jet >20000 lb MTOW	Challenger 604	CL-604	2+9/19	48,300	21,200	19,850	458
21	Jet >20000 lb MTOW	Special Edition	CL-601SE	2+15/19	53,250	19,410	18,305	444
22	Jet >20000 lb MTOW	Dassault	DA-900B	2+12/19	45,700	20,425	19,165	474
23	Jet >20000 lb MTOW	Dassault	DA-900EX	2+12/19	48,500	22,471	21,000	474
24	Jet >20000 lb MTOW	Gulfstream	G-IV	2+14/19	75,000	31,800	29,281	476
25	**Jet <20000 lb MTOW**	Cessna	CJ1 CE-525	1+6/7	10,700	3,850	3,220	377
26	Jet <20000 lb MTOW	Sino Swearingen	SJ30-2	1+4/6	13,600	5,400	4,950	459
27	Jet <20000 lb MTOW	Raytheon	Premier I RA-390	1+6/7	12,590	4,350	3,612	455
28	Jet <20000 lb MTOW	Cessna	CJ2 CE-525A	1+7/8	12,500	4,800	3,930	407
29	Jet <20000 lb MTOW	Cessna	Bravo CE-550	2+7/11	15,000	5,600	4,824	400
30	Jet <20000 lb MTOW	Bombardier	Learjet 31A LR-31A	2+6/10	17,200	5,997	4,124	456
31	Jet <20000 lb MTOW	Raytheon	Beechjet BE-400A	2+7/9	16,300	5,385	4,912	447
32	Jet <20000 lb MTOW	Cessna	Citation Encore CE-560	2+7/11	16,830	6,330	5,400	426
33	**Multi Turboprops >12500 lb MTOW**	Raytheon	Executive 1900D	2+12/19	17,230	6,440	4,458	277
34	Multi Turboprops >12500 lb MTOW	Raytheon	King Air 350	1+9/15	15,100	5,460	3,611	312
35	**Multi Turboprops <=12500 lb MTOW**	Reims Cessna	Caravan II RA406	1+8/13	9,925	4,193	3,183	231
36	Multi Turboprops <=12500 lb MTOW	Raytheon	King Air C90B	1+5/12	10,160	3,150	2,573	246
37	Multi Turboprops <=12500 lb MTOW	Raytheon	King Air B200SE	1+7/15	12,590	4,320	3,645	292
38	Multi Turboprops <=12500 lb MTOW	Raytheon	King Air B200CSE	1+7/15	12,590	4,010	3,645	292
39	Multi Turboprops <=12500 lb MTOW	Raytheon	King Air B200	1+7/15	12,590	3,970	3,645	292
40	Multi Turboprops <=12500 lb MTOW	Piaggio Aero Ind.	Avanti P180	1+7/9	11,600	3,930	2,802	392
41	**Single Turboprop**	Cessna	Caravan I CE-208-675	1+9/9	8,035	3,211	2,224	186
42	Single Turboprop	Cessna	Grand Caravan CE-208B	1+9/9	8,785	3,708	2,224	182
43	Single Turboprop	New Piper	Meridian PA-46-500T	1+4/5	4,893	1,271	1,139	252
44	Single Turboprop	TBM S.A.	TBM 700	1+5/6	6,614	2,314	1,887	300
45	Single Turboprop	Pilatus	PC-12	1+7/10	9,965	3,745	2,704	270
46	**Multi EngineTurbocharged**	New Piper	Seneca V PA-34-220T	1+4/5	4,773	1,305	732	204
47	**Multi Engine Normal**	Raytheon	Baron 58	1+4/5	5,524	1,634	1,164	200
48	**Single Engine Pressurized**	New Piper	Malibu Mirage PA-46-350P	1+4/5	4,358	1,237	720	212
49	Single Engine Pressurized	Extra	EA 400	1+5/5	4,407	1,307	1,080	243
50	**Single Turbocharged**	Cessna	Turbo Skylane CE-T182T	1+3/3	3,110	1,093	522	
51	Single Turbocharged	Cessna	Turbo Stationair CE-T206H	1+5/5	3,617	1,334	528	164
52	Single Turbocharged	El Gavilan	358 EL-1	1+7/7	4,516	1,642	624	135
53	Single Turbocharged	Socata	Trinidad GT T/C TB-21 GT	1+3/4	3,086	1,096	517	166
54	Single Turbocharged	New Piper	Saratoga II TC PA-32R-301T	1+4/5	3,615	1,107	612	194
54	Single Turbocharged	Mooney	Bravo MO-20M	1+3/3	3,374	1,024	534	217
56	Single Turbocharged	Commander	115TC CDR-114TC	1+3/4	3,305	1,153	528	184
57	Single Turbocharged	Raytheon	Bonanza B36-TC	1+4/5	3,866	1,126	612	200
58	Single Turbocharged	Lake Aircraft	Turbo Sea Fury LA-270T	1+3/3	3,151	951	528	155
59	**Single Normally Aspirated**	Cirrus Design	SR20	1+3/3	2,900	950	336	160
60	Single Normally Aspirated	Cessna	Skylane CE-182T	1+3/3	3,110	1,192	522	141

