



52-003

UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

November 26, 1996

Mr. Nicholas J. Liparulo, Manager
Nuclear Safety and Regulatory Activities
Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
P.O. Box 355
Pittsburgh, Pennsylvania 15230

SUBJECT: STAFF RESPONSE TO WESTINGHOUSE LETTER DATED FEBRUARY 12, 1996,
REGARDING ASME CODE CASE N-284, REVISION 1

Dear Mr. Liparulo:

The Nuclear Regulatory Commission Civil Engineering and Geosciences Branch has reviewed your response dated February 12, 1996, to our request for additional information (RAI) regarding the use of ASME Code Case N-284, Revision 1, in the AP600 application. Due to the large number of errors (typographical and otherwise) contained in the revision, the staff is requesting the ASME Boiler and Pressure Vessel Committee for further review and clarification. The staff's comments to the committee are enclosed. Because of this request, the staff is not in a position to endorse the use of Revision 1 to ASME Code Case N-284. However, the staff can perform the review on a case-by-case basis. This appears to have been done in the review of the AP600 steel containment for buckling of the containment ellipsoidal head under internal pressure.

It appears that Westinghouse has used the ASME Code Case N-284 in the design of the equipment hatch inside cover. With respect to its design for buckling, the staff has made its position clear to Westinghouse in RAI #220.100. That is, the buckling of the equipment hatch spherical covers may not be considered to be local because the covers do not form a portion of the containment shell even though they are part of the containment system. Its failure may result in excessive release of radioactive materials.

The boundaries of ASME Subsection NE include the penetration assemblies such as equipment hatches that are attached to the containment vessel. The equipment hatch cover design should be based on ASME Subsection NE-3133.4 and NE-3222.

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Mr. Nicholas J. Liparulo

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Novmeber 26, 1996

If you have any questions regarding this matter, you can contact me at
(301) 415-8548.

Sincerely,

original signed by:

Diane T. Jackson, Project Manager
Standardization Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Docket No. 52-003

Enclosure: As stated

cc w/enclosure:
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Mr. Nicholas J. Liparulo
Westinghouse Electric Corporation

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AP600

cc: Mr. B. A. McIntyre
Advanced Plant Safety & Licensing
Westinghouse Electric Corporation
Energy Systems Business Unit
P.O. Box 355
Pittsburgh, PA 15230

Mr. Ronald Simard, Director
Advanced Reactor Programs
Nuclear Energy Institute
1776 Eye Street, N.W.
Suite 300
Washington, DC 20006-3706

Mr. John C. Butler
Advanced Plant Safety & Licensing
Westinghouse Electric Corporation
Energy Systems Business Unit
Box 355
Pittsburgh, PA 15230

Ms. Lynn Connor
Doc-Search Associates
Post Office Box 34
Cabin John, MD 20818

Mr. M. D. Beaumont
Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
One Montrose Metro
11921 Rockville Pike
Suite 350
Rockville, MD 20852

Mr. James E. Quinn, Projects Manager
LMR and SBWR Programs
GE Nuclear Energy
175 Curtner Avenue, M/C 165
San Jose, CA 95125

Mr. Sterling Franks
U.S. Department of Energy
NE-50
19901 Germantown Road
Germantown, MD 20874

Mr. Robert H. Buchholz
GE Nuclear Energy
175 Curtner Avenue, MC-781
San Jose, CA 95125

Barton Z. Cowan, Esq.
Eckert Seamans Cherin & Mellott
600 Grant Street 42nd Floor
Pittsburgh, PA 15219

Mr. S. M. Modro
Nuclear Systems Analysis Technologies
Lockheed Idaho Technologies Company
Post Office Box 1625
Idaho Falls, ID 83415

Mr. Ed Rodwell, Manager
PWR Design Certification
Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, CA 94303

Mr. Frank A. Ross
U.S. Department of Energy, NE-42
Office of LWR Safety and Technology
19901 Germantown Road
Germantown, MD 20874

Mr. Charles Thompson, Nuclear Engineer
AP600 Certification
NE-50
19901 Germantown Road
Germantown, MD 20874

