Meeting Agenda

Boiling Water Reactor Owners Group
and Nuclear Energy Institute

Recommendations For Resolving Generic Safety Issue 189,
"Susceptibility of Ice Condenser and Mark III Containments to Early Failure
from Hydrogen Combustion During a Severe Accident"

March 31, 2004

- Introduction — NRC
- Proposed Design Criteria Including Alternative Backup Power Supplies and Plant-Specific Probabilistic Risk Assessment Insights — BWROG/NEI & NRC
- Schedule and Actions for Next Several Months — BWROG/NEI & NRC
- Public Comments
- Summary — NRC

ENCLOSURE 1

BWROG GSI-189 COMMITTEE

NRC MEETING
MARCH 31, 2004

BWROG GSI-189 COMMITTEE BACKGROUND

- Committee Formed to Address GSI -189 Impact on BWR Mark III Containment Owners.
- Focus of Effort is on Plant Differences which impact Benefits and Cost
- Reviewed NRC Benefits and Cost Analysis
- Results of Review Documented in Letter (BWROG – 03053).

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ENCLOSURE 2

BWROG LETTER CONCLUSIONS

- Present Worth Calculated Benefits for Mean NUREG 1150 Case for MARK III Containment is $10k.
- Additional Allowance for External Event Benefits Should Approximate Calculated Benefits.
- Total Benefits do not Support Proceeding with Plant Modifications for BWR Owners

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GSI-189 ALTERNATIVES FOR MARK III

- Plants have HPCS Pump with dedicated Diesel Generator
- HPCS (Division 3) Diesel is of different design than the other Emergency Diesels
- SBO leading to Core damage assumes loss of HPCS System Flow
- Division III Diesel would be a potential source of power for Hydrogen Igniters
- Existing additional sources for backup power may be available

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GSI-189 ALTERNATIVES FEBRUARY 3 NRC MEETING

ISSUES FROM MEETING

- PRA Review of SBO leading to core damage
- Review of NRC AEOD report on HPCS
- Cost of Alternate solution Review of NRC AEOD report on HPCS
- Comparison of Alternate approach with Pre-staged generator

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GSI-189 FEBRUARY 3 MEETING ISSUES

AEOD REPORT ON HPCS

- Report confirms HPCS Generator is highly reliable.
- Covers 1987-1998 LER's
- Failures dominated by Maintenance OOS (71%) and injection valve (22%)
- Results consistent with Plant reliability data

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GSI-189
FEBRUARY 3 MEETING ISSUES

PRA REVIEW OF SBO FOR MARK III PLANT 1

- SBO CDF 1.42 E-6/yr
- SBO LERF 5.98 E-8/YR
- 50% of SBO CDF short term (within one hour)
- Includes HPCS crosstie (accounts for ~ 5% reduction in CDF)
- Major contributors to SBO CDF are common cause failures: HVAC, Service Water, DG
- Expect Division 3 Diesel to be available 21% of time based on PRA
- AEOD report notes difference in PRA vs. actual failures
- Igniters working full time only reduces LERF by a maximum of ~15% (3E-08/yr LERF)

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GSI-189
FEBRUARY 3 MEETING ISSUES

PRA REVIEW OF SBO FOR MARK III PLANT 2

- SBO CDF 1.82 E-6/yr
- 65% of SBO CDF short term (within one hour)
- Major contributors to SBO CDF are common cause failures: HVAC, Service Water, DG
- An additional Plant unique source of backup power from a non-safety related battery, without common cause failure, has the potential to further reduce LERF depending on the type of connection and the human reliability analysis

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GSI-189
FEBRUARY 3 MEETING ISSUES

COST OF ALTERNATE SOLUTION

- Use of existing Plant equipment will reduce costs
- Modification for electrical connections
- Incorporate into Plant procedures
- Costs will be Plant specific - less than $100k at one Plant

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GSI-189
FEBRUARY 3 MEETING ISSUES

COMPARISON WITH PRE-STAGED

- Division III Generator highly reliable
- Meets all emergency power requirements
- Operators familiar and trained on system

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GSI-189
FEBRUARY 3 MEETING ISSUES

COMPARISON WITH PRE-STAGED (CONT)

- Less burden on Operations during severe accident
- Cost in line with postulated benefits
- Early installation of backup power for igniters
- Provides additional defense in depth

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GSI-189 ALTERNATIVES SUMMARY

- Resolution of GSI-189 should permit alternatives based on Plant capabilities
- AEOD report supports Division 3 generator is highly reliable
- PRA review supports low benefit for Mark III Owners from igniter backup power
- Costs of Alternate solution in line with benefits
- Comparison supports alternate solution

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DESIGN CRITERIA CHECKLIST (GSI-189)

GSI-189 Modification Scope: Provide non-safety, non-seismic, commercial grade backup power for ONE train of Hydrogen Igniters during a SBO (Station Black Out) event.