Appendix B: Aerospace Industries Association, Aerospace Facts And Figures (abridged)

AEROSPACE FACTS AND FIGURES 2000/2001

TURBINE-ENGINED AIRCRAFT IN THE WORLD AIRLINE FLEET

(By Model, 1995–1999, continued)

	1995[a]	1996[a]	1997[a]	1998[a]	1999[a]
Turboprops—TOTAL	6,457	6,851	7,072	7,010	7,226
Aerospatiale N.262/Mohawk 298	13	9	9	11	12
Aerospatiale/Aeritalia ATR 42	259	283	296	299	296
Aerospatiale/Aeritalia ATR 72	158	177	177	202	222
Airtech CN-235	25	24	24	24	33
Antonov An-8	—	—	2	—	6
Antonov An-12	46	68	71	83	81
Antonov An-22	2	5	3	3	1
Antonov An-24/26/28/30/32	400	484	530	499	475
B.Ae. ATP	52	55	50	57	55
B.Ae. Vanguard	1	—	—	—	—
B.Ae. Viscount	24	20	18	12	12
B.Ae. (HP-137) Jetstream 31	296	274	287	233	258
B.Ae. Jetstream 41	66	74	91	92	92
B.Ae. HS-748	126	126	125	124	118
Beech 18 Turbo	21	20	20	18	9
Beech 90 King Air	35	39	46	39	46
Beech 99	143	140	138	139	110
Beech 100 King Air	46	48	39	39	47
Beech 200/300 Super King Air	121	126	122	111	112
Beech 1300	5	5	9	6	9
Beech 1900C/D	371	389	430	467	469
Bristol 175 Britannia	1	1	—	—	—
Canadair CL-44	2	1	—	—	4
CASA/Nurtanio C-212 Aviocar	114	111	113	105	110
Cessna 208 Caravan I	458	528	608	601	647
Cessna F406 Caravan II	35	28	30	31	30
Cessna 425/441 Conquest I/II	4	5	14	19	19
Convair 580/600/640	111	114	107	107	106
DHC-2/3 Turbo Beaver/Otter	17	22	20	20	24
DHC-5 Buffalo	1	1	1	1	1
DHC-6 Twin Otter	395	394	395	371	365
DHC-7 Dash 7	70	75	69	71	69
DHC-8 Dash 8	365	408	424	444	489
Dornier DO-228	106	112	114	118	121
Dornier DO-328	42	59	61	73	83
Douglas DC-3T Turbo Express	2	1	1	1	3
Embraer EMB-110 Bandeirante	192	211	200	199	199
Embraer EMB-120 Brasilia	254	295	308	316	307
Embraer EMB-121 Xingu	—	—	2	2	3
Fokker/Fairchild F-27/FH-227 Friendship	315	312	318	278	276
Fokker 50	171	176	171	167	188
GAF Nomad	18	13	15	15	16
Grumman G-21 Turbo Goose	1	—	—	—	—
Grumman G-73 Turbo Mallard	5	5	5	5	6
Grumman G-159 Gulfstream I	39	34	30	27	27

(Continued on next page)

TURBINE-ENGINED AIRCRAFT IN THE WORLD AIRLINE FLEET

(By Model, 1995–1999, continued)

