Enclosure 2

MFN 15-069, Supplement 2

GEH's Response to NRC's Request for Supplemental Information # 2 to Item #26 – Fukushima Recommendation 4.2 - Mitigation Strategies

ABWR DCD Revision 6 Markups

1D.2.4 Mitigating Strategies for Beyond Design Basis Events (4.2)

NRC Recommendation

NRC issued Order EA-12-049 (Reference 1D.5-5) to power reactor licensees and holders of construction permits requiring a three-phase approach for mitigating beyond-design-basis external events. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment and spent fuel pool (SFP) cooling capabilities. The transition phase requires providing sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from offsite. The final phase requires obtaining sufficient offsite resources to sustain these functions indefinitely.

Response

The ABWR Design incorporates an ACIWA System. Operation of the ACIWA system is discussed in Subsection 5.4.7.1.1.10. The system can utilize either the diesel driven fire pump (described in Subsection 9.5.1.3.5) or an external pump (e.g. fire truck or trailer mounted pump) using one of two external Reactor Building connection points. Water can be directed to the Reactor Pressure Vessel (RPV), SFP or Containment Spray lines via the RHR system piping. ACIWA support equipment will be housed in a separate building. That building will be capable of withstanding the site specific external events such as seismic events, flooding, and other site specific external events (e.g. hurricanes). The capability of the building housing the ACIWA support equipment will be evaluated in the plant specific PRA (COL License Information item 19.30, Subsection 19.9.30).

Equipment procured for the ACIWA system will be procured in accordance with Diverse and Flexible coping Strategies (FLEX) guidance (Reference 1D.5-3). Equipment survivability was evaluated as part of the PRA and the results are summarized in Subsection 19E.2.1.2.3.4. The equipment that will be installed may be different than that assumed in the PRA and it will be evaluated as required by DCD Tier 1, Section 3.6 Design Reliability Assurance Program (DRAP) Design Requirements. The Design Reliability Acceptance Program (D-RAP) requires confirmation that the SSCs will function reliably when challenged.

INITIAL PHASE: In the initial phase of the event, the ABWR Design Approach (Strategy) for mitigating a beyond-design-basis external event (BDBEE) is characterized by the unavailability of all AC Power except that obtained from the batteries through inverters. This leaves the Reactor Core Isolation Cooling (RCIC) system and firewater as the only systems available for core cooling. This sequence assumes RCIC operates for approximately 8 hours, providing core cooling (Subsection 19E.2.1.2.2).

TRANSITION PHASE: For the transition phase, after the RCIC pump loses DC Power, the operator depressurizes the vessel via the Automatic Depressurization Relief Valves and begins injection with the AC Independent Water Addition (ACIWA) system which can maintain core cooling for an extended period of time.

No containment cooling system is available since all the diesel generators and the Combustion Turbine Generator (CTG) were assumed to fail. The sequence of events for the case in which core cooling is maintained is summarized in Table 19E.2-9 and is depicted in Figures 19E.2-6a through 19E.2-6e.

After the reactor is depressurized, and the firewater system is injecting, pressure in the containment rises slowly since only decay heat is being added to the suppression pool. Water injected via the ACIWA is sufficient to make up for decay heat boil-off and adequate core cooling is maintained. When the wetwell pressure reaches 0.72 MPa (after 32 hours), the Containment Overpressure Protection System (COPS) passive rupture disc will rupture and energy from the containment is released via this vent.

The ACIWA also has the capability to add water to the Spent Fuel Pool to maintain level which provides a means to maintain cooling to the spent fuel stored there.

The above discussion utilizes installed plant equipment and resources to maintain or restore core cooling, containment cooling, and Spent Fuel Cooling and can be considered the Initial and Transition Phase of the BDBEE strategy.

The firewater is stored in two storage tanks that have special seismic qualification and quality assurance requirements (Table 3.2-1, Subsection 9.5.1.3.5, and Figures 9.5-4 and 9.5-5).

Sufficient consumable supplies of fuel for the Diesel Fire Pump, Nitrogen for the ADS Relief Valves and Makeup Water will be available on site to support operation until offsite sources can be made available. This detailed design information will be developed as part of the Flex Integrated Plan and will be based on Plant Specific equipment requirements.

