GE Nuclear Energy

General Electric Company
175 Curtner Avenue, San Jose, CA 95125

March 11, 1993

Docket No. STN 52-001

Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: **Submittal Supporting Accelerated ABWR Review Schedule - Section 19H.5 COL License Information**

Dear Chet:

Enclosed is a draft of SSAR Section 19H.5 COL License Information.

Please provide a copy of this transmittal to Glenn Kelly and Paul Amico.

Sincerely,

Jack Fox

Jack Fox
Advanced Reactor Programs

cc: Jack Duncan (GE)
Norman Fletcher (DOE)

JF93-56

19H.5 COL License Information

The COL applicant shall determine the HCLPF values for the plant-specific/as-designed components corresponding to those generic components defined in Subsection 19H.4.3. The values should be compared to their assumed HCLPF values given in Table 19H.4-6. It should be noted that only the capacities of important contributors (see Section 19.8) need to be determined and compared.

The HCLPF calculations can be made using fragility analysis or the conservative deterministic failure margin (CDFM) approach recommended in EPRI report NP-6041. The location effects should be taken into account in determining the limiting capacity of the same component on different locations.

For structures and components other than the generic components mentioned above, HCLPFs specified in Table 19H.4-6 can be considered achieved when the seismic design adequacy is confirmed if, according to the procedure described in Subsection 2.3.1.2 of Chapter 2, the site-dependent conditions are within the site envelope parameters or the site-specific SSE responses are bounded by those considered in the standardized design. Otherwise, site-specific HCLPF capacities for these structures and components need to be established.

It is not necessary that in each case the HCLPF exceed the value assumed in the margins analysis of the standardized design. However, depending on the degree of difference and the significance of the component in accident sequences, an evaluation of the site-specific plant level HCLPF capacity may be needed. The level of acceptable seismic margin for the plant should be established in a manner consistent with that used in existing nuclear power plants.

The site should also be investigated for the potential of seismic-induced soil failure (liquefaction, differential settlement, or slope stability) beyond the SSE level in accordance with the approach recommended in EPRI report NP-6041.

In order to increase confidence that the seismic capacities of as-designed structures and components are realized in the final constructed plant, a seismic walkdown as well as a review of construction drawings and documents shall be performed by the COL applicant. The walkdown procedure should follow the guidelines described in EPRI report NP-6041, including an assessment of potential seismic vulnerabilities, such as marginal anchorage of equipment and gross deviations from the design documents, and spatial interactions (e.g., operators being disabled due to the failure of the control room suspended ceiling in a seismic event).

Stabilizers or the Skirt, whichever is smaller.

19H.4 COMPONENT FRAGILITY

19H.4.1 General

Seismic fragilities of safety-related components were assessed for the following two categories of components:

(1) ABWR specific components whose fragility evaluation is made according to existing design information.

(2) Generic components whose fragilities are based on the data recommended in Reference 2 or other data sources as appropriate.

19H.4.2 ABWR Specific Components

Detailed seismic fragility evaluations are performed for the following ABWR specific components:

- Reactor pressure vessel (RPV)
- Shroud support
- Control rod drive (CRD) guide tubes
- CRD housings
- Fuel assemblies

The design seismic loads for these components were calculated directly using a coupled building structures and RPV/internals model. Consequently, no subsystem dynamic analyses using input motions at support points were required. Therefore, the fragility evaluation procedures used for the reactor building structures as presented previously are also applicable to these specific components.

Reactor Pressure Vessel (RPV)

The failure of the RPV due to an earthquake results in a sequence similar to a large break loss-of-coolant accident, with the exception that there may be no means to provide makeup (i.e., injection or cooling) to the core. The ABWR RPV is supported by a conical skirt which is anchored to the pedestal with 120 2-1/2" diameter high-strength anchor bolts. At an upper elevation, the RPV is laterally restrained by stabilizers which are connected to the reactor shield wall.

Failure of the RPV support system would result in excessive RPV deflection which could induce failure of the connecting pipes. The ultimate capacity of the support system is provided by both the skirt and the stabilizers. In this analysis, the resistance capacity of the ~~stabilizers~~ support system is conservatively ~~neglected and the RPV is assumed to fail when the support skirt fails either by the shell failure or anchor bolt breakage.~~

The critical failure mode is found to be ~~anchor bolt failure~~ Stabilizer yielding. Its median ground acceleration capacity is ~~5.5g~~ 5.0 with a logarithmic standard deviation of 0.33. The individual factors contributing to the median capacity are shown in Table 19H.4-1.

RPV Internal Components

The internal components examined for seismic fragilities include the shroud support, CRD guide tubes, CRD housings, and fuel assemblies. Failure of those components could potentially result in inability to insert the control rods to shut down the reactor.