	1995[a]	1996[a]	1997[a]	1998[a]	1999[a]
Turboprops (continued)					
Handley Page Herald	15	10	2	1	1
Harbin YU-12 II	41	42	42	48	48
IAI Arava	2	2	3	3	4
Ilyushin IL-18	33	38	34	32	41
Ilyushin IL-114	2	2	2	2	3
LET L-410..........................	61	87	115	118	141
Lockheed L-188 Electra	51	53	36	44	43
Lockheed L-100/L-382 Hercules	56	56	45	35	44
Mitsubishi MU-2B	14	15	15	16	21
Nihon AMC YS-11	81	78	63	49	46
Pilatus Britten-Norman BN-2T Turbo Islander	2	5	6	6	5
Pilatus PC-6 Turbo Porter	25	28	30	24	23
Pilatus PC-XII	—	2	2	14	21
Piper PA-31T/42 Cheyenne ...	16	18	20	20	22
Piper T-1040	12	13	14	13	13
PZL (Antonov) An-28	6	6	3	3	27
Rockwell Turbo Commander	9	9	11	9	8
Saab SF-340A/B	355	379	396	432	414
Saab 2000	22	34	42	45	43
Shorts SC-5 Belfast	2	2	2	2	2
Shorts SC-7 Skyliner/Skyvan ...	35	35	32	30	27
Shorts 330	50	52	48	42	37
Shorts 360	106	104	103	93	102
Swearingen Merlin	38	45	53	55	58
Swearingen Metro	423	398	394	379	398
Transall C-160.....................	6	—	—	—	6
Xian (Antonov) Y-7	66	66	66	66	65
TOTAL AIRCRAFT IN SERVICE	20,041	21,127	22,110	23,002	24,128
Number Manufactured in U.S.	11,775	12,117	12,487	13,139	13,537
Percent Manufactured in U.S.	58.8%	57.4%	56.5%	57.1%	56.1%
Turbojet Aircraft in Service......	12,810	13,425	14,024	14,621	15,453
Number Manufactured in U.S.	9,265	9,520	9,789	10,126	10,430
Percent Manufactured in U.S.	72.3%	70.9%	69.8%	69.3%	67.5%
Turboprop Aircraft in Service ...	6,457	6,851	7,072	7,010	7,226
Number Manufactured in U.S.	2,002	2,074	2,172	2,165	2,226
Percent Manufactured in U.S.	31.0%	30.3%	30.7%	30.9%	30.8%
Turbine-Powered Helicopters In Service	774	851	1,014	1,371	1,449
Number Manufactured in U.S.	508	523	526	848	881
Percent Manufactured in U.S.	65.6%	61.5%	51.9%	61.9%	60.8%

Source: Exxon International Company, "Air World Survey," compiled by Aviation Data Service, Inc. (Annually).

NOTE: The "Air World Survey" covers aircraft in airline service as of December 31. Excludes air taxi operators.

[a] Includes aircraft operated in the Commonwealth of Independent State countries. Formerly grouped under Aeroflot and excluded from the summary.

ACTIVE[1] U.S. AIR CARRIER FLEET

By Type of Aircraft, Number of Engines and Model
Active as of December 1995–1999

	1995	1996	1997	1998	1999
TOTAL	7,411	7,478	7,616	8,111	8,228
Turbojets—TOTAL	4,832	4,922	5,108	5,411[r]	5,630
Four-Engine—TOTAL	435	440	450	447	441
Boeing 707	6	5	3	—	1
Boeing 747	189	195	201	201	188
B.Ae./AVRO 146	21	21	26	18	46
McDonnell Douglas DC-8	219	219	220	228	206
Three-Engine—TOTAL	1,210	1,212	1,224	1,238	1,181
Boeing 727	877	856	874	882	811
Lockheed L-1011	97	102	79	70	66
McDonnell Douglas DC-10/MD-11	236	254	271	286	304
Twin-Engine—TOTAL	3,187	3,270	3,434	3,726[r]	4,008
Airbus A-300	53	62	68	61	68
Airbus A-310	23	27	28	39	39
Airbus A-319	—	—	2	23	40
Airbus A-320	104	113	119	143	162
BAe HS-125	—	—	—	—	1
Beech 400	—	—	—	1	1
Boeing 717	—	—	—	—	2
Boeing 737	1,055	1,055	1,077	1,080	1,179
Boeing 757	440	457	487	510	555
Boeing 767	210	213	234	261	278
Boeing 777	7	15	23	36	53
Canadair CL-600	35	53	77	152	187
Cessna C500/C501	—	—	—	10	9
Dassau AMD	—	—	—	27	27
Embraer ERJ-135	—	—	—	—	7
Embraer ERJ-145	—	—	11	55	95
Fokker F-28	155	155	142	147	145
Israel Aircraft 1124	—	—	—	1	1
Learjet LR-25	—	2	3	7	8
Learjet LR-31	—	—	—	1	1
Learjet LR-35	3	4	9	11	11
McDonnell Douglas DC-9/ MD-80/MD-90	1,102	1,114	1,154	1,158	1,133
Mitsubishi MU-300	—	—	—	2	5
North American NA-265	—	—	—	1	1
Turboprops—TOTAL	1,713[r]	1,696[r]	1,646[r]	1,832[r]	1,788
Four-Engine—TOTAL	81	56	45	39	28
Canadair CL44D	1	—	—	—	—
De Havilland DHC-7	16	12	5	7	6
Lockheed 188 Electra	43	23	22	17	14
Lockheed 382	21	21	18	15	8

