yellow

TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

July 18, 1983

U.S. Nuclear Regulatory Commission
Region II
ATTN: James P. O'Reilly, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

Dear Mr. O'Reilly:

INSPECTION AND ENFORCEMENT BULLETIN 83-02 - STRESS CORROSION CRACKING IN LARGE DIAMETER STAINLESS STEEL RECIRCULATION SYSTEM PIPING AT BWR PLANTS - BROWNS FERRY NUCLEAR PLANT

Enclosed is our response to the subject bulletin for the Browns Ferry Nuclear Plant unit 1. Our response contains the results of the inspections performed on the recirculation and Residual Heat Removal Sytems and the planned weld repair program.

A meeting was held between TVA and the NRC staff in their Bethesda offices on July 6, 1983. That meeting was attended by F. Cantrell, J. Blake, G. Paulk, and others of your staff. The enclosed response includes additional information requested by the NRC staff in that meeting. The requested information regarding weld crown widths will be forwarded when it becomes available.

The enclosed response states our positions regarding the criteria for determining the need for repair and the overlay repair procedure. We need to obtain the NRC staff's final position on the criteria and overlay repair immediately since needed unit 1 repairs are already underway.

If you have any questions, please call Jim Domer at FTS 858-2725.

To the best of my knowledge, I declare the statements contained herein are complete and true.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills, Manager
Nuclear Licensing

Enclosure
cc: See page 2

IE11

cc (Enclosure):
U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. R. J. Clark
Browns Ferry Project Manager
U.S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, Maryland 20814

ENCLOSURE

The welds examined in the Recirculation and RHR Systems and the results of the examinations were reported in the meeting on July 6, 1983 between TVA and the NRC staff.

The following is a summary of what was presented at the meeting. TVA examined the following welds.

Recirc (100% of welds)		RHR (100% of stainless steel piping welds)	
Risers -	40		
Sweepolets -	8	Supply (20") -	7
Large Diameter -	43	Return (24") -	25
	91		32

Of these, the following crack distribution was reported:

Recirc		RHR	
Risers -	6	Supply &	
Sweepolets -	4	Return -	14
Large Diameter -	23		
	33		

Of these 47 cracked welds, TVA proposed to overlay repair 30 and proposed to accept "as is" the other 17 because of the acceptability demonstrated by the flawed pipe analysis.

As a result of increased cracking detected by all utilities performing IEB 83-02 inspections, NRC expressed concern in the July 6 meeting over continued operation without overlay repair of any large diameter recirculation of RHR piping with cracking of 25-percent throughwall or greater. This concern affects the following unit 1 recirculation system welds which TVA has determined by conservative sizing techniques and flawed pipe analysis to be acceptable for continued operation for one fuel cycle without repair: KR-1-24, KR-1-48, GR-1-56, GR-1-64, KR-1-47, GR-1-27, GR-1-57, KR-1-45, GR-1-61, and KR-1-52. In addition, NRC stated that they are considering requiring utilities to perform "full structural" overlay repairs instead of the standard size overlay repairs currently being performed by the industry. The following comments address these two NRC concerns.

1. TVA disagrees with an arbitrary cut-off point of 25-percent throughwall indications as a criteria for determining repairs for large diameter piping because it does not take into account the applied stress at a given weld and ignores the conservatism used by TVA in sizing all indications. The ten recirculation welds identified by NRC in the July 6 meeting (identified above) have relatively low-applied stresses as compared with typical RHR welds and hence the crack growth rate is much less.

   In addition, the ten welds in question can have a considerable margin of error in sizing and still operate safely for one 18-month cycle of operation. The data for these ten welds are summarized below. The description of the indications for these ten welds is presented on page 1 of Attachment 2.