Comments on ASME Code Case N-284, Revision 1

I. Missing Information and Errors of Significance

1. In Rev. 1, there are new equations, which are added to Rev. 0. However, the bases of these equations to enable us to verify their adequacy are not provided.
2. In -1511 (a)(1)
 - a. Should it be 0.033, instead of 0.003 in the third equation for α_{el} ?
3. In -1513
 - a. Should it be -1512, instead of -1714.4 for torodial and ellipsoidal shells?
4. In -1521 (a)
 - a. Should they be $\bar{A} < 0.06$ and $\alpha_{eg} = \alpha_{el}$, instead of $\bar{A} < 0.2$ and $\alpha_{eg} = \alpha_{el}$ in the third equation? If so, there is some disparity. At $\bar{A} = 0.06$, the second equation produces $0.216 + 0.7\alpha_{el}$ and the third equation yield $1.0\alpha_{el}$, which means $\alpha_{el} = 0.72$. This implies $\sigma_y = 0.00251E$. If $E = 30 \times 10^6$ psi, it gives $\sigma_y = 75.3$ ksi. Is this a reasonable yield stress?
 - b. Ref. 1 provides the equations for stringers and rings separately. Rev. 1 provides only one equation for both cases. It seems to be less conservative for stringers. Is this truly intended?
5. In -1611 (c)
 - a. Check the accuracy of the second and the third equations for Δ because there is a discontinuity at $\Delta = 1.7$. The second equation gives 0.3529, whereas the third equation gives 0.9411.
6. In -1712.1.1 (b)(1)
 - a. Ref. 1 provides the coefficient of 1.08 for C_{ef} in the range $1.5 < M_2 < 3.0$, but Rev. 1 has 2.41. Is this a deliberate change or an error?
7. In -1712.2.2
 - a. Should they be $-A_{13}A_{22}$ and t_ϕ , instead of $-A_{13}A_{22}^2$ and $t\phi$?
 - b. Should it be \bar{D}_{ee} , instead of \bar{D} in A_{33} for σ_{eej} ?
 - c. Should it be $A_{11}A_{22} - A_{12}^2$, instead of $A_{11}A_{22}A_{12}^2$ for σ_{eej} ?
 - d. Equation for σ_{eej} under (b) External Pressure is in Rev. 0, but it is missing in Rev. 1.
8. In Fig.-1713.1-1 (a)
 - a. Should it be σ_{ee} , instead of σ_{eo} in EQ (b)?

9. In Fig.-1713.1-1 (b)
 - a. Should it be $\sigma_{\underline{hs}}$, instead of $\sigma_{\underline{hs}}$?
 - b. Should it be $\sigma_{\underline{re}}$, instead of $\sigma_{\underline{he}}$ in the definition of K_s ?
 - c. Should it be $K_s \sigma_{\underline{he}}$, instead of $K_s \sigma_{\underline{re}}$ in the first ordinate point?
 - d. Should it be $\sigma_{\underline{ee}}$, instead of $\sigma_{\underline{ee}}$ in the interaction curve equation?
 - e. Should it be $(K_s \sigma_{\underline{ee}}, K_s \sigma_{\underline{ee}})$, instead of $(\sigma_{\underline{ee}}, \sigma_{\underline{ee}})$ in the curve point?
10. In -1714.3 (b)
 - a. Is the coefficient of 5.92 correct? Rev. 0 indicates it to be 4.81.

II. Typographical Errors

1. For consistency and to avoid misunderstanding, use italics for all subscripts and superscripts in notations. In the following, the underlined subscripts and superscripts represent italics.
2. In -1120
 - a. Should it be $\sigma_{\underline{is}} = \sigma_i FS / \alpha_{\underline{ij}}$, instead of $\sigma_{is} = \sigma_i FS / \alpha_{ij}$?
 - b. Should they be $\sigma_{\underline{eei}}$ and $\sigma_{\underline{eei}}$, instead of $\sigma\phi_{ej}$ and $\sigma\phi\theta_{ej}$?
 - c. Should they be $\sigma_{\underline{xa}} = \alpha_{\underline{e}} \sigma_{\underline{ei}} / FS$ and $\sigma_{\underline{xc}} = n \sigma_{\underline{xa}}$, instead of $\sigma_{xa} = \alpha\phi_j \sigma\phi_j / FS$ and $\sigma_{xc} = n \phi \sigma_{xa}$?
3. In -1200
 - a. Should it be "i = 1 or 2 corresponding to ϕ or θ ...", instead of "i = 1 or 2 corresponding to ϕ to θ "?
 - b. Should it be $I_{\underline{ei}}$, instead of I_e for $I_{\underline{ei}}$ since $I_{\underline{ei}}$ is defined?
 - c. Suggest changing $\Sigma h_e t_e^3 / 3$ to $\Sigma (h_e t_e^3) / 3$ for J_i for clarity.
 - d. Suggest changing $[\sigma_{\underline{ee}} / \sigma_{\underline{re}}] 2$ to $[\sigma_{\underline{ee}} / \sigma_{\underline{re}}]^2$ for clarity.
 - e. For R_1 and R_2 , should it be ϕ , instead of μ ?
 - f. Should it be A_e / I_e , instead of A_e / I_e for t_e ?
 - g. Suggest listing t_e , t_e , and $t_{\underline{ee}}$ on separate lines, instead of on one line.
4. In Fig. -1511-1
 - a. Should it be $\alpha_{\underline{il}}$, instead of $a_{\underline{il}}$ in the ordinate?
 - b. Should they be $\alpha_{\underline{el}}$ and $\alpha_{\underline{eol}}$, instead of $a_{\underline{el}}$ and $a_{\underline{eol}}$?
 - c. Should it be $\alpha_{\underline{el}}$, instead of $a_{\underline{el}}$?

