NORTHEAST UTILITIES

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May 22, 1984

Docket No. 50-423
B11190

Director of Nuclear Reactor Regulation
Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: 1) W. G. Counsil to B. J. Youngblood, NRC Mechanical Engineering Branch Review Meeting (January 17-19, 1984), dated March 1, 1984.

Dear Mr. Youngblood:

Millstone Nuclear Power Station, Unit No. 3
Revised Response to Mechanical Engineering Branch
Questions 210.31, 210.34, 210.36, 210.37, 210.44 and 210.45

Attached are Northeast Nuclear Energy Company's (NNECO) revised responses to Mechanical Engineering Branch Questions 210.31, 210.34, 210.36, 210.37, 210.44 and 210.45.

If there are any questions, please contact our licensing representative directly.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY, ET AL

By Northeast Nuclear Energy Company Their Agent

W. G. Counsil

W. G. Counsil
Senior Vice President

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STATE OF CONNECTICUT)
) ss. Berlin
COUNTY OF HARTFORD)

Then personally appeared before me W. G. Counsil, who being duly sworn, did state that he is Senior Vice President of Northeast Nuclear Energy Company, an Applicant herein, that he is authorized to execute and file the foregoing information in the name and on behalf of the Applicants herein and that the statements contained in said information are true and correct to the best of his knowledge and belief.

Lorraine J. D'Amico
Notary Public

My Commission Expires March 31, 1988

NRC Letter: December 5, 1983

Question No. Q210.31 (Section 3.9.2)

Provide the acceptance criteria that will be used to determine if the vibration levels observed or measured during the preoperational testing are acceptable. Specifically address how the vibration amplitudes will be related to a stress level and what stress levels will be used for both steady-state and transient vibration.

Response:

Vibration levels are observed or measured during preoperational testing for both steady state and transient vibration conditions. The programs used to monitor these conditions are described below.

Steady State Vibrations

Visual observations are used for judging acceptability of steady state vibration. Visual observations may be aided by hand-held instruments (e.g., vibrometers) when considered appropriate by engineers experienced in piping design.

A screening velocity or displacement will be established. If the measurement indicates that the velocity or displacement limit is exceeded, the measured values are reconciled with the respective analyses by considering the specific piping configuration, velocity or displacement amplitude measured, stress indices, and the endurance strength of the material properly accounting for the impact of high cycle effects. If system modifications are required, the applicable ASME design calculations are reconciled to assure acceptable system characteristics for all applicable design conditions.

The maximum alternating stress intensity (S_{alt}) will be used to establish the acceptance stress criteria for steady state vibrations.

For ASME Class 1 piping:

$$S_{alt} = C_2 K_2 \frac{M}{Z} \leq 0.8 S_{el}$$

where:

C_2 = Secondary stress index defined in the ASME Code

K_2 = Local stress index defined in the ASME Code

M = Maximum zero to peak dynamic moment loading due to vibration displacement

Z = Section modulus of pipe

S_{el} = Alternating stress at 10^6 cycles from Figure I-9.1 or I-9.2 of Section III of the ASME Code.

For ASME Classes 2 and 3 piping, and for ANSI B31.1 piping the above equation is applicable, setting:

$$C_2 K_2 = 2i$$

where:

i = Stress intensification factor, as defined in the ASME Code, Subsection NC, ND; or B31.1.

Transient Vibrations

Transient vibration conditions are subjected to visual and instrumented observations as described in the response to NRC Question 210.30. When instrumented observations are taken, the acceptance criteria are based on the applicable fluid system transient analysis (stress, deflection, etc) results. Instrumented observations are considered acceptable if they are within the transient analysis results acceptance criteria. If instrumented results exceed the acceptance criteria, the results are reconciled with the design analysis. When system modifications are required to achieve acceptable levels of transient vibration, the ASME design calculations are reviewed and modified as necessary to assure acceptable system characteristics.

NRC Letter: December 5, 1983

Question No. Q210.34 (Section 3.9.3)

Provide the basis for assuming that ASME Code Class 1, 2 and 3 piping systems are capable of performing their safety function under all plant conditions. Describe the methodology used to assure the functional capability of essential piping systems when service limits C or D are specified. ← A

Response:

ASME III Classes 1, 2 and 3 piping systems are designed for all plant conditions in accordance with the ASME III code requirements as shown in FSAR Tables 3.9B-10, 3.9B-11, and 3.9B-12.