FINAL PHASE: The final phase, which requires obtaining offsite resources to sustain these functions indefinitely, would normally begin after the 72-hour point.

The COL Applicant will identify additional equipment to be procured to provide defense in depth mitigation capability. Equipment to be considered includes:

- High capacity pumps which will be in addition to those described above
- Portable diesel generators to provide power to lighting and instrumentation
- Portable DC power supplies
- Handheld satellite phones
- Various hoses, fittings, cables, and jumpers necessary to connect the above equipment

The COL applicant will prepare a FLEX Integrated Plan for mitigating a Beyond Design Basis External Event (BDBEE) (Subsection 13.5.3.2). This plan will be patterned after the industry FLEX program (Reference 1D.5-3). The FLEX Integrated Plan will provide site specific guidance and strategies to restore core, containment and spent fuel cooling following a BDBEE. The strategies will be capable of mitigating a simultaneous loss of all AC power (including the CTG) and loss of normal access to the ultimate heat sink, and will be capable of being implemented in all operating modes. Subsection 19E.2.2.3 and Appendix 19Q discuss the design capabilities to be used in implementing the plan. The following COL License Information items provide additional guidance:

Item No.	Subject	Subsection
1.5	Emergency Procedures and Emergency Procedure Training Program	1A.3.1

Item No.	Subject	Subsection
1.13	Station Blackout Procedures	1C.4.1
9.9	Spent Fuel Firewater Makeup Procedures and Training	9.1.6.9
9.10	Protection of RHR System Connections to FPC System	9.1.6.10
9.19	Use of Communication System in Emergencies	9.5.13.2
9.31	Portable and Fixed Emergency Communication Systems	9.5.13.14
9.37	Operation Procedures for Station Blackout	9.5.13.20
13.4	Emergency Procedures Development (This includes the FLEX Integration Plan)	13.5.3.2
19.7	Procedures and Training for Use of ACIWA System	19.9.7
19.12	Procedures for Operation of RCIC from Outside the Control Room	19.9.12
19.14	Accident Management	19.9.14
19.19c	Procedures to Assure SRV Operability During Station Blackout	19.9.22

The equipment required to mitigate the BDBEE will be adequately protected from external events (COL License Information item 19.19b, Subsection 19.9.21). NRC Order EA-12-049 (Reference 1D.5-5) to power reactor licensees and holders of construction permits requires a three-phase approach for mitigating beyond-design-basis external events. Based on site specific evaluations of available consumables, this may be simplified to two phases if it can be shown that on site capability is sufficient to reach the point at which offsite supplies would be available. The site specific evaluation will also determine the durations of each phase based on predicted replenishment times for the consumables and this will be documented in the FLEX Plan.

The ABWR design does not take credit for the CTG that is part of the design bases for SBO. The design as described in Subsection 19E.2.2.3 credits the installed RCIC, ACIWA, and the Containment Overpressure Protection (COPS) systems to provide core, containment, and spent fuel cooling during all phases in accordance with the NRC Order.

To support the implementation of the FLEX Plan, the following system design requirements have been added to the original design:

- Added ACIWA subsystem to RHR Loop B, including connection to the Fire Protection system (FP) and external hose connection for fire truck.
- Made FP diesel-driven fire pump fuel capacity sufficient for 72 hours of operation;
- Included severe weather/flooding protection for ACIWA and the diesel-driven fire pump.
- Analyzed RCIC system for operation with 121°C (250°F) pump suction temperature.
- Added Reactor Building (RB) external connections for FLEX diesel generators to 480VAC RB 1E power centers.
- Replaced control of SRVs G, J, K, and P with Control of ADS SRVs C, H, L and R on the Remote Shutdown Panel (RSP)
- Added Wide Range RPV Water Level indication (Division I and II) (Cold Calibration) to the RSP.
- Added N2 Supply Header Pressure indication (Division I and II) to the RSP
- Added CST Water Level indication (Division I) to the RSP
- Added Containment Wide Range Pressure indication (Division I and II) to RSP
- Added Wide Range Suppression Pool Water Level indication (Division I and II) to the RSP

1D.5 References

1D.5-1 SECY-11-0137, "Prioritization of Recommended Actions to be taken in response to Fukushima Lessons Learned" October 3, 2011.