ELECTRICAL DESIGN CRITERIA ISSUES:

- **Requirement for Power:** Initiate backup power supply within two (2) hours of event with a maximum of 1 full day of operation required, or as justified by site's actions.

- **Remote Indication requirements:** No additional indication beyond existing indication required.

- **Power Requirements:** Assume power requirements for igniters only; no fans, dampers, or hydrogen analyzers required.

- **Safety/Non-Safety Interface:** If existing Diesel option chosen, Safety/Non-safety equipment interface required If stand alone generator utilized, follow existing Design Specification safety/non-safety interface requirements.

- **Environmental Qualification (50.49):** Not required.

MECHANICAL DESIGN CRITERIA ISSUES:

- **Fuel Storage Quantity and Quality:** If stand alone generator; fuel type and storage/tank specifications required.

- **Environmental Qualification (50.49):** Not required.

STRUCTURAL (CIVIL) DESIGN CRITERIA ISSUES:

- **Tornado Protection:** According to PRA, this would be beneficial, but not cost effective. Tornado protection not required.

- **Fire Protection:** Fire protection required to be the same as existing in the area of modification; no additional requirements added. No Appendix R requirements. Fire protection would be beneficial, but not cost effective.

- **Seismic Requirements:** Seismic required to be the same as existing in the area of modification; no additional requirements added. Seismic qualification would be beneficial, but not cost effective.

OPERATIONS DESIGN CRITERIA ISSUES:

- **Operator Burden:** Modification design should result in minimal burden on the operating staff during emergency conditions.

- **Emergency Operating Procedures:** EOP procedures possibly affected, may want inclusion into APs. Procedure updates required.

- **Operator Training:** Operator continuing training will require update (appropriate to mod) and may require demonstration of ability of operator response.

- **Testing Requirements:** If existing Diesel option chosen, existing testing frequency would be sufficient, with potential procedure changes and additional operator action (verify breaker operation) required, and if stand alone generator option chosen; testing requirements, frequency determination, and procedure additions are required.

- **Technical Specifications:** There are four criteria listed within 10 CFR 50.36 that requires TS. This modification does not meet any of the criteria; therefore a TS change is not required.

- **Maintenance Rule:** Currently Hydrogen Mitigation is a Risk Significant Function. Backup supply mod to be reviewed for inclusion within Maintenance Rule scope.

- **Procedural Controls:** Updates to UFSAR, Procedure changes and/or additions, etc.

ENVIRONMENTAL DESIGN CRITERIA ISSUES:

- **Environmental Impacts:** Evaluation of environmental impacts for fuel storage/tanks of stand alone generator would be required.

SECURITY DESIGN CRITERIA ISSUES:

- **Security Requirements:** Not required.

ALL AREAS WILL REQUIRE 50.59 (FULL SAFETY EVALUATION FOR EACH AREA)

McGuire Results

		CDF		LERF	
Seismic	Seismic Event	7.39E-06	73.4%	1.37E-06	72.6%
Tornado	Tornado Event	1.53E-06	15.2%	2.89E-07	15.3%
T3	Loss of Offsite Power	1.09E-06	10.8%	2.21E-07	11.7%
FMFP	Main Feedwater Pump Fire	2.80E-08	0.3%	3.75E-09	0.2%
FACTB	Turbine Building Fire	2.23E-08	0.2%	3.16E-09	0.2%
T11	Loss of Essential Bus	1.30E-08	0.1%	1.29E-09	0.1%
T1	Reactor Trip			8.15E-10	0.0%
T4	Loss of Main Feedwater			1.62E-10	0.0%
SBO		1.01E-05		1.89E-06	