Numerous operating fluid transient events have occurred in operating nuclear power plants (NUREG-0582 and NUREG/CR-2059). Many of these events caused code allowable stresses to be exceeded, and some were severe enough to significantly damage piping and pipe supports. None of these events resulted in a loss of functional capability where the integrity of the pressure boundary was maintained. Other experiences, such as the effects of the 1979 Imperial Valley earthquake on the El Centro Steam Plant (NUREG/CR-1665), which did not cause any loss of functional capability although design to withstand earthquake was minimal and the earthquake was of high intensity, indicate that functional capability is, again, not a practical concern.

The difference between operating experience and academic concern is in part explained by a study of seismic design margins for piping (NUREG/CR-2137) where lower bound margins of 1.4 or greater indicated significant reserve strength when designed to ASME III rules. In addition, stresses are dominated by stress intensification factors which address fatigue strength of local areas, but are not indicative of the general state of stress in the piping system. Although ASME Level D stress limits theoretically permit gross yielding of piping while only protecting the pressure boundary, practical experience indicates otherwise. Failures of the pressure boundary have occurred due to unanticipated loads (e.g., waterhammer, vibration, etc) or corrosion/erosion, but gross yielding of an intact pressure boundary has not led to a loss of functional capability.

Functional adequacy of piping systems subjected to dynamic and earthquake loadings is adequately confirmed by an increasing body of published reports. However, the record is silent regarding postulated pipe ruptures. It is contended that conformance with plant arrangement requirements of SRP 3.6.1.and 3.6.2 (i.e., separation, enclosure, or restraint) effectively mitigates concerns regarding functional capability of essential systems, structures, or components.

The practice of reducing code allowable stresses to preclude theoretical gross yielding for very low probability loads may in fact reduce the overall safety and reliability of the piping system. Lower allowable stresses are achieved by additional pipe supports, and usually snubbers (which reduce dynamic stresses without increasing thermal or deadweight stresses), resulting in a stiffer system with higher stresses during normal plant operation, but theoretically lower stresses for the low probability design events applicable to Level D stress limits which are dynamic in nature. Additional pipe supportrs, particularly snubbers, and increased piping stiffness are often cited (e.g., NUREG/CR-2136 and S. H. Bush letter to N. J. Palladino of August 20, 1981) as sources of potential failures due to limiting access for maintenance and inservice inspection, difficulty in installation and proper adjustment, and higher stresses during normal plant operation.

The use of service limits C or D does not compromise the functional capability of ASME Code Classes 1, 2 and 3 piping systems because:

a. an increasing body of evidence confirms the general integrity (both pressure boundary and functional capability) of piping systems subjected to dynamic loading, and

b. proper conformance to NRC guidelines for protection against postulated piping failure mitigates this load case as a concern for essential piping systems.

<u>Additional Response</u> (5/84)

The Staff requested additional justification for assuring that functional capability is maintained for piping systems subjected to service conditions C and D. Although it is Millstone 3's position that the ASME III code requirements provide inherent conservatism such that functional capability is not a practical concern, an evaluation was performed to further investigate this matter.

The question of functional capability addresses primary loads on piping systems for Level C and D service conditions. A review of the load combinations for the various service conditions is helpful in understanding the Millstone 3 specific situation. For all practical purposes, the difference between level B and D is the OBE loading versus the SSE loading. The LOCA load in the Faulted condition is not considered since it is our intention to request an exemption from postulating breaks in the reactor coolant main loop piping. Service level C includes pipe whip and jet impingement effects which are rarely required to be analyzed due to system redundancy and separation in plant layout. Therefore, pipe design is governed either by Level B or D for primary loads.

A review of the ARS (Amplified Response Spectra) used for the OBE and SSE indicates additional conservatism in piping design for Millstone 3. The OBE utilizes 1/2% damping while the SSE utilizes 1% damping which is certainly conservative with respect to the current Regulatory Guide position. The difference in damping results in a situation in which the OBE tends to govern

design (i.e. service Level B stress governs design). This results because the OBE accelerations are typically greater in the resonant range of the ARS where the SSE dictates in the rigid range. For typical piping systems at Millstone 3, the majority of the mass participation occurs in the resonant range resulting in a greater stress for the OBE than the SSE. The use of low damping and the fact that the Level B sevice condition typically governs pipe design for primary loads provides assurance that functional capability is not a practical concern for Millstone 3.

As additional justification for assuring that functional capability is not a practical concern, a review of certain critical systems was performed utilizing the functional capability criteria from the NEDO-21985 report as suggested by the Staff. Since the functional capability concern deals primarily with the SSE and accident conditions, those systems most critical to mitigate the consequences of an accident and reach and maintain a safe shutdown condition were chosen for the review. They are as follows:

- QSS Quench Spray System
- RSS Recirc Spray System
- SIL Low Head Safety Injection System
- SIH High Head Safety Injection System
- RHS Residual Heat Removal System
- CCP Component Cooling System
- SWP Service Water System

The details of the reivew are contained in the Attachment Q210-34-1. The results concur with the assumptions made above regarding the practicality of the matter. In every case, the pipe stress problems passed the functional capability criteria, most by substantial margins. Since the systems reviewed cover a variety of pipe sizes and materials, these conclusions can also be applied to the balance of Category I piping. Consequently, no further action on this issue is deemed necessary.

