GE Nuclear Energy

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Attention: Robert C. Pierson, Director
Standardization and Non-Power Reactor Project Directorate

Subject: **Main Steamline Seismic Classification - Open Issue 3 of SECY-91-153**

Enclosed are thirty-four (34) copies of the GE response to the subject open issue. Response to this issue includes the static seismic design procedure to be utilized in evaluation of the seismic capability of the condenser anchorage and the turbine building.

It is intended that GE will amend the SSAR with this response in a future amendment.

Sincerely,

SSDua

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TABLE 3.2-1

CLASSIFICATION SUMMARY (Continued)

Principal Component[a]	Safety Class[b]	Location[c]	Quality Group Classification[d]	Quality Assurance Requirement[e]	Seismic Category[f]	Notes	
B2 Nuclear Boiler System (Continued)							
210.20 4. Piping including supports main steamline (MSL) and feedwater (FW) line up to and including the outermost isolation valve	1	C,SC	A	B	1		
5. Piping including supports-MSL from outermost isolation valve to and including seismic interface restraint and FW from outermost isolation valve to the seismic interface restraint including the shutoff valve and the restraint	2	SC	B	B	1		
6. Piping including supports-MSL from the seismic interface restraint to the turbine stop valve	N	SC,T	B	~~E~~ B	...	(r)	210.6 210.7 260.4
7. Deleted							
8. Piping-FW beyond the seismic interface restraint	N	SC,T	D	E	...		260.4
9. Deleted							
10. Pipe whip restraints - MSL/FW	3	SC,C	...	B	...		
210.20 11. Piping including supports-other within outermost isolation valves							
a. RPV head vent	1	C	A	B	1	(g)	
b. RPV head spray	1	C	A	B	1	(g)	
c. Main steam drains	1	C,SC	A	B	1	(g)	
210.20 12. Piping including supports-other beyond outermost isolation valves							
a. RPV head vent	N	C	D	E	...		260.4
b. RPV head spray	N	SC	D	E	...		
c. Main steam drains	N	SC	D	E	...		

TABLE 3.2-1

CLASSIFICATION SUMMARY (Continued)

Principal Component[a]	Safety Class[b]	Location[c]	Quality Group Classification[d]	Quality Assurance Requirement[e]	Seismic Category[f]	Notes
4. Turbine bypass piping including supports	N	T	~~D~~ B	~~E~~ B	--	(r)
5. Turbine stop valve, turbine bypass valves, and the main steam leads from the turbine control valve to the turbine casing	N	T	D	E	--	(l)(n)(o)
6. Feedwater system components beyond outboard shutoff valve	N	T	D	E	--	
7. Turbine generator	N	T	--	E	--	
8. Condenser	N	T	--	E	--	(dd)
9. Air ejector equipment	N	T	--	E	--	
10. Turbine gland sealing system components	N	T	D	E	--	
11. Circulating water system	N	T	D	E	--	
N. Offgas System						
1. Pressure vessels including supports	N	T	--	E	--	(p)(q)
2. Atmospheric tanks including supports	N	T	--	E	--	(p)(q)
3. 0-15 psig tanks including supports	N	T	--	E	--	(p)(q)
4. Heat exchangers including supports	N	T	--	E	--	(p)(q)
5. Piping including supports and valves	N	T	--	E	--	(p)(q)
6. Pumps including supports	N	T	--	E	--	(p)(q)

TABLE 3.2-1

CLASSIFICATION SUMMARY (Continued)

Principal Component[a]	Safety Class[b]	Location[c]	Quality Group Classification[d]	Quality Assurance Requirement[e]	Seismic Category[f]	Notes
U3 Fire Protection System (Continued)						
6. CO_2 actuation modules	N	RZ,T	---	E	---	(t) (u)
7. Cables	N	SC,C,X, RZ,T,W	---	E	---	(u)
8. Sprinklers	N	SC,X	D	E	---	(u)
U4 Civil Structures						
1. Reactor Building (Secondary Containment and Clean Zone)	3	SC,RZ	---	B	I	
2. Control Building	3	X	---	B	I	
3. Service Building	N	H	---	E	---	
4. Radwaste Building substructure	3	W	---	B	I	
4a. Radwaste Building	N	W	---	E	---	
5. Turbine Building	N	T	---	E	---	(v)(dd)