Weld No.	Initial Crack Size (Percent Throughwall)	Allowed Initial Crack Size for One Cycle (Percent Throughwall)	Percent Error Margin for Safe Operation
KR-1-24	25	51	104
KR-1-48	30	50	67
GR-1-56	29	50	72
GR-1-64	33	51	55
KR-1-47	23	50	117
GR-1-27	37	52	41
GR-1-57	33	51	55
KR-1-45	23	41	78
GR-1-61	30	51	70
KR-1-52	27	50	85

As presented in the July 6 meeting, TVA used very conservative residual stress and IGSCC crack-growth curves in performing the flawed pipe analysis and in every case assumed the maximum recorded flaw depth to be 360° around the weld. As pointed out in the July 6 meeting, TVA has a very high confidence level in our examination technique for the following reasons: (1) a transfer technique was employed before scanning every weld to account for acoustic differences and to ensure uniform sensitivity; (2) all scanning was performed using the half-node technique to reduce metal path and hence the propensity for error; (3) all sizing was performed using a 60° transducer and the half-node technique; and (4) a sizing technique was used which the NRC Region II inspector indicated was very conservative.

Based on the above data and the conservatisms used in the examinations and flawed pipe analysis, it is TVA's position that the ten recirculation piping welds identified above have more than an adequate margin of safety to operate for one fuel cycle without an overlay repair.

2. TVA has serious problems with the "full structural" overlay concept for the following reasons. A "full structural" overlay is more than twice as thick as the standard overlays currently being performed by most utilities. The compressive residual stresses developed by the standard overlay put a compressive stress around the crack tip. Flawed pipe analyses demonstrate zero crack growth for at least 5 years.

Therefore, thicker overlays are not warranted from a structural integrity viewpoint. The increased thickness of "full structural" overlays significantly reduce the inspectability of the repair joint. TVA, as well as the rest of the industry, is committed to producing the most inspectable overlays possible, and "full structural" overlays defeat this purpose. Of greater concern to TVA, however, is the adverse effect that "full structural" overlays may have on the rest of the piping system. Due to the amount of shrinkage involved with overlays of this thickness, the resultant stress at adjacent welds and welds at or near terminal ends is expected to increase significantly. Given the present number of overlays currently planned for unit 1, it is TVA's opinion that "full structural" overlays could adversely affect the structural integrity of the recirculation and RHR systems.

We also believe it is important to consider the tremendous time increase associated with performing "full structural" overlays. Below is a comparison of the time required to perform standard overlays versus "full structural" overlays for three pipe diameters (provided by TVA's prime welding contractor for unit 1):

Pipe Diameter (Inches)	Standard Overlay (Hours)	Full Structural Overlay (Hours)
12.75	6.7	9.3
22.00	19.3	45.0
28.00	28.6	72.5

As can be seen from the above comparison, for large diameter pipe it takes approximately 2-1/2 times longer to perform a "full structural" overlay than to perform a standard overlay. Given the number of welds currently planned to be repaired on unit 1, TVA's welding contractor estimates it would take an additional 40 days to perform "full structural" overlays. In addition, the man-rem exposure will significantly increase.

In summary, TVA believes that the ten large diameter welds in question have more than an adequate margin of safety to operate for one fuel cycle without an overlay repair. In addition, TVA plans to utilize the overlay designs recommended by NUTECH Engineers, Inc., the prime contractor for the overlay repairs on unit 1.

Attachment 1
Results of Crack Growth Analysis
(Large Diameter Recirculation Piping)

Weld No.	Initial Crack Size (Percent Throughwall)*	Crack Depth at 18 Mos. (Percent Throughwall)	Allowed Initial Crack Size for 18 Mos. Cycle (Percent Throughwall)	Months to 50-Percent Throughwall	Months to 63-Percent Throughwall	Disposition
KR-1-37	35	42	55	37	68	Overlay
KR-1-34	8	23	46	55	69	Accept as is
KR-1-15	27	35	54	54	84	Overlay
KR-1-12	6	25	30	35	40	Accept as is
KR-1-3	43	-	-	10	23	Overlay
KR-1-24	25	36	51	46	68	Accept as is
GR-1-1	8	22	50	63	81	Accept as is
GR-1-2	15	29	50	52	70	Accept as is
GR-1-3	35	46	48	23	39	Overlay
KR-1-2	15	30	47	48	63	Accept as is
GR-1-58	45	-	-	8	26	Overlay
KR-1-48	30	41	50	34	52	Accept as is
GR-1-56	29	40	50	36	55	Accept as is
GR-1-64	33	42	51	33	54	Accept as is
KR-1-47	23	35	50	43	61	Accept as is
GR-1-27	37	46	52	26	48	Accept as is
GR-1-57	33	43	51	30	50	Accept as is
KR-1-45	23	38	41	32	43	Accept as is
GR-1-54	49	-	-	2	16	Overlay
KR-1-25	14	28	51	59	80	Accept as is
GR-1-60	36	46	50	24	43	Overlay
GR-1-61	30	40	51	37	59	Accept as is
KR-1-52	27	37	50	40	60	Accept as is

*Where these vary from the approximate percent in attachment 2, the percent is always greater and therefore the calculations are more conservative.