Attachment
Q210.34-1

Implementation

For Millstone Unit 3 where the piping systems essential to safety are already designed and/or constructed the only method of demonstrating functional capability is to apply the new stress indices and allowables to the maximum stresses developed in the existing calculations.

A comparison of the FCC (Functional Capability Criteria) and equation (9) of subsections NB-3650, NC-3650 and ND-3650 shows the following:

1) For Class 1 Piping

   a) ASME stress indices are always greater than or equal to FCC stress indices

   b) For all service levels the FCC allowable stresses are greater than or equal to 1.5Sy

2) For Class 2 and Class 3 piping

   a) For welding elbow or pipe bend FCC stress index, B is 44% higher than the ASME stress index.

   b) For welding tee the FCC stess index, B_2, is 20% higher than the ASME stress index.

   c) For all other fittings the ASME stress index B_2, is equal to or greater than the FCC stress index.

   d) For all service levels the FCC allowable stresses for all components equals 1.5 Sy.

For each calculation the highest stress point was conservatively amplified by maximum increase of the stress index B_2 of equation (9) and compared to 1.5 Sy (at temp.)

$$\left[1.44 \quad \frac{P_{max} D_o}{4 t_n} \quad + \quad .75i \left(\frac{M_a + M_o}{Z} \right) \right] \leq \quad 1.5\,S_y$$

For each calculation the pipe size was checked for Do/t less than or equal to 50. In those cases where Do/t was greater than 50, the appropriate increase in intensification factor from the NEDO-21985 report was applied.

Results

Of the 148 calculations checked for functional capability there were no piping elements which failed the FCC provided in report NEDO-21985.

NRC Letter: December 5, 1983

Question No. Q210.36 (Section 3.9.3)

The staff review of FSAR Section 3.9B.3.4 and 3.9N.3.4 finds that there is insufficient information regarding the design of component supports. Per SRP Section 3.9.3, our review includes an assessment of design and structural integrity of the supports. The review addresses three types of supports: (1) plate and shell, (2) linear, and (3) component standard types. For each of the above three types of supports, provide the following information (as applicable) for our review:

(a) Describe for typical support details which part of the support is designed and constructed as component supports and which part is designed and constructed as building steel (NF vs AISC jurisdictional boundaries).

(b) Provide the complete basis used for the design and construction of both the component support and the building steel up to the building structure. Include the applicable codes and standards used in the design, procurement, installation, examination, and inspection.

(c) Provide the loads, load combinations, and stress limits used for the component support up to the building structure.

(d) Provide the deformation limits used for the component supports.

(e) Describe the buckling criteria used for the design of component supports.

Response:

BOP Scope

a. The reactor vessel support system (RVSS) is classified "plate and shell". It has been designed, fabricated, and installed in accordance with ASME III, Subsection NF. The RVSS bears on a concrete floor. Connection to building structure is by embedded thread rod, designed in accordance with NF.

All other nonintegral supports for ASME III equipment are linear types but can have component standard elements within the load path. These are designed, fabricated, and installed in accordance with ASME III/NF. For linear type supports, the jurisdictional boundaries are defined as follows:

- Attachment to embedded plates via welding to or bolting into embedded plates; the plate is per AISC and bolts or welds fall within NF jurisdiction.

- Grouted in surface mounted plates anchored by threaded embedded rods, rods (bolting), and nuts are in accordance with AISC. Surface plates are designed and fabricated in accordance with ASME III/NF but are defined as being outside the NF jurisdictional boundary.

b. Equipment supports are designed, fabricated, inspected, and installed in accordance with ASME III/NF. This includes the component standard support elements included in the load path except leveling devices on the RVSS and hydraulic snubbers on the steam generator and RCP supports. These exceptions were in accordance with ASME III to the greatest extent feasible. There are no occurrences of intervening building steel within the load path. Design criteria for building steel is in FSAR Section 3.8.

c. Loading combinations are in accordance with FSAR Section 3.9B.3.1.1 for Class 1 supports and Section 3.9B.3.1.2 for Classes 2 and 3 supports. Allowable stress is in accordance with ASME III NF-3100 for plate and shell, normal and upset conditions. For linear type supports, including component standard types within the load path, stress allowables are in accordance with ASME III, Appendix XVII for normal and upset conditions. Faulted condition allowables are in accordance with Appendix F.

d. All equipment supports are elastic. Deformation limits are not used.

e. For the RVSS, buckling for a cylindrical shell was considered.