		CDF		LERF	
14PI	Cycling Relief Valve, Start failure of SSHR, no injection	6.32E-06	62.7%	1.27E-06	67.0%
15PI	Cycling Relief Valve, Run failure of SSHR, no injection	1.96E-06	19.5%	4.22E-07	22.3%
7PI	RCP Seal LOCA, injection failure, with SSHR	1.66E-06	16.5%	1.73E-07	9.1%
4PI	Stuck Open Pressurizer Safety Valve, no Injection	1.22E-07	1.2%	2.96E-08	1.6%
10PI	RCP Seal LOCA, recirculation failure, with SSHR	8.74E-09	0.1%	7.53E-10	0.0%
Fast		6.32E-06	62.7%	1.27E-06	67.0%
Slow		3.75E-06	37.2%	6.25E-07	33.0%
		1.01E-05		1.89E-06	

Approximately 97% of frequency is 2 unit LOOP.

The SSF DG is available in approximately 98% of the non-seismic SBO CDF and is assumed to fail in the seismic analysis.

In the slow sequences secondary side heat removal is available for a significant length of time following the initiating event.

When secondary side heat removal fails initially (fast) core damage occurs in approximaetly 3 hours.

Catawba Results

		CDF		LERF	
Seismic	Seismic Event	8.32E-06	69.8%	8.98E-07	56.1%
FTB	Turbine Building Flood	2.79E-06	23.4%	5.58E-07	34.9%
T3	Loss of Offsite Power'	4.56E-07	3.8%	9.12E-08	5.7%
TORNSW	Tornado Strikes Switchyard	2.42E-07	2.0%	4.84E-08	3.0%
TORNF4	F4 or Greater Tornado Strikes Plant	6.26E-08	0.5%	1.25E-08	0.8%
T11	Loss of Essential Bus	3.36E-08	0.3%	6.72E-09	0.4%
T1	Reactor Trip	1.05E-08	0.1%	2.10E-09	0.1%
FACTB	Turbine Building Fire	7.92E-09	0.1%	1.58E-09	0.1%
FDG	Diesel Generator Fire	1.51E-09	0.0%	3.02E-10	0.0%
T12	Loss of Instrument Air	1.08E-09	0.0%	2.16E-10	0.0%
SBO		1.19E-05		1.62E-06	

		CDF			LERF	
15PI	Cycling Relief Valve with Run failure of SSHR	3.37E-06	28.3%		6.74E-07	42.1%
7PI	RCP Seal LOCA, injection failure, with SSHR	7.66E-06	64.2%		7.66E-07	47.9%
14PI	Cycling Relief Valve with Start failure of SSHR	7.07E-07	5.9%		1.41E-07	8.8%
4PI	Stuck Open Pressurizer Safety Valve, no Injection	1.87E-07	1.6%		1.87E-08	1.2%
1PI	Large LOCA Injection Failure (seismically induced)	4.21E-09	0.0%		4.21E-10	0.0%
Fast		7.11E-07	6.0%	0	1.42E-07	8.9%
Slow		1.12E-05	94.0%	0	1.46E-06	91.1%
		1.19E-05			1.60E-06	

Approximately 96% of frequency is 2 unit LOOP.

The SSF DG is available in approximately 98% of the non-seismic SBO CDF and is assumed

In the slow sequences secondary side heat removal is available for a significant length of time following the initiating event.

When secondary side heat removal fails initially (fast) core damage occurs in approximaetly 3 hours.

MNS

		CDF	No seismic	LERF	
14PI	Cycling Relief Valve, Start failure of SSHR, no injection	3.00E-08	1.1%	1.03E-08	2.0%
15PI	Cycling Relief Valve, Run failure of SSHR, no injection	1.90E-06	70.9%	4.10E-07	79.0%
7PI	RCP Seal LOCA, injection failure, with SSHR	6.19E-07	23.1%	6.86E-08	13.2%
4PI	Stuck Open Pressurizer Safety Valve, no Injection	1.22E-07	4.6%	2.96E-08	5.7%
10PI	RCP Seal LOCA, recirculation failure, with SSHR	8.74E-09	0.3%	7.53E-10	0.1%
Fast		3.00E-08	1.1%	1.03E-08	2.0%
Slow		2.65E-06	98.7%	5.09E-07	98.0%
		2.68E-06		5.19E-07	