NOTES (Continued)

s. The recirculation motor control system (RMCS) is classified Quality Group C and Safety Class 3 which is in accordance with the requirements of 10CFR50.55a. The RMCS, which is part of the reactor coolant pressure boundary (RCPB), meets 10CFR50.55a(c)(2). Postulated failure of the RMCS piping cannot cause a loss of reactor coolant in excess of normal makeup (CRD return or RCIC flow), and the RMCS is not an engineered safety feature. Thus, in the event of a postulated failure of the RMCS piping during normal operation, the reactor can be shutdown and cooled down in an orderly manner, and reactor coolant makeup can be provided by a normal make up system (e.g., CRD return or RCIC system). Thus, per 10CFR50.55a(c)(2), the RMCS need not be classified Quality Group A or Safety Class 1. Since the RMCS is not an engineered safety feature (e.g., it does not provide emergency reactivity control, emergency core coolant, or primary reactor containment), the system need not be classified Quality Group B or Safety Class 2. The RMCS is classified Quality Group C and Safety Class 3, however, the system is designed and constructed in accordance with ASME Boiler and Pressure Vessel Code, Section III, Class 1 criteria as specified in Subsection 3.9.3.1.4 and Figure 5.4-14.

260.4 t. A quality assurance program for the Fire Protection System meeting the guidance of Branch Technical Position CMEB 9.5-1 (NUREG-0800), is applied.

u. Special seismic qualification and quality assurance requirements are applied.

v. See Subsection 11.3.4.6 for the offgas vault seismic requirements.

w. The condensate storage tank will be designed, fabricated, and tested to meet the intent of API Standard API 650. In addition, the specification for this tank will require: (1) 100% surface examination of the side wall to bottom joint and (2) 100% volumetric examination of the side wall weld joints.

x. The cranes are designed to hold up their loads under conditions of OBE and to maintain their positions over the units under conditions of SSE.

y. All off-engine components are constructed to the extent possible to the ASME Code, Section III, Class 3.

z. Components associated with a safety-related function (e.g., isolation) are safety-re

aa. Structures which support or house safety-related mechanical or electrical components are safety-related.

bb. A quality assurance requirements shall be applied to ensure that the design, construction and testing requirements are met.

260.4 cc. A quality assurance program, which meets or exceeds the guidnace of Generic Letter 85-06, is applied to all non-safety related ATWS equipment.

dd. The condenser anchorage and turbine building procedure given in Subsection 3.7.4.16 and the codes, load combinations, and structural acceptance criteria given in Table 3.2-4.

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Table 3.2-4

Codes and Specifications, Loads and Load Combinations, and Structural Acceptance Criteria for Nonseismic Structures

1.0 Applicable Codes and Specifications

(1) ACI 318, Code Requirements for Concrete Structures

(2) AISC, Specification for Design, Fabrication and Erection of Structural Steel for Buildings

2.0 Loads and Load Combinations*

2.1 Load combinations for Concrete Members

For any load combination in this subsection, where any load reduces the effects of other loads, the corresponding coefficient for that load shall be taken as 0.9 if it can be demonstrated that the load is always present or occurs simultaneously with the other loads. Otherwise, the coefficinet shall be taken as zero.

The strength design method will be used and the following load combinations will be satisfied:

$$U = 1.4D + 1.7L + 1.7H + 1.7B$$

$$U = 1.05D + 1.28L + 1.28H + 1.28B + 1.28W$$

$$U = 1.05D + 1.28L + 1.28H + 1.28B + 1.4E$$

2.2 Load Combinations For Steel Members

The elastic working stress design method is used for the following load combinations:

$$S = D + L$$

$$S = D + L + W$$

$$1.6S = D + L + E$$

In all of these load combinations, both cases of L having its full value or being completely absent are checked.

3.0 Structural Acceptance Criteria

The structural acceptance criteria are defined in ACI 318 Code and the AISC Specification. In addition all acceptance criteria as defined in the static seismic analysis section apply.

*All abreviations for loads have been taken from SSAR Subsection 3.8.4.3.1.1.

Where small, non-Seismic category piping is directly attached to Seismic Category I piping, its effect on the Seismic Category I piping is accounted for by lumping a portion of its mass with the Seismic Category I piping at the point of attachment.