   For linear type supports the buckling criteria is in accordance with ASME III, Appendix XVII-2220.

Millstone 3 pipe supports consist of linear and component standard types. Plate and shell type supports are not used for pipe support applications. The response to items (a) through (e) of the question as applicable to pipe supports are:

a. All linear type supports (except for dual function restraints described in response to NRC Question 210.23) and component standard supports within the load path are designed according to AISC code with the exceptions noted in Tables Q210.36-1 and Q210.36-2

b. All pipe supports (except for dual function restraints described in the response to NRC Question 210.23) are designed, fabricated, installed, and inspected in accordance

with AISC Code and with Tables Q210.36-1 and Q210.36-2. When pipe supports include integral welded attachments to pressure retaining boundaries, the integral welded attachments are designed, fabricated, installed, and inspected in accordance with the Code rules applicable to the pressure retaining members.

c. Loads and load combinations used for linear type pipe supports are described in Tables Q210.36-1, Q210.36-2, and Q210.36-3. The allowables are based on AISC Code and Tables Q210.36-1 and Q210.36-2. The loads, load combinations, and the corresponding allowables for designing integral welded attachments to pressure retaining boundaries are described in FSAR Section 3.9B.3, Tables 3.9B-10, 3.9B-11, and 3.9B-12.

d. All pipe supports are designed elastic. Deformation limits are not defined.

e. Buckling criteria used for pipe supports is in accordance with AISC Code, 7th Edition. (See Table Q210.36-4 for applicable AISC Code equations used for buckling check.)

NSSS Scope

a. Westinghouse has supplied supports only for those Class 2 and 3 components also supplied by Westinghouse to which the supports are attached. This equipment is divided into two groups.

The first group consists of auxiliary tanks and heat exchangers. The supports for these components are, for the most part, plate and shell type supports. These supports meet the requirements of Subsection NF of the ASME Code with the exception of the volume control tank supports, which, because of the procurement date, are designed to the requirements of the AISC Code. The FSAR will be amended to clarify this point by May 1984.

The second group consists of Class 2 and 3 auxiliary pumps. The supports for these pumps are linear type supports. The supports for the charging and safety injection pumps meet the requirements of Subsection NF of the ASME Code. Other auxiliary pump supports are designed by the pump manufacturer to pressure boundary stress limits, but in no case is yield stress exceeded. The FSAR will be amended to clarify the point by May 1984.

c. The loads and load combinations of the supports for the auxiliary equipment supplied by Westinghouse are the same as those of the supported component. These loads and load combinations are given in FSAR Table 3.9N-4

d. There are no permanent deformation limits for the supports for tanks, heat exchangers, or pumps since these supports are required to remain elastic. Additionally, the supports for active pumps must not deform such that specified critical clearances are maintained so that the pump remains operable. The clearances are specified in the pump specifications.

e. Buckling, for all auxiliary equipment supports, is prevented by maintaining the two thirds of critical buckling criteria.

Additional Response (5/84)

The staff raised several questions regarding the following topics.

a) Allowable tensile stress for faulted conditon

b) Load combination for faulted condition

c) Comparison of ASME-NF criteria versus Millstone 3

d) Clarification of Buckling Criteria

a) The Staff questioned the allowable stress values used for support design under faulted loading conditions. Millstone 3 support design is based on Appendix F of the ASME code. Appendix F first appeared in the Winter 1972 addenda and provides allowable values for member stress when linear elastic analysis is performed.

The use of Appendix F allowables for non-NF supports is justified based on the comparison of NF versus Millstone criteria provided in section c.) of this response. The design criteria and programs in place for material control and tracability, fabrication, erection, and inspection of pipe supports meet the intent of NF. With the exception of examination criteria for primary members welds on Class 1 supports and variations in inspector qualifications, the Millstone program is essentially equivalent to NF requirements.

Pipe supports are fabricated almost exclusively from SA-36 plate and SA-500 Grade B tube steel. For these materials .7Su governs design rather than 1.2 Sy. The ultimate tensile stress limits the design to 1.13 Sy by definition.

A consideration should be given to the fact that the support loads are developed from piping analyses which are extremely conservative. Damping values of 1/2% for OBE and 1% for SSE produce support loads which are much greater than could be expected from actual experience. The current Regulatory Guide position allows damping values greater than those used for Millstone 3 and actual test data supports the use of even higher damping values (especially for the SSE event). The response spectra utilized in the piping analyses are developed from a structural analysis which assumes conservative damping values. Without even considering other conservative factors, the damping values alone compensate for the

variation between Appendix F allowables and the .95Sy allowable recommended by the Staff.