(Continued on next page)

ACTIVE[a] U.S. AIR CARRIER FLEET (Continued)

By Type of Aircraft, Number of Engines, and Model
Active as of December 1995–1999

	1995	1996	1997	1998	1999
Twin-Engine—Total	1,632[r]	1,635[r]	1,596[r]	1,789[r]	1,759
Airtech CN-235	—	—	—	—	1
Beech BE90	1	3	2	8	6
Beech BE99	36	27	28	36	38
Beech BE100	1	2	1	2	4
Beech BE200	4	11	7	19	19
Beech BE1900	289	254	243	325	239
B.Ae. ATP	10	10	9	—	9
B.Ae. Jetstream	174	223	215	203	184
CASA C212 Aviocar	1	—	—	3	4
Cessna CE208B	—	—	—	137	167
Cessna C441	2	2	2	4	2
Convair 580/600/640	34	23	19	15	12
DeHavilland DHC-6	44	38	49	54	54
DeHavilland DHC-8	137	151	154	169	180
Dornier DO328	33	39	47	35	39
Embraer EMB110	14	3	1	1	1
Embraer EMB120	217	235	227	218	225
Fairchild/Fokker F-27/FH-227	35	36	44	38	38
Grumman G-73	5	5	5	5	3
Gulfstream 690A	—	—	1	—	—
Mitsubishi MU-2	—	3	11	13	14
Nihon YS-11	11	11	—	—	—
Piper PA31T	5	9	10	6	6
Piper 42	1	2	2	2	2
Saab-Fairchild SF340	219	226	253	271	275
Shorts SC-7	3	3	3	3	3
Shorts SD-3	38	39	33	15	20
SNAIS ATR-42	110	99	95	83	79
SNAIS ATR-72	51	51	55	60	60
Swearingen SA-226	13	9	7	4[r]	3
Swearingen SA-227	144	121	73	60	72
Single-Engine—TOTAL	—	5	5	4	1
Piston-Engine—TOTAL	748[r]	739[r]	728[r]	751[r]	688
Four-Engine—TOTAL	15	18	19	17	19
Douglas DC-6	15	18	19	17	19
Three-Engine—TOTAL	1	7	4	3	3
Pilatus Britten-Norman BN2A-MK-3 Turbo Islander	1	7	4	3	3
Twin-Engine—TOTAL	333[r]	317[r]	298[r]	391[r]	292
Single-Engine—TOTAL	399	397	407	340	374
Helicopters—TOTAL	118	121	134	117	122

Source: Federal Aviation Administration. "FAA Statistical Handbook of Aviation" (Annually).

NOTE: Effective 1978. Includes certificated route air carriers, supplemental air carriers (charters), multi-engine aircraft in passenger service of commuters, and all aircraft over 12,500 pounds operated by Part 121 and Part 135 commuter operators.

[a] "Active aircraft" equals the average number of aircraft reported in operation during the last quarter of the year.

[r] Revised.

Appendix C: Analysis Spreadsheet (abridged)