- d. Suggest change of the figure number to Fig. -1511-1, instead of Fig. 1511-1.
5. In Fig. -1511-2
 - a. Should it be $\alpha_{\underline{eL}}$, instead of $a_{\underline{eL}}$ in the ordinate?
 - b. Suggest change of the figure number to Fig. -1511-2, instead of Fig. 1511-2.
6. In -1512 (b)
 - a. Should it be $\alpha_{\underline{2L}}$, instead of $\alpha_{\underline{2}}L$ for $1.73 < M < 23.6$?
7. In Fig. -1512-1
 - a. Should it be $\alpha_{\underline{1L}}$, instead of $a_{\underline{1L}}$ in the ordinate?
 - b. Should they be $\alpha_{\underline{1L}}$ and $\alpha_{\underline{2L}}$, instead of $\alpha_{\underline{1}}L$ and $\alpha_{\underline{2}}L$?
 - c. Suggest change of the figure number to Fig. -1512-1, instead of Fig. 1512-1.
8. In -1611 (c)
 - a. Suggest deleting the duplicate equation $\Delta < 0.48$.
9. In -1712.1.1 (b)(1)
 - a. Should it be $C_{\underline{er}}$, instead of $C_{\underline{er}}$?
 - b. Suggest changing $(R/t)^3$ to $(R/t)^{\frac{3}{2}}$ for $C_{\underline{er}}$ for clarity in the range $M_{\underline{e}} \geq 1.65 R/t$.
10. In -1712.1 (b)(2)
 - a. Should it be $C_{\underline{eh}}ER/t$, instead of $C_{\underline{eh}}Et/t$?
 - b. Should it be $C_{\underline{eh}} = 0.988$, instead of $\theta_h = 0.988$?
 - c. Should it be $(R/t)^{\frac{3}{2}}$, instead of $(R^{\frac{3}{2}}/t)$ in the range $M_{\underline{e}} \geq 1.65 R/t$?
11. In -1712.1.2 (c)
 - a. Suggest changing $(b/a)^2$ to $(b/a)^{\frac{2}{3}}$ for clarity.
12. In -1712.1.3 (a)
 - a. Suggest aligning the equations for C , and deleting the duplicate equation.
13. In -1712.2.1
 - a. Should it be $L_{\underline{e}}^{\frac{1}{2}}R^{\frac{3}{2}}$, instead of $L_{\underline{e}}^{\frac{1}{2}}R^{\frac{3}{4}}$ in (c)?
14. In -1712.2.2
 - a. Suggest changing $l_{\underline{ee}} = l_{\underline{e}} L_{\underline{i}} = L_{\underline{e}}$ to $l_{\underline{ee}} = l_{\underline{e}}$, $L_{\underline{i}} = L_{\underline{e}}$ for clarity.
15. In -1712.2.3
 - a. Should it be $1.944Et_1^{\frac{1}{2}}$, instead of $1.944Et^{\frac{1}{2}}$?

- b. Should it be $Rt_2^{\frac{1}{2}}$, instead of $Rt_2^{\frac{1}{2}}$?
- c. Should it be l_{22} , instead of l_2 ?
- 16. In -1713.1.1
 - a. Should they be σ_{hel} and σ_{hel} , instead of σ_{hel} and σ_{rel} since they are not defined in the -1200 Notations?
 - b. Should it be σ_2 , instead of $\sigma\phi$ in (b)?
 - c. Should they be "Axial Compression Plus In-Plane Shear" and σ_{ra} , instead of "Axial Compression Plus Shear" in the title and σ_{ra} in (c)?
- 17. In -1713.1.3
 - a. Should it be $\sigma_{\theta} \neq 0$, instead of $\sigma_{\theta} \neq 0$?
 - b. Suggest changing the article number to -1713.1.3, instead of 1713.1.3.
- 18. In -1713.2.1
 - a. Should it be $\sigma_{xc} = n_2 \sigma_{xa}$, instead of $\sigma_{xc} = n_{\phi \sigma xa}$?
 - b. Should it be $\sigma_{rc} = n_2 \sigma_{ra}$, instead of $\sigma_{rc} = n_{\theta \sigma ra}$?
- 19. In -1714.1
 - a. Suggest deleting the duplicate equation.
- 20. In -1714.3 (a)
 - a. Should it be $M_{s1.8}$, instead of $M_{s1.8}$?
- 21. In -1714.4
 - a. Should it be Fig. -1713.1.3-1, instead of Fig. 1713.3 for R_2 ?

Reference:

1. Miller, C.D., "Summary of Buckling Tests on Fabricated Cylindrical Shells in USA," Buckling of Shells in Offshore Structures, Ed. by Harding, J. E., Dowling, P. J., and Agelidis, N., London, Granada Publishing, 1982, pp. 429 - 471.