Also pertinent to this discussion is the fact that the containment spray systems (Quench Spray, Recirc Spray and portions of Safety Injection) are designed to Level B allowables for the Faulted condition.

From a design standpoint member stress is rarely the limiting factor for piping supports. Typically anchor bolts or weld stress have the least amount of design margin available whereas member stress is usually low.

The NF comparison in conjunction with the conservative factors outlined above justifies the use of Appendix F allowables for pipe support design.

b) The Staff questioned the load combinations used for the Faulted condition for support design. Specifically, thermal loads, loads due to SSE anchor movements and LOCA loads are not included in the load combination.

Justification for this position may be found in ASME III Subsection NF. For linear type supports NF 3231.1(c) states that faulted conditions may be considered independently of all other design and operating conditions and that constrained free end displacement and differential support motion effects need not be considered. Therefore loads imposed on supports due to contrained thermal expansion of piping and anchor movements due to thermal SSE and LOCA are not included in the Faulted loading combination.

From a practical standpoint, Level B load combination tends to govern design rather than Level D. LOCA induced loads were not included since it is our intention to request an exemption from postulating reactor coolant main loop breaks. As discussed in the response to Q210.34, the amplified response spectra are such that the OBE tends to govern design. As discussed in section a) above, the support loads which are the product of a very conservative piping analysis, result in an adequate support design considering the concerns of the Staff.

The fact that the code does not require these loads to be considered together with the inherent conservatism in the support design as outlined above adequately address the Staff's concerns.

c) The Staff requested a comparison of ASME III NF requirements versus the codes, standards and procedures envoked for Millstone 3 piping supports.

Subsection NF of Section III, Division 1, of the ASME Boiler and Pressure Vessel Code contains requirements for construction of supports for Code Class 1, 2, and 3 piping systems. The construction of most of the piping supports for Millstone 3 were ordered prior to the first publication of Subsection NF in Section III of the ASME Code. The effective ASME Code for the piping and supports for Millstone 3 is the 1971 Edition with the Summer 1973 Addenda.

At that time, the rules governing construction of piping supports included ANSI B31.7-1967, paragraphs 120 and 121 (for Class 2 and 3 supports). Neither of the ANSI documents provide specific guidance regarding loading combinations for upset, emergency, or faulted operating conditions. Both ANSI documents reference standards of the American Institute of Steel Construction for guidance in the design of supplementary steel for supporting structures, without providing specific rules for boundaries. Integral attachments associated with the supports, welded to the piping pressure boundary, are addressed in ASME Section III.

The piping supports for Millstone 3 are designed in accordance with the AISC Manual of Steel Construction except that the design limits of ASME Section III, Appendix F are used for the faulted condition. Other elements of the construction of these supports meet or exceed the requirements of the referenced ANSI and AISC Codes applicable to piping supports.

The Millstone 3 jurisdictional boundaries between piping, supports, and building structure are similar to NF boundaries. Integral attachments to piping meet the applicable requirements for the piping to which they are attached. Material wholly or partially embedded in concrete and material whose function is to support the building are considered building structure. Load carrying members between the piping or integral attachments and the building structure are considered piping supports.

Materials and allowable stresses for piping supports are selected from those permitted by NF, including Section III, and Cases N-71-11 and N-224-1. Although material quality assurance activities do not necessarily meet the requirements of NF-2610, the requirements of 10CFR50, Appendix B and the ASTM material specifications have been met. Materials have been furnished with identification and Certificates of Compliance, and are currently being procured with Certified Material Test Reports. Welding filler material meets the requirements of Section III. NB-2400 and NB-4400. Material identification is controlled by physical segregation to assure identification to the point of installation.

Welding of piping supports meets the requirements of ASME Section IX, including welding procedure specifications and welding procedure and performance qualifications. Welder identification is traceable to a drawing, and not to individual welds.

TABLE Q210.36-2

LOAD CONDITIONS FOR LINEAR TYPE PIPING SUPPORTS FOR CONTAINMENT SPRAY SYSTEMS(1)(2)

Plant Operating Condition	Load Conditions(3)	Allowable(4) Tensile Stress
Normal/Upset	D + T + R	$0.6\ S_y$
	D + T + R + E + A + H + W	$0.8\ S_y$
Faulted(5)	D + E' + H + W	$0.8\ S_y$
	T + R' + A'	$0.8\ S_y$

NOTES:

Refer to notes on Table Q210.36-1.

