TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

5N 157B Lookout Place

SEP 18 1987

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of	)	Docket Nos. 50-259
TENNESSEE VALLEY AUTHORITY	)	50-260
		50-296
		50-327
		50-328
		50-390
		50-391
		50-438
		50-439

NRC BULLETIN NO. 87-01 - THINNING OF PIPE WALLS IN NUCLEAR POWER PLANTS

Enclosed is TVA's response to NRC Bulletin 87-01 dated July 9, 1987.

TVA's response to this bulletin was originally due to NRC by September 11, 1987. Through coordination with the appropriate Project Managers, TVA was verbally granted an extension to September 18, 1987.

This response is for information only and does not constitute any commitments to the NRC. TVA's program for pipe erosion/corrosion inspections is not finalized and, any changes to that program which occur will not necessarily be presented to the NRC.

Should additional information on this subject be required, please refer any questions to Ron Westbrook of my staff at (615) 751-7508.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

R. Gridley

R. Gridley, Director
Nuclear Safety and Licensing

Sworn to and subscribed before me
this 18th day of Sept. 1987

Paulette H. White

Notary Public
My Commission Expires 8-24-88

Enclosure
cc: See page 2

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U.S. Nuclear Regulatory Commission

SEP 18 1987

Enclosure
cc (Enclosure):

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ENCLOSURE

Response to NRC Bulletin No. 87-01

Tennessee Valley Authority

1. NRC Question: Identify the codes or standards to which the piping was designed and fabricated.

   TVA Response: Refer to Attachment 1 for a list of the codes and/or standards to which our piping was designed and fabricated. As stated in TVA's letter to NRC dated August 21, 1987, Watts Bar is reviewing the application of later editions and addenda to ASME Section III Code of Record. The ASME Section III editions and addenda referenced in attachment 1 are subject to this review.

2. NRC Question: Describe the scope and extent of your programs for ensuring that pipe wall thicknesses are not reduced below the minimum allowable thickness. Include in the description the criteria that you have established for:

   a. Selecting points at which to make thickness measurements;
   b. Determining how frequently to make thickness measurements;
   c. Selecting the methods used to make thickness measurements; and
   d. Making replacement/repair decisions.

   *TVA Response: To ensure that pipe wall thicknesses are not reduced below the minimum allowable thickness because of single-phase or dual-phase flow erosion-corrosion (EC), TVA has routinely performed visual and ultrasonic inspections during plant outages for dual-phase flow EC and has this year included inspections for single-phase flow EC at our licensed plants (Sequoyah units 1 and 2 and Browns Ferry units 1, 2, and 3). Systems which are included in these inspections include the condensate, feedwater, main and reheat steam, heater drains and vents, extraction steam, and turbine drains. Where the piping inside surfaces were physically accessible, visual inspections were performed. When damage was observed, ultrasonic testing was used to quantify its depth. Refer to Attachment 2 for a list of procedural documents. Piping which could not be visually examined was inspected from the outside using ultrasonic testing only. Portions of the condensate system where the temperature is less than 200 degrees Fahrenheit did not have to be included in our inspections. Also, connected piping that did not qualify as "high energy" was not considered. TVA defines high energy pipes as those which are in normal plant operation at a maximum temperature equal to or greater than 200 degrees Fahrenheit and/or a maximum pressure equal to or greater than 275 psig.

Since it is not feasible or necessary to measure the thickness of the piping at every point, TVA identifies locations which appear to experience the most severe EC conditions based upon design studies, previous experience, and system walkdowns. TVA has performed a design study (refer to Attachment 3) on Browns Ferry, Sequoyah, and Watts Bar which identified areas potentially susceptible to dual-phase flow EC using Keller's equation (refer to EPRI Report NP-3944 dated April 1985 entitled "Erosion-Corrosion in Nuclear Plant Steam Piping; Causes and Inspection Program Guidelines"). Since a quantitative analysis method was not available when TVA started inspecting for single-phase flow EC, system drawings were reviewed and walkdowns were performed to identify areas which appeared to be susceptible based upon EPRI guidelines (refer to EPRI report on Single-Phase Erosion-Corrosion of Carbon Steel Piping dated February 19, 1987). The criteria that are used for single-phase flow and dual-phase flow EC include:

1. Piping material susceptibility;
2. Complex piping configuration;
3. High fluid bulk velocity;
4. System temperature;
5. Moisture content in dual-phase flow systems; and
6. Prior history of problem areas.