Type	Manufacturer	Model	Seating (Crew + Passenger)	Maximum Payload (lb)	Maximum Speed (kt)	Required Crew (number)	Crew Weight (lb)	Explosive Capacity (lb)	Maximum Ramp Weight (lb)	Maximum Takeoff Weight (lb)	Useful Load (lb)	Maximum Fuel (lb)	Available Fuel With Maximum Payload (lb)	Impact Energy (cal)	Fuel Energy (cal)	Explosive Energy (cal)
1 Ultra Long Range Jets	Gulfstream	Gulfstream V G-V	4+15/19	6,100	488	4	700	5,400	90,900	90,500	42,500	40,994	36,400	318,041,845	208,151,623,891	2,700,000
2 Ultra Long Range Jets	Bombardier	Global Express BD-700	4+13/19	6,700	499	4	700	5,000	95,250	95,000	44,950	43,170	39,250	339,198,154	219,200,507,463	2,500,000
3 Ultra Long Range Jets	Airbus	A319 Corporate Jetliner	4+12/48	34,725	486	4	700	34,025	167,380	166,450	73,135	71,815	38,410	563,743,139	364,643,701,493	17,012,500
4 Ultra Long Range Jets	Boeing	737-700-IGW BBJ1	4+8/149	31,430	470	4	700	30,730	171,500	171,000	76,930	71,887	45,500	541,852,322	363,846,438,806	15,365,000
5 Ultra Long Range Jets	Boeing	737-800 BBJ2	4+8/189	37,985	470	4	700	37,285	174,700	174,200	74,395	64,968	36,400	651,789,536	355,270,352,239	18,642,500
6 Jet >20000 lb MTOW	Bombardier	Learjet 45 LR-45	2+8/9	2,305	456	2	350	1,955	20,750	20,500	7,065	6,062	4,750	61,124,079	30,780,483,582	977,500
7 Jet >20000 lb MTOW	Cessna	Citation Excel CE-560-XL	2+8/11	2,300	423	2	350	1,950	20,200	20,000	7,500	6,740	6,200	61,514,431	34,223,104,478	975,000
8 Jet >20000 lb MTOW	Bombardier	Learjet 60 LR-60	2+5/10	2,300	453	2	350	1,950	23,750	23,500	9,060	7,910	6,750	69,153,138	40,163,910,448	975,000
9 Jet >20000 lb MTOW	Raytheon	Hawker 800XP	2+8/15	2,050	447	2	350	1,700	28,120	28,000	11,720	10,000	9,670	80,220,547	60,776,119,403	850,000
10 Jet >20000 lb MTOW	Israel Aircraft	Astra SPX IA-1125A	2+7/9	2,900	465	2	350	2,550	24,800	24,650	10,700	9,365	7,800	76,427,845	47,551,835,821	1,275,000
11 Jet >20000 lb MTOW	Fairchild Dornier	Envoy 3 Corporate Do328-310	2+16/32	7,968	387	2	350	7,616	34,789	34,524	13,941	11,154	5,975	74,143,295	66,636,660,522	3,808,000
12 Jet >20000 lb MTOW	Fairchild Dornier	Envoy 3 Executive Do328-310	2+10/12	6,445	387	2	350	6,095	34,789	34,524	11,420	11,154	5,975	74,143,295	66,636,653,582	3,047,500
13 Jet >20000 lb MTOW	Embraer	Legacy Shuttle EMB-145	2+19/37	7,695	457	2	350	7,345	44,246	44,092	16,667	11,501	8,972	132,044,702	67,483,644,778	3,672,500
14 Jet >20000 lb MTOW	Cessna	Citation X CE-750	2+8/12	2,400	506	2	350	2,050	36,400	36,100	14,400	12,931	12,000	132,536,964	85,858,600,000	1,025,000
15 Jet >20000 lb MTOW	Israel Aircraft	Galaxy	2+8/19	4,200	476	2	350	3,850	35,600	35,450	15,800	15,000	11,600	115,175,159	76,164,179,104	1,925,000
16 Jet >20000 lb MTOW	Dassault	Falcon 50EX DA-50	2+8/19	3,320	481	2	350	2,970	39,900	39,700	17,650	15,520	14,330	131,707,177	78,204,537,313	1,485,000
17 Jet >20000 lb MTOW	Embraer	Legacy Executive EMB-145	2+12/15	6,636	459	2	350	6,286	48,633	48,479	19,926	17,702	13,360	146,458,215	89,983,866,567	3,143,000
18 Jet >20000 lb MTOW	Dassault	Falcon 2000 DA-2000	2+8/19	5,910	479	2	350	5,560	36,000	35,800	13,291	12,154	7,340	117,703,061	61,713,246,522	2,780,000
19 Jet >20000 lb MTOW	Bombardier	Corporate Jetliner CL-601RJ	2+10/30	12,340	460	2	350	11,990	51,250	51,000	19,590	14,305	7,250	154,744,200	72,820,238,806	5,995,000
20 Jet >20000 lb MTOW	Challenger 604	CL-604	2+9/19	4,900	468	2	350	4,550	48,300	48,200	21,200	19,850	16,300	151,379,661	100,790,597,015	2,275,000