TABLE Q210.36-1

LOAD CONDITIONS FOR LINEAR TYPE PIPING SUPPORTS
(Except for Containment Spray Systems)[1][2]

Plant Operating Condition	Load Conditions[3]	Allowable[4] Tensile Stress
Normal/Upset	D + T + R	0.6 S_y
	D + E + H + T + R + A + W	0.8 S_y
Faulted[5]	D + E' + H + A' + W Delete	1.2 S_y or 0.7 S_u[6]

NOTES:

1. See Table Q210.36-2 for allowable tensile stress values for containment spray system pipe supports.

2. Containment spray system is comprised of the following:

   - recirculation (containment) spray piping
   - quench spray piping
   - portions of SIL/SIH piping

3. See Table Q210.36-3 for identification of loadings.

4. Buckling check is performed using the provisons of AISC Code, 7th Edition. (See Table Q210.36-4 for list of AISC Code equations used.)

5. For ANSI B31.1 piping, faulted conditions noted above do not apply; and under normal/upset condition, unless otherwise specified in applicable support summaries, loads due to seismic conditions are not considered. When seismic load becomes applicable, the allowable of 0.8 S is used as stated above.

6. The faulted allowables are based upon the guidance provided in Appendix XVII of ASME III, 1974 Edition.

Nondestructive examination includes visual examination of all welds. The surface and volumetric examinations of Subsection NF are not necessarily peformed. Visual examiners are qualified to NRC Reg. Guide 1.58 and ANSI N45.2.6. Some are also qualified to ASNT-SNT-TC-1A and/or AWS D1.1.

The only significant difference between the NF requirements and the construction program requirements is the examination criteria for Class 1 and/or primary member welds and the qualification of the examiners. However, the measures described herein are believed to be sufficiently in excess of the ANSI and AISC requirements referenced by the applicable Edition and Addenda of Section III to provide adequate assurance of the integrity of the piping supports.

d.) The Staff requested additional information regarding the buckling criteria utilized for both SWEC and W scopes.

NSSS Scope

Plate and shell type supports for Class 2 and 3 auxiliary equipment are evaluated for buckling and instability through selective use of the criteria of Appendix XVII, Subarticle XVII-2200 and Subsection NC, Subparagraph NC-3133.6 of Section III of the ASME Code.

Subparagraph NC-3133.6 gives methods for calculating the maximum allowable compressive stress in cylindrical shells subjected to axial loadings that produce longitudinal compressive stresses in the shell.

Subarticle XVII-2200 gives requirements for structural steel members including allowable compressive loads based on slenderness ratios and interaction equations for combined stresses.

Use of the above requirements, in addition to those of Subsection NF, in the design of plate and shell type supports for Westinghouse supplied auxiliary equipment, ensures the dimensional stability of the support throughout the range of applied loadings.

BOP Scope

SWEC design utilized AISC buckling criteria as outlined in Table Q210.36-4. No increase in Fa (allowable stress) is allowed for either upset or faulted conditions.

Buckling does not typically govern pipe support member stress due to the fact that Millstone 3 supports are usually fabricated from short, heavy sections.

TABLE Q210.36-3

LOADING APPLICABLE TO PIPE SUPPORT DESIGNS
(See Tables Q210.36-1 and Q210.36-2)

D - Sustained mechanical loads, including deadweight of piping, components, contents, and insulation

T - Loads due to thermal expansion of the system in response to average fluid temperature

R - Loads induced in the piping due to the thermal growth of equipment and/or structures to which the piping is connected as a result of plant normal or upset plant conditions.

R' - Loads induced in the piping due to the thermal and pressure growth of equipment and/or structures to which the piping is connected as a result of plant faulted conditions.

E - Inertia effects of the OBE.

E' - Inertia effects of the SSE.

A - Loads induced in the piping due to response of the connected equipment and/or civil structures to the OBE (commonly referred to as OBE anchor movements).

A' - Loads induced in the piping due to response of the connected equipment and/or civil structures to the SSE (commonly referred to as SSE movements).

H - Loads resulting from occasional loads other than seismic. Examples of these loads would be: water hammer, steam hammer, opening and closing of safety relief valves, etc.

Y - Effects of components striking pipe (pipe whip) or effects of blowdown of an adjacent system (jet impingement loads), as defined for the emergency plant condition.

W - Loads imposed by wind. (Wind load is not considered to occur concurrently with earthquake loads.)

TABLE Q210.36-4

AISC CODE EQUATIONS USED FOR BUCKLING CHECK
(Based on AISC Code, 7th Edition)

AISC Code Equation No.	Description
1.5.1.3.1	Axial compression when: $\frac{Kl}{r} < C$
1.5.1.3.2	Axial compression when: $\frac{Kl}{r} \geq C$
1.5.1.4.4	Bending minor axis and major axis.
1.6.1(a)	Axial compression plus bending.
1.6.2	Axial tension plus bending.