Recommendations for inspection frequency are based upon the expected EC rate as determined by inspection results and the design study for dual-phase flow (which uses Keller's equation) and for single-phase flow by subtracting the measured wall thickness from the nominal wall thickness (unless actual original wall thickness is known, in which case it would be used in lieu of nominal wall thickness) and dividing by the number of operating hours to date. This rate is then linearly extrapolated to predict when the pipe wall could experience thinning below the design minimum wall thickness. If wall thinning is detected, future inspections will be performed on an as-needed basis in accordance with the predicted EC rate and remaining component life such that the component will be replaced/repaired prior to its degradation below design minimum wall thickness. A database is planned to maintain the inspection results to be used for trending analyses. If trending indicates that the pipe wall thickness of the component in question will approach the design minimum wall thickness, before the next scheduled outage, the component will be replaced or repaired. Even if the component is not going to approach the design minimum wall thickness before the next scheduled outage, TVA may elect to replace/repair the component based upon schedule considerations, material availability, etc.

Regarding our construction permit plants, Watts Bar and Bellefonte, the program established by the NUMARC subcommittee (using the CHEC computer code) will be used for the single-phase flow systems (condensate and feedwater) to determine which of these areas should be included in the inspection program. Along with the NUMARC program, other areas will be identified based upon engineering judgment and past experience. Plans are to identify the highest risk areas and inspect them preoperationally to establish a baseline for future analysis. At the first refueling outage, plans are to again examine these areas ultrasonically to determine the actual wall thickness. Inspections after the first refueling outage will be scheduled based on actual experience. Where damage is detected, future examinations will be scheduled based on the rate of wall loss; where no damage is detected, examination will be scheduled based on engineering judgment to ensure continued acceptable operation. TVA included Watts Bar in the design study discussed above and has performed a baseline inspection on Watts Bar for areas suspected to be susceptible to dual-phase flow EC.

3. NRC Question: For liquid-phase systems, state specifically whether the following factors have been considered in establishing your criteria for selecting points at which to monitor piping thickness (item 2a):

   a. Piping material (e.g., chromium content).
   b. Piping configuration (e.g., fittings less than 10 pipe diameters apart).
   c. pH of water in the system (e.g., pH less than 10).
   d. System temperature (e.g., between 190 degrees and 500 degrees Fahrenheit).
   e. Fluid bulk velocity (e.g., greater than 10 fps).
   f. Oxygen content in the system (e.g., oxygen content less than 50 ppb).

*TVA Response: Since single-phase flow EC is the result of a combination of factors, TVA considers the synergistic effect of all the above factors in our selection criteria. Only plain carbon steel piping (i.e., negligible chromium content) is included in our inspections for single-phase flow EC since even small amounts of chromium (i.e., ≥1 percent) in a material will significantly improve its resistance to EC according to data available in EPRI Report NP-3944. The piping configuration is also considered in our selection criteria. Fittings less than 10 pipe diameters apart (and piping in between) and piping immediately downstream of orifices and flow control valves are considered potentially susceptible to EC. Studies have shown that EC is more likely to occur in certain temperature ranges--200-350 degrees Fahrenheit for single-phase flow--with the greatest effect being at approximately 270 degrees Fahrenheit based upon bell-shaped curves developed for this parameter (EPRI Report NP-3944). Locations within this temperature range are inspected as well as areas with temperatures up to 500 degrees Fahrenheit if other criteria warrant inspection. The fluid bulk velocity of the areas which have been inspected generally exceed 10 fps; however, our inspections were not limited to these areas. The pH and the oxygen are maintained at levels less than those necessary to enhance EC resistance. Therefore, the other four factors are used in establishing points to be monitored.

