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October 14, 1986

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Frederick J. Shon
Administrative Judge
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Washington, D.C. 20555

In the Matter of
GPU NUCLEAR CORPORATION, et al.
(Steam Generator Plugging Criteria)
Docket Nos. 50-289-OLA-1 and 50-289-OLA-2

Dear Administrative Judges:

Attached for the information of the Board and the parties is a letter dated October 3, 1986 from Licensee to the Staff providing information relevant to Change Request 148.

Sincerely,

Bruce W. Churchill
Counsel for Licensee

Enclosure
cc: Service List (attached)

DS03

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
GPU NUCLEAR CORPORATION, et al.	)	Docket Nos. 50-289-OLA-1
	)	50-289-OLA-2
	)	(Steam Generator
(Three Mile Island Nuclear	)	Plugging Criteria)
Station, Unit No. 1)	)	

SERVICE LIST

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October 3, 1986
5000-86-1050
5211-86-2174

Office of Nuclear Reactor Regulation
Attn: J. F. Stolz, Director
PWR Projects Directorate No. 6
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Stolz:

Three Mile Island Nuclear Station Unit 1 (TMI-1)
Operating Licensing No. DPR-50
Docket No. 50-289
Regulatory Guide 1.121
Extent of Applicability to OTSG's

This letter is a follow-up to prior discussions regarding the applicability of Regulatory Guide 1.121 to Once Through Steam Generators (OTSG's).

The once through steam generators employed on B&W designed plants use a vertical vessel with a straight tube fixed at both a lower and upper tubesheet. Characteristic of this design is that any differential thermal expansion between the tubes and the steam generator shell, during either steady state or transient modes of operation, give rise to axial strain in the tubes and hence axial tube loads. In addition, any pressure differential between the primary and secondary sides can also produce axial loads, although these are always much smaller than the thermal expansion induced loads. The pressure differential on the tubes also produces tube stresses oriented in the circumferential (hoop) direction. All analyses for once through steam generators show that the axial loads are controlling, and where there have been instances of in service cracking, as at TMI, the cracks are circumferentially oriented as would be expected because of the critical loading (axial) conditions.

In contrast to once through steam generators, recirculation steam generators of the type used in Westinghouse and Combustion Engineering designed plants are vertical shell vessels with a U-tube design in which both inlet and outlet ends of each tube are fixed to a single tubesheet. The tubes are not axially restrained to any significant degree and are free to expand. Temperature differences between inlet and outlet legs give rise to modest bending moments in the U bends, but no significant axial loads are produced. The dominant and controlling tube loads, and therefore stresses, are in the hoop direction due to internal pressure. This direction of dominant stress is confirmed in the recirculation steam generators in which observed cracks have been predominantly in the axial direction.

In summary, both recirculation and once through steam generators have pressure induced tube loading which cause circumferential tube stresses, but the once through steam generators uniquely have a dominant axial tube load. The axial tube load, however, is not force or pressure driven but rather thermally driven and hence, self limited. This latter type load is described in the ASME Section III Code as a secondary type stress. For the purposes of reviewing the applicability of Regulatory Guide 1.121 to once through steam generators, the subsequent discussion uses the nomenclature, definitions and underlying methodology contained in the ASME Section III Code.

ASME Code - Primary and Secondary Stresses

The ASME Boiler and Pressure Vessel Code, Section III, Subsection NB, provides definitions for the categorization of loads and stresses into primary, secondary and peak stress components. Code allowable stresses are dependent upon the load effects considered (i.e., primary stresses alone or in combination with secondary stresses) and the frequency of the stress occurrence.

A thermal stress is classified as a secondary stress and not classified as a primary stress, (NB-3213.8, NB-3213.9). A secondary stress is a normal or shear stress developed by the constraint of adjacent material or by self constraint of the structure (i.e., the thermal induced axial tube load in OTSG's). A basic characteristic of a secondary stress is that it is self limiting. Local yielding and/or minor strain can relax the loads which originally caused the stress to occur, and failure from one application of such secondary stresses is not expected. Thermal induced stress (secondary stress) is developed in a solid body (i.e., the composite OTSG shell and fixed tubes) whenever a volume of material is prevented from assuming the size and shape that it freely should take under a change in temperature. General thermal stress is associated with distortion of the structure in which it occurs (NB-3213.13).