NRC Letter: December 5, 1983

Question No. Q210.37 (Section 3.9.3)

The staff's review of your component support design finds that additional information is required regarding the design basis used for bolts.

(a) Describe the allowable stress limits used in equipment anchorage, component supports, and flanged connections.

(b) Provide a discussion of the design methods used for expansion anchor bolts used in component supports.

Response:

BOP Scope

a. All bolting within the ASME III, NF jurisdictional boundaries, whether for equipment anchorage, support, or flange connection, is in accordance with ASME III, Appendix XVII and Code Case 1644. Bolt stresses are maintained below yield strength for all load combinations.

   Bolts for flange connections are designed in accordance with ASME III.

   All other bolts are per AISC (7th Edition) specifications.

b. Basic allowable values of shear and tension, including rules for consideration of interaction, are used based on manufacturers' test data and SWEC analysis.

   Performance specifications and testing assure a minimum safety factor of 4 against anchor failure.

The criteria for determining design load on anchor bolts consider base plate flexibility effects where applicable.

The maximum bolt hole diameter allowed for surface mounted base plates utilizing expansion type anchor bolts or poured-in-place inserts is the nominal bolt diameter plus one eighth of an inch.

NSSS Scope

Westinghouse has no responsibility for bolting used for equipment anchorage. The only bolting for tanks and heat exchanger supports is on the regenerative heat exchanger. These bolts, as are any support bolts for the NF designed pump supports (charging and safety injection pumps; see response to Question 210.36), meet the requirements of ASME Code Case 1644. Any bolting on other pump supports are to pressure boundary limits, as are valve body-to-bonnet bolts. Flanged connections for Westinghouse supplied equipment are to the requirements of Appendix XI of the ASME Code.

NRC Letter: February 17, 1984

Question Q210.44

In your response to Question 210.25, you provided the staff (during the January 17 through 19, 1984, meeting) with a copy of a report prepared by Teledyne Engineering Services for the inelastic analyses performed on the RCL nozzles. The staff review of the report noted that for the faulted (evaluated to emergency limits) condition, only the SSE loading was considered as required per your design specification requirements. The staff requires the combination of LOCA plus SSE loads evaluated for the faulted condition limits. Provide the basis for not including LOCA loads in the inelastic analyses performed for the two 3-inch charging line nozzles, four 3-inch high pressure safety injection nozzles, and 12 sets of circumferential as-welded butt welds.

Response:

The piping engineering and design specification requires LOCA and SSE effects to be evaluated concurrently in the faulted condition. Refer to FSAR Tables 3.9B-10 and 3.9B-12 for a description of the applicable load combinations.

It is the Applicant's intention to request an exemption from General Design Criterion 4 and the need to consider reactor coolant loop pipe breaks for Millstone 3 (refer to W.G. Counsil letter to H.R. Denton, April 9, 1984); therefore, LOCA loads may be eliminated from design consideration.

Based on this, LOCA loads were not applied in these analyses.

NRC Letter: February 17, 1984

Question Q210.45

During the January 17 through 19, 1984, meeting, the staff reviewed your design specification for ASME Class 1, 2, and 3 piping supports. The staff found that your load combinations and stress limits given in the design specification were not consistent with those provided in the FSAR nor with those provided in your response to Question 210.36. The staff was informed that the design specification was being updated and revised to reflect the design actually used for Millstone 3.

a. Provide the basis for assuring that adequate design controls have been established for a consistent design of safety-related piping supports.

b. Provide a revised design specification and consistent FSAR commitments for piping supports which reflect the design basis actually used for Millstone.

c. Since your design basis requirements appear to be changing, what programmatic controls do you have for identifying design nonconformances?

Response:

The Millstone 3 FSAR, as originally submitted, did not contain information related to pipe support analysis and design.

The Applicant's response to NRC Question 210.36 provides this missing information. This response is identical to the pipe support design criteria included in the engineering and design specification (M149).

a. To ensure the consistency and control of the pipe support design efforts, a project criteria document for pipe supports (NETM-45) has been issued and this will be updated as necessary to reflect changes to the design criteria.

   Care is also taken to ensure that the criteria setforth in this project procedure is in conformance with project licensing (FSAR) and the engineering and design specification for piping.

b. The pipe support design criteria, as included in the piping engineering and design specification (M149) are summarized in Attachment 1. The FSAR commitments for pipe supports are contained in the response to NRC Question 210.36.

   Note that on revised Table Q210.36-1, the A' term has been deleted for the faulted condition load combination for supports on systems other than the containment spray system. The A' term had been included erroneously.

c. Millstone 3 design criteria for pipe supports have remained essentially the same during the design process; the applicable criteria are included in Item b.