4. NRC Question: Chronologically list and summarize the results of all inspections that have been performed, which were specifically conducted for the purpose of identifying pipe wall thinning, whether or not pipe wall thinning was discovered, and any other inspections where pipe wall thinning was discovered even though that was not the purpose of that inspection.

   a. Briefly describe the inspection program and indicate whether it was specifically intended to measure wall thickness or whether wall thickness measurements were an incidental determination.

   b. Describe what piping was examined and how (e.g., describe the inspection instrument(s), test method, reference thickness, locations examined, means for locating measurement point(s) in subsequent inspection).

   c. Report thickness measurement results and note those that were identified as unacceptable and why.

   d. Describe actions already taken or planned for piping that has been found to have a nonconforming wall thickness. If you have performed a failure analysis, include the results of that analysis. Indicate whether the actions involve repair or replacement, including any change of materials.

TVA Response: Attachment 2 contains TVA's documentation on programs and procedures for performing inspection for pipe wall thinning. Attachment 4 contains reports of wall thinning inspections which have been performed at TVA plants since 1977. A cover sheet is attached to each inspection report to briefly summarize the results and to provide the detailed information requested. When no reports were written regarding the inspections, just a cover sheet is included.

TVA has been replacing components which have been thinned due to EC with stainless steel materials. In a few cases, carbon steel has been used as the replacement material on a temporary basis because of material unavailability. Base metal weld repairs have also been performed on a temporary basis.

5. NRC Question: Describe any plans either for revising the present or for developing new or additional programs for monitoring pipe wall thickness.

*TVA Response: Plans call for the current wall thinning programs at Sequoyah and Watts Bar plants to be revised as needed to include inspection of additional piping. For example, we are evaluating the recent Trojan Plant program (NRC information Notice 87-36) for impact on our inspection program. Future plans are for TVA to participate in the NUMARC initiative regarding selection and inspection of piping for wall thinning at Sequoyah and Browns Ferry Nuclear Plants. Since Watts Bar and Bellefonte Nuclear Plants may not be operational for some time, schedules for piping EC inspections at those plants will not have the same priority as Browns Ferry and Sequoyah Nuclear Plants.

*TVA's response is for information only and does not constitute a commitment(s) to the NRC. TVA's plans for pipe EC inspections are not finalized, and any changes that occur will not necessarily be presented to the NRC.

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ATTACHMENT 1

Piping Codes and Standards

Plant	System	Codes (ANSI/ASME)	Standards (ASTM/ASME)
BFN	Main Steam	B31.1 1967	A-106 gr B A-333 gr 1 A-53 gr B
	Condensate	B31.1 1967	A-155 gr KC-70, CL 2 A-106 gr B
	Feedwater	B31.1 1967	A-155 gr KC-70 CL 1 A-106 gr B
	Extraction	B31.1 1967	A-155 gr KC-70 CL 2 A-106 gr B
	Htr. Dr. & Vnts	B31.1 1967	A-106 gr B A-312 gr TP304

Plant	System	Codes (ANSI/ASME)	Standards (ASTM/ASME)
SQN	Main steam from SG to flued head	*B31.1 1967 **B31.7 1969	A-106 gr B A-155 gr KCF70 CL 1 (A516gr70) A-420 gr WPL1 (A516gr70) A-105 gr II
	MS & reheat from flued head to turbine & other points	B31.1 1967	A-155 gr KC70 CL 1 A-106 gr B A-234 gr WPB (A515 gr70) A-105 gr II
	Condensate	B31.1 1967	A-106 gr B A-155 gr KC60 CL 2 A-234 gr WPB A-181 gr I A-105 gr II A-216 gr WC
	FW from flued head to SG	*B31.1 1967 **B31.7 1969	A-333 gr 1 A-106 gr B A-420 gr WPL6 (A516gr60) A-420 gr WPL6 (A333gr6) A-105 gr II
	FW from pump discharge to valve vault room	B31.1 1967	A-155 gr KC70 CL 1 A-106 gr B A-234 gr WPB (A515gr70) A-234 gr WPB A-105 gr II A-216 gr WCB A-903 TP WP304
	Extraction	B31.1 1967	A-155 gr KC70 CL 2 A-106 gr B A-234 gr WPB (A515gr70) A-234 gr WPB A-105 gr II A-403 TP304 A-403 TP316 A-376 TP304 A-376 TP316
	Htr. Dr. & Vents	B31.1 1967	A-106 gr B A-234 gr WPB A-105 gr II A-234 gr WCV A-53 gr B A-312 TP316 A-403 WP304 A-182 gr F304 A-312 gr TP304 A-376 gr TP304