1D.5-2 SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned From Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami".

1D.5-3 NEI 12-06 [Revision ~~0~~2] "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"~~ August, 2012~~December 2015.

1D.5-4 SRM for SECY 12-0025, "Staff Requirements-SECY-12-0025 Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Tohoku Earthquake and Tsunami" March 9, 2012.

1D.5-5 EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design-Basis External Events," March 12, 2012.

1D.5-6 EA-12-050, "Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents" March 12, 2012.

1D.5-7 EA-12-051, "Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," March 12, 2012.

1D.5-8 NUREG-2115, "Central and Eastern United States Seismic Source Characterization".

1D.5-9 SECY-11-0093, "The Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," July 12, 2011.

1D.5-10 NEI 12-01, Guidelines for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities.

1D.5-11 NEI 12-02 [Revision 1] "Industry Guidance for Compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" August 2012.

1D.5-12 JLD-ISG-2012-03, ~~SECY-11-0124, "Recommended Actions to be taken Without Delay from the Near Term Task Force Report", September 9, 2011~~ "Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation," August 29, 2012.

1D.5-13 SECY-11-0124, "Recommended Actions to be taken Without Delay from the Near Term Task Force Report", September 9, 2011.

1D.5-14 JLD-ISG-2012-01 [Revision 1], "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, January 22, 2016.

Table 1.8-21 Industrial Codes and Standards* Applicable to ABWR (Continued)

Code or Standard Number	Year	Title
[*H-46855B*	*1979*	*Human Engineering Requirements for Military Systems, Equipment and Facilities*][5]
[*HDBK-217*	*Latest Edition*	*Reliability Prediction of Electronic Equipment*][3]
[*HDBK-251*	*Latest Edition*	*Reliability/Design: Thermal Applications*][3]
[*HDBK-759A*	*1981*	*Human Factors Engineering Design for Army Material*][5]
STD-282	1956	Filter Units, Protective Clothing Gas-Mask Components and Related Products: Performance-Test Methods
[*STD-461C*	*1987*	*Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference*][3][4]
[*STD-462*	*1967*	*Measurement of Electromagnetic Interference Characteristics*][3][4]
[*STD-1472D*	*1989*	*Human Engineering Design Criteria for Military Systems, Equipment and Facilities*][5]
[*STD-1478*	*1991*	*Task Performance Analysis*][5]
Others		
ASCE 7	1988	Minimum Design Loads for Buildings and Other Structures
ERDA 76-21	1976	Testing of Ventilation Systems, Section 9 of Industrial Ventilation Systems
[*IEC 801-2*	*1991*	*Electronic Capability for Industrial-Process Measurement and Control Equipment*][3]
[*IEC 880*	*1986*	*Software for Computers in the Safety Systems of Nuclear Power Stations*][3][4]
[*IEC 964*	*1989*	*Design for Control Rooms of Nuclear Power Plants, Bureau Central de la Commission Electrotechnique Internationale*][5]
[*ISO 7498*	*1984*	*Open Systems Interconnection-Basic Refence Model, as the Data Link Layer and Physical Layer*][3]
NEI 00-01	2009	Guidance for Post Fire Safe Shutdown Circuit Analysis, Rev. 2
NEI 06-12 R2	2006	B.5.b Phase 2 & 3 Submittal Guideline
NEI 12-01	2012	Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities
NEI 12-02	2012	Industry Guidance for Compliance with NRC Order EA-12-051, “To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation”
~~NEI 12-06 R0~~ NEI 12-06 R2 2015	~~2012~~	Diverse and Flexible Coping Strategies (FLEX) Implementation Guide
NEI 14-01 R0	2014	Emergency Response Procedures and Guidelines for Beyond Design Basis Events and Severe Accidents
NEI 91-04 R1	1994	Severe Accident Issue Closure Guidelines