21 Jet >20000 lb MTOW	Special Edition	CL-601SE	2+15/19	5,660	444	2	350	5,310	53,250	53,000	19,410	18,305	13,750	140,820,276	92,945,696,567	2,655,000
22 Jet >20000 lb MTOW	Dassault	DA-900B	2+12/19	2,945	474	2	350	2,595	45,700	45,500	20,425	19,166	17,430	146,507,475	97,312,432,836	1,297,500
23 Jet >20000 lb MTOW	Dassault	DA-900EX	2+12/19	4,836	474	2	350	4,486	48,500	48,300	22,471	21,200	17,635	155,608,242	106,829,850,746	2,243,000
24 Jet >20000 lb MTOW	Gulfstream	G-IV	2+14/19	6,800	476	2	350	6,450	75,000	74,600	31,800	29,281	26,000	242,371,481	148,677,666,224	3,225,000
25 Jet <20000 lb MTOW	Cessna	CJ1 CE 525	1+6/7	1,650	377	1	175	1,275	10,700	10,600	3,850	3,220	2,200	21,803,163	16,349,910,448	637,500
26 Jet <20000 lb MTOW	Sino Swearingen	SJ30-2	1+4/6	1,800	459	1	175	1,625	13,600	13,500	5,400	4,950	3,000	40,783,822	25,134,179,104	812,500
27 Jet <20000 lb MTOW	Raytheon	Premier I RA-390	1+6/7	1,760	465	1	175	1,585	12,590	12,500	4,350	3,612	2,590	37,107,491	18,340,334,328	792,500
28 Jet <20000 lb MTOW	Cessna	CJ2 CE 525A	1+7/8	1,600	407	1	175	1,425	12,500	12,375	4,800	3,930	3,200	29,394,279	19,955,014,925	712,500
29 Jet <20000 lb MTOW	Cessna	Bravo CE-550	2+7/11	1,900	400	2	350	1,550	15,000	14,800	5,000	4,324	3,700	30,955,527	24,494,400,000	775,000
30 Jet <20000 lb MTOW	Bombardier	Learjet 31A LR-31A	2+6/10	2,297	456	2	350	1,947	17,200	17,000	5,997	4,124	3,700	60,683,261	20,940,071,642	973,500
31 Jet <20000 lb MTOW	Raytheon	Beechjet BE-400A	2+7/8	2,085	447	2	350	1,735	16,300	16,100	6,385	4,912	3,300	46,128,540	24,941,223,881	867,500
32 Jet <20000 lb MTOW	Cessna	Citation Encore CE-560	2+7/11	2,100	426	2	350	1,750	16,830	16,630	6,330	5,400	4,230	42,275,314	27,419,104,478	875,000
33 Multi Turboprops >12500 lb MTOW	Raytheon	Executive 1900D	2+12/19	4,375	277	2	350	4,025	17,230	17,120	6,440	4,458	2,065	18,836,142	22,835,994,030	2,012,500
34 Multi Turboprops >12500 lb MTOW	Raytheon	King Air 350	1+9/15*	2,860	312	1	175	2,685	15,100	15,000	5,460	3,811	2,600	20,937,712	18,335,256,716	1,342,500
35 Multi Turboprops <=12500 lb MTOW	Reims Cessna	Caravan II RA406	1+8/13	2,768	231	1	175	2,593	9,925	9,850	4,193	3,183	1,425	7,536,834	16,162,038,806	1,296,500
36 Multi Turboprops <=12500 lb MTOW	Raytheon	King Air C90B	1+5/12	2,202	246	1	175	2,027	10,160	10,100	3,150	2,573	948	8,764,303	13,064,895,522	1,013,500
37 Multi Turboprops <=12500 lb MTOW	Raytheon	King Air B200SE	1+7/15	2,730	272	1	175	2,555	12,590	12,500	4,320	3,645	1,530	15,282,865	18,507,806,522	1,277,500
38 Multi Turboprops <=12500 lb MTOW	Raytheon	King Air B200CSE	1+7/15	2,420	292	1	175	2,245	12,590	12,500	4,010	3,645	1,680	16,282,855	18,507,846,522	1,122,500
39 Multi Turboprops <=12500 lb MTOW	Raytheon	King Air B200	1+7/15	2,380	252	1	175	2,205	12,590	12,500	3,970	3,645	1,530	15,282,855	18,507,895,522	1,102,500
40 Multi Turboprops <=12500 lb MTOW	Piaggio Aero Ind.	Avanti P180	1+7/9	1,830	322	1	175	1,655	11,600	11,550	3,930	2,802	2,100	25,443,714	14,227,468,657	827,500
41 Single Turboprop	Cessna	Caravan I CE-208-675	1+8/9	2,643	186	1	175	2,468	8,035	8,000	3,211	2,224	568	3,963,567	11,292,808,955	1,234,000
42 Single Turboprop	Cessna	Grand Caravan CE-208B	1+9/9	3,140	182	1	175	2,965	8,785	8,750	3,700	2,224	669	4,157,039	11,292,608,955	1,482,500
43 Single Turboprop	New Piper	Meridian PA-46-500T	1+4/5	771	262	1	175	596	4,893	4,850	1,271	1,139	600	4,773,898	5,783,400,000	298,000
44 Single Turboprop	TBM S.A.	TBM 700	1+5/6	1,483	300	1	175	1,308	6,614	6,579	2,314	1,887	831	8,450,459	9,581,453,731	654,000