CNS

		CDF	No seismic	LERF	
15PI	Cycling Relief Valve with Run failure of SSHR	3.37E-06	93.4%	6.74E-07	95.9%
7PI	RCP Seal LOCA, injection failure, with SSHR	0.00E+00	0.0%	0.00E+00	0.0%
14PI	Cycling Relief Valve with Start failure of SSHR	5.00E-08	1.4%	1.00E-08	1.4%
4PI	Stuck Open Pressurizer Safety Valve, no Injection	1.87E-07	5.2%	1.87E-08	2.7%
8PI	RCP Seal LOCA, injection failure, without SSHR	0.00E+00	0.0%	0.00E+00	0.0%
1PI	Large LOCA Injection Failure (seismically induced)	0.00E+00	0.0%	0.00E+00	0.0%
Fast		5.00E-08	1.4%	1.00E-08	1.4%
Slow		3.56E-06	98.6%	6.93E-07	98.6%
		3.61E-06		7.03E-07	

DRAFT DESIGN CRITERIA

GSI – 189, "Susceptibility of Ice Condenser and Mark III Containments to Early Containment Failure Due to Hydrogen Combustion During a Severe Accident"

Ruth C. Reyes-Maldonado
US Nuclear Regulatory Commission
NRR/DSSA/SPLB
March 31st, 2004

ENCLOSURE 3

Draft Design Criteria

Timing for Igniter Initiation/Operator Response Time

- System should be designed so that igniters can be loaded onto backup power source prior to the onset of core damage in the frequency-dominant, SBO core melt accidents at each plant.
- The time at which igniters are required is plant specific and varies based on plant type and which SBO accidents are most likely:
  - BWR - fast SBO: < 1h; slow SBO: >3 h
  - PWR - fast SBO: ~ 2h; slow SBO: >4 h

Draft Design Criteria

Portable versus Pre-Staged Generator

- Not specified. Utility may determine that pre-staging is necessary to meet the functional requirement for igniter initiation time. On multi-unit sites, can use either a single generator located and sized to supply both units, or one generator per unit.
- Provide flexibility while still meeting the functional requirements. The capability to power igniters at both units simultaneously should be provided to address dual unit SBOs.

Draft Design Criteria

EOPs versus SAMG

- Guidance on igniter actuation should be entered sufficiently early in an event that necessary actions can be completed prior to the onset of core damage. In general, should include guidance within EOPs or other plant procedures that would be entered following immediate actions to prevent core damage.
- Actions to provide backup power to igniters are less critical than immediate actions to prevent core damage, and should be prioritized accordingly. SAMG would not be entered until core damage is imminent, and would not be expected to result in timely igniter actuation (unless system is designed to be actuated from the control room).

Draft Design Criteria

Remote Indication

- Not required. Utility may determine that remote indication is desirable.
- Local manual operation and indication is acceptable provided that the functional requirement for igniter initiation time is met. Remote indication may be desirable, (e.g., if system is designed to be actuated from the control room).

Draft Design Criteria

Testing

- System shall be designed to permit appropriate periodic inspection and testing of the functional features such as start up, cooling, lubrication, exhaust, and ventilation systems including power supply to assess continuity of the systems and condition of the subcomponents. Shall be tested periodically to ensure the operability and functional performance.
- Testing should include (i) demonstration of startup operation within acceptable limits and time as well as full load carrying capability, and (ii) demonstration of the proper functionality of the cooling, lubrication, exhaust, fuel supply and control systems during fully loaded operation. Test data shall be maintained and made available to the inspectors as needed.

Draft Design Criteria

Maintenance Rule

- The licensee shall evaluate the system against the scoping criteria of 10 CFR 50.65(b). Because the system is expected to be relied upon to mitigate accidents, or may be used in the plant emergency operating procedures, the staff anticipates that the system would be within the scope of the Maintenance Rule.
- Monitoring the performance of the system under the Maintenance Rule will provide additional assurance that the system is capable of performing its intended function.
- In accordance with the Maintenance Rule, the licensee should either:
  - demonstrate that the preventative maintenance program effectively controls system performance or,
  - monitor the performance of the system against licensee established goals in a manner sufficient to provide reasonable assurance that the system can perform its intended functions.