Furthermore, non-Seismic Category I piping (particularly high energy piping as defined in Section 3.6) is designed to withstand the SSE to avoid jeopardizing adjacent Seismic Category I piping if it is not feasible or practical to isolate these two piping systems.

3.7.3.14 Seismic Analysis for Reactor Internals

The modeling of RPV internals is discussed in Subsection 3.7.2.3.2. The damping values are given in Table 3.7-1. The seismic model of the RPV and internal is shown in Figure 3.7-32.

3.7.3.15 Analysis Procedures for Damping

Analysis procedures for damping are discussed in Subsection 3.7.2.15.

(A) →

3.7.4 Seismic Instrumentation

3.7.4.1 Comparison with NRC Regulatory Guide 1.12

The seismic instrumentation program is consistent with Regulatory Guide 1.12.

3.7.4.2 Location and Description of Instrumentation

The following instrumentation and associated equipment are used to measure plant response to earthquake motion:

(1) three triaxial time-history accelerographs (THA);

(2) three peak-recording accelerographs (PRA);

(3) two triaxial seismic triggers;

(4) one seismic switch (SS);

(5) four response spectrum recorders;

(6) recording and playback equipment; and

(7) annunciators.

The location of seismic instrumentation is outlined in Table 3.7-7.

3.7.4.2.1 Time-History Accelerographs

Time-history accelerographs produce a record of the time-varying acceleration at the sensor location. This data is used directly for analysis and comparison with reference information and may be, by calculational methods, converted to response spectra form for spectra comparisons with design parameters.

Each triaxial acceleration sensor unit contains three accelerometers mounted in an orthogonal array (two horizontal and one vertical). All acceleration units have their principal axes oriented identically. The mounted units are oriented so that their axes are aligned with the building major axes used in development of the mathematical models for seismic analysis.

One THA is located on the reactor building (RB) foundation mat, El (-) 13.2 M, at the base of an RB clean zone for the purpose of measuring the input vibratory motion of the foundation mat. A second THA is located in an RB clean zone at El (+) 26.7 M on the same azimuth as the foundation mat THA. They provide date on the frequency, amplitude, and phase relationship of the seismic response of the reactor building structure. A third THA is located in the free field at the finished grade approximately 160 M from any station structures with axes oriented in the same direction as the reactor building accelerometers.

Two seismic triggers, connected to form redundant triggering, are provided to start the THA recording system. They are located in the free field at the finished grade 160 M from the reactor building. The trigger unit consists of orthogonally mounted acceleration sensors that actuate relays whenever a threshold acceleration is exceeded for any of the three axes. The trigger is engineered to discriminate against false starts from other operating inputs such as traffic, elevators, people, and rotating equipment.

INSERT A

3.7.3.15 Analysis Procedure for Nonseismic Structures in Lieu of Dynamic Analysis

The method described here can be used for non-seismic structures in lieu of a dynamic analysis.

Structures designed to this method should be able do the following:

a. Resist minor levels of earthquake ground motion without damage.

b. Resist moderate levels of earthquake ground motion without structural damage, but possibly experience some nonstructural damage.

c. Resist major levels of earthquake ground motion having an intensity equal to the strongest either experienced or forecast at the building site, without collapse, but possibly with some structural as well as nonstructural damage.

3.7.3.15.1 Lateral Forces

Seismic loads are characterized as an force profile that varies with the height of the structure. These forces are applied at each floor of the structure and the resulting forces and moments are calculated from static equilibrium.

The buildings total base shear is characterized by the following equation.

$V = Z*I*C*W/R_w$; where,

$V =$ Total lateral force or shear at the base.

$F_x F_i F_n$ = Lateral force applied to level i, n, or x respectively

$F_t =$ That portion of V considered to be concentrated at the top of the structure in addition to F_n

$Z =$ seismic zone factor

$I =$ importance factor

$C =$ Numerical Coefficient

$R_w =$ Numerical Coefficient

$S =$ coefficient for site soil characteristics

$T =$ Fundamental period of vibration of the structure in the direction under consideration, as determined by using the properties and deformation characteristics of the resisting elements in a properly substantiated analysis.

$W =$ Total dead load of building including the partition load where applicable.