Tables 19H.4-2 through 19H.4-5 show the failure modes and associated median ground acceleration capacities of those components. The contributing factors are also shown in these tables. ~~Note that the reference design ground acceleration is 0.15g OBE since the OBE loads were used in evaluating the factors of safety.~~

insert ②

As noted, the fuel assemblies are found to have the lowest seismic capacity among the RPV internal components. ~~The failure mode is buckling of the fuel channel. The corresponding median ground acceleration capacity is 1.7g with a logarithmic standard deviation of 0.26.~~

19H.4.3 Generic Components

Detailed fragility evaluations for safety-related components other than those specific components presented above cannot be made at this stage of certification due to lack of design details.

The ABWR generic components of interest for this seismic risk analysis are the following:

- Cable trays
- Large flat-bottom storage tanks

Their seismic fragilities and corresponding HCLPF values are summarized in Table 19H.4-6. These generic seismic capacities are selected from a review of ALWR recommendation (Reference 2) and other PRA studies (References 3 and 4)

- ~~Accumulators~~
- Air-operated valves
- Heat exchangers
- Off-site Power (transformers and ceramic insulators)
- Batteries and battery racks
- Battery chargers/Inverters
- Electric equipment (chatter failure mode)
- ~~Panelboards/Instrumentation panels~~
- Switchgear/Motor control centers
- Transformers (not off-site transformers)
- Diesel generators and support systems
- Turbine-driven pumps
- Motor-driven pumps / Diesel-driven pumps
- Small tanks (e.g., standby liquid control tank)
- Motor-operated valves
- Safety relief, manual, and check valves
- Hydraulic control units
- Heating, ventilation, and air conditioning ducting
- Air handling units / room air conditioners
- Piping
- ~~Buried welded steel piping~~
- Service Water Pump House

Except for the first five components listed, the fragility values recommended in Reference 2 were adopted for the ABWR seismic risk analysis. The generic fragilities in Reference 2 were chosen based on a review of prior PRAs and other fragility data. These median capacities are considered achievable for the ALWRs with an evolutionary improvement in the seismic capacities of components designed to 0.3g SSE. Detailed descriptions of these component categories are provided in Annex 2 of Reference 2. The component fragilities and uncertainties are summarized in Table 19H.4-6. The first five components on the list are discussed below.

The cable tray fragility is taken to be 3g instead of 2g as recommended in Reference 2. The higher capacity is based on recent information presented in Reference 3 regarding generic fragility data for three typical types of supports for electrical conduits. Since failure of cable trays is typically assumed to occur due to support failure, and the support design is similar to that used for supporting conduits, the conduit support fragility is considered equally applicable to cable trays. The median fragilities of the three support types reported in Reference 3 range approximately from 18.5g to 23g in terms of spectral acceleration. According to Annex A of Reference 2, the fundamental frequency of cable trays is typically in the 5 to 10 Hz range and a representative response amplification factor of 5% damping is about 3.8 at relatively high elevations. The corresponding lower bound median ground acceleration capacity is thus 4.9g. A smaller capacity of 3g was conservatively used as the seismic fragility for cable trays. The logarithmic standard deviation is estimated to be 0.6.

For large flat-bottom storage tanks such as diesel oil storage tanks, condensate storage tanks, and fire water storage tanks that are located in the yard and founded on grade, the generic fragility is estimated based on previous PRAs data compiled in Reference 4. A total of 23 data points in this component category were examined. For each of the data points, a capacity margin factor was obtained as the ratio of the fragility level to the SSE peak ground acceleration. The resulting capacity margin factors are found to range from 1.85 to 10.47, with median value at about 5.7. Since the ABWR tanks are to be designed following the flexible-wall approach, the potential of under-design using the rigid-wall approach will not exist. A median capacity margin higher than the median of the data base is thus considered achievable, and is estimated to be 7. The corresponding fragility is 2.1g, which is the product of the median capacity margin factor and 0.3g peak ground acceleration of the design SSE for the ABWR standard plant. The associated logarithmic standard deviation is estimated to be 0.45. The most probable failure mode is anchorage failure.

For accumulators, Reference 2 recommends a 2g median peak ground acceleration capacity. The recommended 2g capacity is conservative since it is less than the median value of about 3.5g of the data base from which the 2g capacity was estimated. A lesser conservative but more realistic capacity at 2.5g median peak ground acceleration, which is still less than the data base median value, is considered achievable for the ABWR accumulators. The associated logarithmic standard deviation is estimated to be 0.45. The predominant failure mode is failure of supports.