Draft Design Criteria

Seismically Qualified

- The backup power source and the fuel don't have to be seismically qualified but shall be stored or secured such that they will remain functional following the occurrence of a safe shutdown earthquake (SSE).
- Credit for operation following seismic events was not assumed in the cost analysis and benefits of seismic qualification would be highly site-specific. An industrial grade backup power source, appropriately stored/secured for seismic events, would have a high likelihood of surviving seismic events and would provide risk reduction benefits in moderate seismic events. Qualification of the backup power source for seismic events would substantially increase the cost of implementation without a commensurate increase in risk reduction benefits.

Draft Design Criteria

Tornado Protection/Hurricanes and High Winds

- The backup power source and the fuel don't have to be tornado qualified but should be stored or secured such that it will remain functional following a tornado (i.e., if portable kept inside a structure that can withstand tornado effects).
- Even though tornados and high winds contribute only a small fraction of total plant risk, tornadoes have a high likelihood of causing loss of offsite power. The licensee can increase the availability of the backup power source in tornado and high wind events by considering these threats and their likely trajectories when determining the location(s) where the backup power source would be staged.

Draft Design Criteria

Igniter Coverage/Number of Igniters

- Provide backup power to sufficient igniters (number and location) to prevent accumulation of significant concentrations of hydrogen in any major compartment within containment.
- Each compartment within containment is equipped with at least one igniter from each train. Powering one of two full trains of igniters would provide igniter coverage in every compartment, and was assumed in the cost-benefit analysis. Powering less than one full train can be acceptable if justified by analysis.

Draft Design Criteria

Power Requirements

- System shall be capable of generating sufficient capacity to supply AC backup power needed for the functioning of all hydrogen igniters determined necessary to prevent accumulation of hydrogen in any major compartments within containment.
- Provide flexibility while still meeting the functional requirements.

Draft Design Criteria

Independence

- System shall be designed to be independent.
- The backup power system, including the onsite electric distribution system, shall be designed to have sufficient independence to provide reasonable confidence that it will be able to perform its function during postulated accidents involving a station blackout (SBO).

Draft Design Criteria

Backup Power to Air Return Fans or Hydrogen Analyzers

- Not required.
- Severe accident containment analyses performed for GSI-189 show that air return fans need not be supplied from backup power. Hydrogen analyzers need not be powered because sufficient hydrogen concentration information for decision-making can be inferred from plant parameters.

Draft Design Criteria

Fuel Type

- Not specified.
- Any reliable type can be acceptable: propane, natural gas, gasoline or diesel.

Draft Design Criteria

Fire Protection

- The power source and location should not cause a significant increase in risk from fires.
- Considered a non-safety related system. Implementation of backup power and storage of fuel shall not adversely impact other systems required for safe shutdown.

Draft Design Criteria

Fuel Storage and Quality

- Sufficient fuel to provide for 24 hours of operation shall be stored on site.
- Storage of fuel shall not adversely impact other systems required for safe shutdown. Fuel quality expected to be covered by the Maintenance Rule.

Draft Design Criteria

Security Requirements

- The location of the backup power source and fuel should take advantage of the existing security measures.
- System and components are expected to be located/stored within the protected area.

Draft Design Criteria

50.59 Requirements

- Changes can be implemented under 10CFR50.59.
- Implementation will have minimal, if any, impact on safety-related systems and licensing basis events.

Draft Design Criteria

Safety/Non-Safety Interface

- The backup power system shall be designed such that their failure will not prevent safety-related structures, systems and components (SSCs) from fulfilling their safety-related function.
- Switches and disconnects would be provided to maintain necessary isolation between safety and non-safety related power.

Draft Design Criteria

Operator Training/Job Performance Measures

- Include use of the backup power source within the training provided to control room and equipment operators, commensurate with their responsibilities for operation.
- Incorporate within the initial and recurring training already provided to control room and equipment operators. This would be expected to include system walk-downs and demonstration of the capability to position, start, and load the backup power supply in a timely manner.

Draft Design Criteria

Significance Determination Process (SDP)

- Backup power to igniters is not addressed in current SDP tools.
- The need to update the SDP tools will be considered.

Draft Design Criteria

Environmental Impacts

- Backup power supply should be designed to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.