These Code definitions are applicable to pressure vessels (i.e., OTSG) and to penetrations. In the application of Regulatory Guide 1.121 to OTSG's, it is not proposed to simply disregard thermal stress as is done in Section XI of the Code where, for ductile materials only, primary stresses are considered when performing flow stability evaluations. Rather, we should extract the physical understanding that is the basis for Code guidance. Conceptually, if a less stiff part of a structure (i.e., tube) is displaced to its yield strength by a more massive part of a structure (i.e., shell), solely because of there being a temperature difference between them, an increase in stress in the less stiff structure much beyond the yield strength will not occur because strain deformation of the less stiff member will bring it into size conformance with the more massive member. With reasonable ductility of materials (metals) usually encountered, parting or other mechanical failure of the less stiff member will not occur.

Regulatory Guide 1.121 Applicability

In assessing the integrity of steam generator tubes, with or without flaws, Regulatory Guide 1.121 makes use of margins to be applied to calculated tube loads to assure sufficient conservatism exists in comparing predicted to required tube capacity. These margins are based upon factoring normal loads by 3 and accident loads by 1.428. For recirculation steam generators, these factors have been applied to pressure effects (a primary load) in assessing repair limits. Since pressure effects are the predominant and critical recirculation generator load, this application of load increase by 3 or 1.428 provides the necessary margin.

For the case of OTSG's, application of Regulatory Guide 1.121 factors is equally appropriate for primary stresses as for recirculation generators. We show the results of this factor application to OTSG primary stresses in Table 1, attached. Code allowables are never exceeded. Since OTSG's have a significant axial tube load (stress) which is not a primary but rather a secondary stress, a treatment of this secondary stress in a manner consistent with the underlying development of the Code would not involve application of safety factors to these secondary stresses. These secondary stresses are more significant in considering fatigue resistance. A Code consistent, and conservative approach is to apply the Regulatory Guide 1.121 margins to strain and determine the new load in recognition of the load redistribution that occurs. This redefined load could then be used in assessing tube failure and the impact of tube flaws.

Summary

In summary, we believe Regulatory Guide 1.121 is a technically sound approach when applied to evaluating steam generators with predominant primary stresses. In the case of once through steam generators, meaningful strain-limited or secondary stresses exist. In this latter case, we conclude that Regulatory Guide 1.121 is not directly applicable in cases where significant secondary stress exists. We believe a proper approach is to put margin on total strain and demonstrate that the component has the capacity to resist the resulting stress and not fail. This approach will ensure a high reliability of tube integrity under all normal and accident loading conditions.

Very truly yours,

R. F. Wilson

R. F. Wilson
Vice President
Technical Functions

/amm
Attachment

cc: R. Conte
J. Thoma

bcc: J. Peter Paine (EPRI)
J. Lang (EPRI)
T. Gerber (EPRI)
J. Cuvilier (B&W)
B. Churchill(Shaw, Pittman)

TABLE 1

OTSG TUBING DESIGN BASIS
AXIAL STRESSES
(based on unflawed tube)

	Maximum Normal Operating Stress		
	Design Basis (DB)	3XDB	Sect. III Allow.
Mechanical [(1)] (Primary)	6,809	20,427	23,000
Mechanical + Thermal [(2)] (Primary + Secondary)	17,571	52,713	69,000

	Maximum Accident Stress		
	Design Basis (DB)	1.428DB	Sect. III Allow.
Mechanical [(3)] (Primary)	8,920	12,666	27,600
Mechanical + Thermal [(3)] (Primary + Secondary)	49,841		No Limit; Evaluation not required for secondary stresses

(1) 0 to 15% power change

(2) Cooldown from 15% power

(3) Main steam line break

GENERAL REFERENCES

1. ASME Code - Section III

2. Lang, J., F., et al, Analysis of Leak-Before Break for Steam Generator Tubes, Proceedings of Third International Topical Meeting on Reactor Thermal Hydraulics, Vol. 2, Sessions 13 -21, C. Chong and G. Brown, Eds, Newport, Rhode Island, October 15-18, 1985.

3. Griesbach, T., et al, Analysis Methods for Evaluating Leak-Before-Breaks in U-Tube Steam Generators, Ibid.

4. Babcock & Wilcox Topical Report No. BAW-10146, Determination of Minimum Required Tube Wall Thickness for 177-FA Once-Through Steam Generators, Oct. 1980.