45 Single Turboprop	Pilatus	PC-12	1+7/10	2,820	270	1	175	2,645	9,965	9,930	3,745	2,704	925	10,369,743	13,729,902,987	1,322,500
46 Multi Engine Turbocharged	New Piper	Seneca V PA-34-220T	1+4/5	1,011	204	1	175	836	4,773	4,750	1,305	722	294	2,034,541	3,716,811,940	418,000
47 Multi Engine Normal	Raytheon	Baron 58	1+4/5	1,325	200	1	175	1,150	5,524	5,500	1,834	1,164	309	3,154,852	5,910,340,299	575,000
48 Single Engine Pressurized	New Piper	Malibu Mirage PA-46-350P	1+4/6	1,002	212	1	175	827	4,358	4,340	1,237	720	235	2,796,981	3,656,880,597	413,500
49 Single Engine Pressurized	Extra	EA 400	1+5/6	886	243	1	175	711	4,407	4,407	1,307	1,000	421	3,731,508	6,453,820,896	355,500
50 Single Turbocharged	Cessna	Turbo Skylane CE-T182T	1+3/3	939	167	1	175	764	3,110	3,100	1,083	522	164	1,554,139	2,650,513,433	382,000
51 Single Turbocharged	Cessna	Turbo Stationair CE-T206H	1+5/6	1,162	164	1	175	987	3,617	3,600	1,334	528	172	1,388,414	2,880,979,104	493,500
52 Single Turbocharged	El Gavilan	358 EL-1	1+7/7	1,464	136	1	175	1,289	4,516	4,500	1,642	624	178	1,176,004	3,103,429,851	644,500
53 Single Turbocharged	Socata	Trinidad GT T/C TB-21 GT	1+3/4	949	165	1	175	774	3,095	3,086	1,096	517	147	1,219,395	2,625,125,373	387,000
54 Single Turbocharged	New Piper	Saratoga II TC PA-32R-301T	1+4/5	912	194	1	175	737	3,615	3,600	1,107	612	195	1,542,830	3,107,496,507	368,500
55 Single Turbocharged	Mooney	Bravo MO-20M	1+3/3	832	217	1	175	657	3,374	3,368	1,024	634	182	2,274,156	2,711,444,776	328,500
56 Single Turbocharged	Commander	115TC CDR-114TC	1+3/4	843	184	1	175	668	3,305	3,305	1,153	629	305	1,604,490	2,000,979,104	334,000
57 Single Turbocharged	Raytheon	Bonanza B36-TC	1+4/5	960	200	1	175	785	3,866	3,850	1,126	612	166	2,208,256	3,107,408,507	392,500
58 Single Turbocharged	Lake Aircraft	Turbo Sea Fury LA-270T	1+3/3	781	155	1	175	606	3,151	3,140	951	528	170	1,081,737	2,680,979,104	303,000
59 Single Normally Aspirated	Cirrus Design	SR20	1+3/3	851	160	1	175	676	2,900	2,900	950	336	99	1,064,552	1,700,077,612	338,000
60 Single Normally Aspirated	Cessna	Skylane CE-182T	1+3/3	1,064	141	1	175	889	3,110	3,100	1,192	522	129	883,749	2,650,513,433	444,500
61 Single Normally Aspirated	Cirrus Design	SR22	1+3/3	1,000	181	1	175	825	3,400	3,400	1,150	486	150	1,507,220	2,467,719,403	412,500
62 Single Normally Aspirated	Lancair	Columbus 300 LC40-550-FG	1+3/3	1,074	190	1	175	899	3,400	3,400	1,200	588	126	1,703,009	2,985,835,821	449,500
63 Single Normally Aspirated	Cessna	Stationair CE-206H	1+5/5	1,281	142	1	175	1,106	3,614	3,600	1,436	528	155	1,040,809	2,680,979,104	553,000
64 Single Normally Aspirated	Mooney	Eagle 2 M-20S	1+3/3	989	177	1	175	814	3,300	3,300	1,106	450	117	1,482,481	2,284,925,373	407,000
65 Single Normally Aspirated	Socata	Trinidad GT TB-20 GT	1+3/4	1,144	185	1	175	969	3,097	3,086	1,282	517	139	1,204,739	2,625,125,373	484,500
66 Single Normally Aspirated	New Piper	Saratoga PA-32R-301	1+4/5	930	166	1	175	755	3,615	3,600	1,206	612	276	1,622,404	3,107,490,507	377,500
67 Single Normally Aspirated	Mooney	Ovation 2 M-20R	1+3/3	929	190	1	175	754	3,374	3,368	1,074	634	146	1,743,444	2,711,444,776	377,000
68 Single Normally Aspirated	Commander	115 M-20R	1+3/4	898	160	1	175	723	3,260	3,250	1,168	528	260	1,193,032	2,680,979,104	361,500
69 Single Normally Aspirated	Raytheon	Bonanza A36	1+4/5	979	174	1	175	804	3,663	3,650	1,133	444	154	1,584,602	2,254,459,701	402,000
70 Single Normally Aspirated	Lake Aircraft	Sea Fury LA-250	1+5/5	882	132	1	175	707	3,151	3,140	1,031	528	149	784,624	2,680,979,104	353,500