$w_i w_x$ =That portion of W which is located at or is assigned to level i or x, respectively

$h_i h_x$ =Height in feet above the base to level i or x, respectively

INSERT A (CONTINUED)

The ABWR design will fix Z and I and leave R_w and C as variables for each building and site.

The value of I has been selected for power generating facilities.

$$I = 1.0$$

The site coefficient Z will be selected to provide enveloping coverage for most of the US east of the rocky mountains.

$$Z = 0.15$$

The value C is calculated based upon the following formula:

$C = 1.25*S/T^{2/3}$ where: C need not exceed 2 "5

The value of S is dependent on the site soil characteristics. The value of S shall be selected from Table 3.7-11.

The value of R_w shall be selected from the Table 3.7-12 according to the type of construction material and framing system under consideration.

3.7.3.15.2 Lateral Force Distribution

The concentrated force at the top of the structure shall be determined according to the following formula:

F_t = 0.07*T*'/ where,

F_t need not exceed 0.25V and may be considered as 0 where T is 0.7 seconds of less. The remaining portion of the total base shear V shall be distributed over the rest of the structure including level n according to the following formula:

$$F_x = \frac{(V - F_t) w_x h_x}{\sum_{i=1}^{n} w_i h_i}$$

At each level designated x, the force F_x shall be applied over the area of the building in accordance with the mass distribution on that level.

3.7.3.15.3 Accidental Torsion

In addition, the vertical resisting elements depend on diaphragm action for shear distribution at any level, the shear resisting elements shall be capable of resisting torsional moment assumed to be equivalent to the story shear acting with an eccentricity of not less than 5 percent of the maximum building dimension at that level.

INSERT A (CONTINUED)

3.7.3.15.4 Lateral Displacement Limts

Lateral deflections or drift of a story relative to its adjacent stories shall not exceed 0.005 times the story height nor $0.04/R_w$ for buildings less than 65 feet in height. For buildings greater in height, the calculated story drift shall not exceed 0.004 times the story height nor $0.04/R_w$. These drift limits may be exceeded when it is demonstrated that greater drift can be tolerated by both structural elements and nonstructural elements that could effect life safety. For designs using working stress methods, this capacity may be determined using an allowable stress increase of 1.7. The rigidity of other elements shall also be considered.

3.7.3.15.5 Ductility Requirements

All framing elements not required by design to be part of the lateral force-resisting system shall be investigated and shown to be adequate for vertical load-carrying capacity and induced moment due to $3R_w/8$ times the distortions resulting from the code required lateral forces.

Connections shall be designed to develop the full capacity of the members or shall be based upon the above forces without the one-third increase usually permitted for stresses resulting from earthquake forces.

(NEW)

Table 3.7-11 Site Coefficients

TYPE	DESCRIPTION	S FACTOR
S_1	A soil profile with either: (a) A rock like material characterized by a shear wave velocity greater than 2,500 fps or by other suitable means of classification. or (b) Stiff or dense soil condition where soil depth is less than 200 feet.	1.0
S_2	A soil profile with dense or stiff soil conditions, where the soil depth exceeds 200 feet.	1.2
S_3	A soil profile 40 feet or more in depth and containing more than 20 feet of soft to medium stiff clay but not more than 40 feet of soft clay.	1.5
S_4	A soil profile containing more than 40 feet of soft clay.	2.0

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Table 3.7-12 Structural Systems

Basic Structural System	Lateral Load Resisting System Description	R_w
A Bearing Wall	1. Shear Walls - concrete	6
	2a. Braced frames where bracing carries gravity loads - steel	6
	2b. Braced frames where bracing carries gravity loads- concrete	4
B Building Frame	1. Steel eccentric braced frame	10
	Shear walls - concrete	8
	Concentric braced frames- steel	8
	Concentric braced frames - concrete	8
C Moment Resisting frame	Special moment resisting space frames	12
	Concrete interndiate moment-resisting space frames (OMRSF)	7
	Ordinary moment resisting space frames(OMRSF) - steel	6
	Ordinary moment resisting space frames(OMRSF) - concrete	5
D Dual		
1.Shear Walls	a. Concrete with SMRSF	12
	b. Concrete with concrete IMRSF	9
2. Steel EBF with steel SMRSF		12
3.Concentric braced frames	a. Steel with steel SMRSF	10
	b. Concrete with concrete SMRSF	9
	c. Concrete with concrete IMRSF	6