   In addition, to ensure that design nonconformances are resolved, a stress reconciliation program has been implemented by Millstone 3.

   A part of this task involves review of support functions as installed, the design specification requirements including the loads used for support design, and the reconciliation of any nonconformances.

ATTACHMENT 1

PIPE SUPPORT/DUCT SUPPORT DESIGN CRITERIA DOCUMENT

TABLE 3.5-0

LOADINGS APPLICABLE TO PIPE SUPPORT DESIGNS

D - Sustained mechanical loads, including deadweight of piping, components, contents, and insulation

T - Loads due to thermal expansion of the system in response to average fluid temperature

R - Loads induced in the piping due to the thermal growth of equipment and/or structures to which the piping is connected as a result of plant normal or upset plant conditions.

R' - Loads induced in the piping due to the thermal and pressure growth of equipment and/or structures to which the piping is connected as a result of plant faulted conditions.

E - Inertia effects of the OBE.

E' - Inertia effects of the SSE.

A - Loads induced in the piping due to response of the connected equipment and/or civil structures to the OBE (commonly referred to as OBE anchor movements).

A' - Loads induced in the piping due to response of the connected equipment and/or civil structures to the SSE (commonly referred to as SSE movements).

H - Loads resulting from occasional loads other than seismic. Examples of these loads would be: water hammer, steam hammer, opening and closing of safety relief valves, etc.

Y - Effects of components striking pipe (pipe whip) or effects of blowdown of an adjacent system (jet impingement loads), as defined for the emergency plant condition.

W - Loads imposed by wind. (Wind load is not considered to occur concurrently with earthquake loads.)

PIPE SUPPORT/DUCT SUPPORT DESIGN CRITERIA DOCUMENT

TABLE 3.5-1

LOAD CONDITIONS FOR LINEAR TYPE PIPING SUPPORTS
(Except for Containment Spray Systems)[1][2]

Plant Operating Condition	Load Conditions[3]	Allowable[4][8] Tensile Stress
Normal/Upset	D + T + R	0.6 Sy
	D + E + H + T + R + A + W	0.8 Sy
Faulted[5]	D + E' + H + W	1.2 Sy or 0.7 Su[6]

NOTES:

1. See Table 3.5-2 for allowable tensile stress values for containment spray system pipe supports.

2. Containment spray system is comprised of the following:

    - recirculation (containment) spray piping
    - quench spray piping
    - portions of SIL/SIH piping

3. See Table 3.5-0 for identification of loadings.

4. Buckling check is performed using the provisons of AISC Code, 7th Edition. (See Table 3.5-3 for list of AISC Code equations used.)

5. For ANSI B31.1 piping, faulted conditions noted above do not apply; and under normal/upset condition, unless otherwise specified in applicable support summaries, loads due to seismic conditions are not considered. When seismic load becomes applicable, the allowable of 0.8 Sy is used as stated above.

6. The faulted allowables are based upon the guidance provided in Appendix XVII of ASME III, 1974 Edition.

7. For consideration of Building Settlement and Hydrotest Loads, see Sections 3.6.2.1 and 3.6.2.2, respectively.

8. Allowable stress values apply to structural supports members and are not applicable to the integral attachment to piping which are evaluated to the ASME III piping rules. See NETM 44 (Ref. 8.4.10) Tables 4-1 through 4-6 for piping loading combinations and stress limits.

ATTACHMENT 1 (Cont)

PIPE SUPPORT/DUCT SUPPORT DESIGN CRITERIA DOCUMENT

TABLE 3.5-2

LOAD CONDITIONS FOR LINEAR TYPE PIPING SUPPORTS
FOR CONTAINMENT SPRAY SYSTEMS[1][2]

Plant Operating Condition	Load Conditions[3]	Allowable[4][8] Tensile Stress
Normal/Upset	D + T + R	0.6 Sy
	D + T + R + E + A + H + W	0.8 Sy
Faulted[5]	D + E' + H + W	0.8 Sy
	T + R' + A'	0.8 Sy

NOTES:

Refer to notes on Table 3.5-1.

PIPE SUPPORT/DUCT SUPPORT DESIGN CRITERIA DOCUMENT

TABLE 3.5-3

AISC CODE EQUATIONS USED FOR BUCKLING CHECK
(Based on AISC Code, 7th Edition)

AISC Code Equation No.	Description
1.5.1.3.1	Axial compression when: $(Kl/r) < Ccr$
1.5.1.3.2	Axial compression when: $(Kl/r) \geq Ccr$
1.5.1.4.4	Bending minor axis and major axis.
1.6.1(a)	Axial compression plus bending.
1.6.2	Axial tension plus bending.