Plans for Next Reporting Period

Work on Tasks 1 through 8 will continue.

Property Acquired

A HP X4000 Linux workstation costing $6.6K was acquired so that classified calculations (e.g., PRONTO calculations) that support this program can be performed by staff of SNL Organization 6141.

No equipment with a value greater than $500 was purchased during the current month.

Travel

J. L. Sprung traveled to Washington DC to attend a briefing by Holtec International staff on the Hi-Star transportation cask system at NRC Headquarters in Rockville MD on 19 September.

Budget Status

The following table presents program costs ($K) by task for the current month and for the fiscal year to date:

Task	Title	Current Month	Fiscal Year to Date
1.1	Jetliner Crash into an ISFSI	122.5	674.4
1.2	Small Plane Crash into an ISFSI	0.1	30.3
1.3	ANSYS/LS-DYNA Jetliner Model	8.3	109.4
1.4	Jetliner Crash into a Spent Fuel Rail Cask	0.0	0.0
1.5	Small Plane Crash into a Spent Fuel Rail Cask	0.0	0.0
1.6	Small Plane Crash into Other Radioactive Material Packages	0.0	0.0
2.0	Weapons, Radioactive Materials, Consequences	14.0	74.0
3.0	Models for Other Spent Fuel Transportation Casks	2.6	3.3
4.0	Models for Other Spent Fuel Storage Casks	0.0	0.0
5.0	Threat Assessment for Sabotage Scenarios Involving Storage Casks	0.0	0.0
6.0	Threat Assessment for Sabotage Scenarios Involving Transportation Casks	19.9	83.6
7.0	Models for Transportation Packages for Other Radioactive Materials	0.0	0.0
8.0	Threat Assessment for Sabotage Scenarios Involving Other Packages	0.0	0.0
	Code Demonstrations	0.0	0.0
	NRC Support	13.3	136.5
	NISAC	20.7	53.8
	DOE Added Factor [a]	0.0	4.8
	TOTAL	201.3	1170.1

a. DOE waived this load beginning the month of May 2002.

The financial reporting for this month is based on the 189 submitted at the end of February of 2002. $201.3 K was spent during September of FY2002. Total FY2002 spending was $1170.1 K. $1741.9 K will be carried over into FY03.