The seismic fragility for generic air-operated valves was estimated based on the achieved test level of main steam isolation valves qualified previously for other BWR plants. This achieved test level was increased by a modest 25% to postulate failure (typically stem binding or failure of the air line) in terms of spectral acceleration capacity. Considering amplification through building structures and piping,

Table 19H.4-6
SEISMIC ~~FRAGILITY~~ CAPACITY SUMMARY

Fragility

Structure/Component	Failure Mode	Capacity[a] Am (g)	Combined[a,b] Uncertainty	HCLPF (g)
Reactor Building	Wall Shear	3.2 ~~2.8~~	0.45	1.12
Containment	Shear	3.1 ~~4.2~~	0.44	1.11
RPV Pedestal	Flexural	5.0 ~~7.9~~	0.44	1.80
Control ~~Other category I~~ building	~~Structural~~ Shear	4.1 ~~2.8~~	0.44 ~~0.45~~	1.44
~~Non category I buildings~~ Service Water Pump House	~~Structural~~	1.7 ~~1.5~~	0.45 ~~0.50~~	0.60
Reactor pressure vessel	Support ~~Skirt anchor bolts~~	5.0 ~~5.9~~	0.33	2.32
Shroud support	Buckling	2.0 ~~1.9~~	0.36	0.87
CRD guide tubes	Buckling	1.8 ~~1.7~~	0.36 ~~0.46~~	0.78
CRD housing	Plastic yielding	3.5 ~~3.9~~	0.45	1.20
Fuel Assemblies	Channel deflection ~~buckling~~	1.4 ~~1.5~~	0.35	0.62
Cable trays	Support	3.0	0.60	0.74
Large flat-bottom storage tanks	Anchorage	2.1	0.45	0.79
~~Accumulators~~	~~Support~~	~~2.5~~	~~0.45~~	
Air-operated valves	Stem binding/Air line	2.0 ~~2.5~~	0.60	0.74
Heat Exchanger	Anchorage	2.0	0.45	0.70
Off-site power	Ceramic insulators	0.3	0.55	0.08
Batteries and battery racks	Anchorage/LOF	3.3 ~~3.0~~	0.46 ~~0.45~~	1.13
Battery chargers/Inverters	LOF	2.2 ~~2.3~~	0.46 ~~0.45~~	0.75
Electric equipment (chatter)				
function req'd during event	Relay chattering (c)	N.A. ~~0.8~~	N.A. ~~0.50~~	N.A.
function req'd after event	Relay chattering (c)	2.0 ~~2.0~~	0.50	0.63
~~Panelboards/Instrumentation panels~~	~~Functional/Structural~~	~~3.0~~	~~0.45~~	
Switchgear/Motor control centers	Functional/Structural (c)	1.8 ~~2.5~~	0.46 ~~0.45~~	0.62
Transformers	Functional/Structural	1.8 ~~1.5~~	0.46 ~~0.45~~	0.62
Diesel generators & support systems	Support	1.8 ~~2.5~~	0.46 ~~0.45~~	0.62
Turbine-driven pumps	Anchorage	2.0	0.45	0.70
Motor-driven pumps	Anchorage/Impeller deflection	1.8 ~~1.6~~	0.46 ~~0.45 or 0.60~~	0.62
Small tanks	Anchorage	1.8 ~~2.5~~	0.46 ~~0.45~~	0.62
Motor-operated valves	Operator distortion	3.0	0.60	0.74
Safety relief, manual & check valves	Internal damage	3.0	0.60	0.74
~~Hydraulic control units~~ valves	~~LOF~~ Internal damage	3.6 ~~2.0~~	0.60 ~~0.50~~	0.89
HVAC ducting	Support	3.0 ~~2.0~~	0.60	0.74
Air handling units / Room A.C.	Blade rubbing	2.0	0.50	0.63
Piping	Support	3.0	0.60	0.74
~~Buried welded steel piping~~ Diesel-driven pumps	~~Buckling/~~ Support	1.8 ~~2.0~~	0.46 ~~0.40~~	0.62
Hydraulic Control Unit	LOF	2.0	0.50	0.63

LOF for supply ... [illegible]

Table 19H.4-6

SEISMIC FRAGILITY SUMMARY (Cont.)

Notes:

a. Capacities are in terms of median peak ground acceleration.

b. Combined uncertainties are composite logarithmic standard deviations of uncertainty and randomness components.

c The potential for relay chatter was treated in the following manner. Only the scram safety function is required during a seismic event. This function is fail-safe, so relay chatter would cause a safe state failure (scram) even if relays were employed. For the ABWR, the scram actuating devices are solid state power switches with no failure mode similar to relay chatter. The scram function is supplemented by an alternate scram method (energizing the air header dump valves) to provide diversity. This method uses relay actuation, but no credit was taken for this capability in the seismic analysis. Therefore, there is no potential for relay chatter to prevent safety actions during a seismic event.

Switchgear and motor control centers do include relays whose failure could prevent safety actions after the seismic event. It was assumed that the indicated capacity of this equipment (2.5) was more representative than the specific relay chatter value (2.0) since switchgear and motor control centers are normally qualified with the auxiliary relays in place. Also, the type of auxiliary relays used tend to be the most rugged of relay types and would have a capacity above 2.0. The multiplexer output devices for ECCS and RHR operation have been assumed to be solid state devices (rather than relays), so the relay chatter failure mode does not apply.