* B31.1 is for design
** B31.7 is for fabrication

Plant	System	Codes (ANSI/ASME)	Standards (ASTM/ASME)
SQN (cont)	Turbine drains	B31.1 1967	A-106 gr B A-234 gr WPB A-105 gr II

Plant	System	Codes (ANSI/ASME)	Standards (ASTM/ASME)
WBN	MS from SG to flued head	ASME III-2 1971 edition thru summer 1973 addendum	SA-106 gr B SA-155 gr KCF 70, CL 1 SA-234 gr WPB (SA516gr70) SA-105 SA-350 gr LF1
	MS and reheat from flued head to turbine and other points	B31.1 1973	A-106 gr B A-155 gr KC70 CL 1 A-234 gr WPB (A515gr70) A-234 gr WPB A-105 A-105 gr I A-105 gr II
	Condensate	B31.1 1973	A-106 gr B A-155 gr KC70, CL 2 A-105 A-234 gr WPB A-105 gr II A-216 gr WCB
	FW from flued head to SG	ASME III-2 1971 edition thru summer 1973 addendum	SA-333 gr 6 SA-106 gr B SA-105 SA-420 gr WPL6 SA-350 gr LF 1
	FW from pumps discharge to valve vault rooms	B31.1 1973	A-155 gr KC70 CL 1 A-106 gr B A-234 gr WPB (A515gr70) A-234 gr WPB A-105 A-216, gr WCB A-182 gr F304 or F316 A-403 gr WP304 or 316 A-312 TP304
	Extraction	B31.1 1973	A-155 KC-70, CL 2 A-106, gr B A-234 gr WPB (A515gr60) A-234 gr WPB A-105 A-155 KC-70 CL 1
	Htr. Dr. & Vnts.	B31.1 1973	A-106 gr B A-234 gr WPB A-105 A-155 gr KC-70 API-5L gr B A-53, gr B A-515 gr KC70 CL 1 A-312 TP304L
	Turbine drains	B31.1 1967	A-106 gr B A-234, gr WPB

Plant	System	Codes (ANSI/ASME)	Standards (ASTM/ASME)
BLN	Main & reheat steam	ASME III-2S 1974 edition thru summer 74 addendum B31.1 1973	SA-106, gr B SA-106, gr B, CMTR reqd SA-155, KCF 70 Class 1, or SA-672 Class 31, gr C70 SA-106, gr B
	Condensate	B31.1 1973	A-106, gr B A-106, gr B, CMTR reqd A-155, KC 70 or KCF 70, CL 1
	Feedwater	ASME III-2S 1974 edition thru summer 74 addendum B31.1 1973	SA-106, gr B SA-106, gr B, CMTR reqd SA-155, KCF 70 Class 1 A-106, gr B A-155, KCF 70 Class 1
	Extraction	B31.1 1973	A-106, gr B, CMTR reqd A-155, KC 70 or KCF 70
	Heater drains & vents	B31.1 1973	A-106, gr B, CMTR reqd
	Turbine drains	B31.1 1973	A-106, gr B
	Turbine steam seal	B31.1 1973	A-106, gr B; other material supplied by contractors

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ATTACHMENT 2

Listing of Procedural Documents

Inspection Program - Division of Nuclear Power - Steam/Water Erosion of Piping and Corrosion of Raw Water Carbon Steel Piping (T.S.09.01.01.14.02).

Sequoyah Nuclear Plant (SQN) Surveillance Instruction - 714, Extraction Steam Pipe Wall Degradation Monitoring Program.

SQN Surveillance Instruction - 733, Wall Degradation Monitoring Program for the Feedwater/Condensate Piping, Turbine, and Heater Drain Lines.

Watts Bar Nuclear Plant (WBN) Technical Instruction - 31.13, Wall Thickness Measurement of Piping, Tanks, and Vessels.

Nondestructive Examination Procedure N-UT-26 of SQN TI-51, Ultrasonic Examination for the Detection of I.D. Pitting, Erosion, and Corrosion.