ATTACHMENT 2

KR-1-24	28" Pipe/Elbow	
	Elbow Side of Weld	
	@ 2:30 approx. 2" long	Approx. 10% thru wall
	@ 4:30 approx. 2" long	Approx. 17% thru wall
	@ 11:00 approx. 3" long	Approx. 25% thru wall
	@ 12:35 approx. 4" long	Approx. 8% thru wall
	Pipe Side of Weld	
	@ 4:30 approx. 3" long	Approx. 9% thru wall
KR-1-45	28" Pipe/Elbow	
	Indications 360° intermittent both sides of the weld	
		Approx. 23% thru wall
KR-1-47	28" Pipe/Elbow	
	Elbow Side of Weld	
	@ 5:00 to 8:00 approx. 21" long	Approx. 23% thru wall
	Pipe Side of Weld	
	@ 5:00 to 8:00 approx. 21" long	Approx. 20% thru wall
KR-1-48	28" Pipe/Elbow	
	Indications 360° intermittent both sides of the weld	
		Approx. 28% thru wall
KR-1-52	28" Pipe/Elbow	
	Elbow Side of Weld	
	Indications 360° intermittent	Approx. 27% thru wall
GR-1-27	28" Pipe/Pump Discharge Side	
	Pipe Side of Weld	
	@ 6:30 approx. 1" long	Approx. 36% thru wall max.
	@ 8:30 approx. 1" long	"
	@ 10:00 to 11:00 approx. 7" long	"
	@ 12:00 to 2:00 approx. 14" long	"
	@ 4:45 approx. 1" long	"
GR-1-56	28" Pipe/Valve	
	Elbow Side of Weld	
	@ 12:30 to 3:00 approx. 17-1/2" long	Approx. 29% thru wall
GR-1-57	28" Pipe/Valve	
	Pipe Side of Weld	
	Indications 360° intermittent	Approx. 32% thru wall
GR-1-61	28" Pipe/Pipe	
	Upstream Side of Weld	
	@ 5:30 approx. 5" long	Approx. 28% thru wall
	@ 8:00 approx. 12" long	Approx. 23% thru wall
	Downstream Side of Weld	
	@ 7:30 to 11:00 approx. 25" long	Approx. 30% thru wall

KR-1-12	22" Pipe/Cross	
	Pipe Side of Weld	
	@ 7:00 approx. 3" long	Approx. 6% thru wall
KR-1-34	22" Pipe/Cross	
	Pipe Side of Weld	
	@ 6:00 approx. 4" long	Approx. 8% thru wall
	@ 3:00 approx. 6" long	Approx. 6% thru wall
KR-1-37	22" End Cap	
	Cap Side of Weld	
	@ 11:30 to 3:00 approx. 19" long	Approx. 35% thru wall
	@ 7:00 to 8:30 approx. 9" long	Approx. 35% thru wall
KR-1-14	Sweepolet Weld	
	Saddle Side of Weld	
	@ 5:30 approx. 2" long	Approx. 10% thru wall
	@ 6:20 approx. 2" long	Approx. 10% thru wall
	Header Side of Weld	
	@ 11:20 approx. 9" long	Approx. 19% thru wall
KR-1-20	Sweepolet Weld	
	Header Side of Weld	
	@ 2:00 approx. 1" long	Approx. 29% thru wall
KR-1-36	Sweepolet Weld	
	Saddle Side of Weld	
	@ 12:00 to 3:00 approx. 18" long	Approx. 25% thru wall
	@ 8:00 to 9:00 approx. 6" long	Approx. 25% thru wall
KR-1-42	Sweepolet Weld	
	Header Side of Weld	
	@ 4:00 approx. 1" long	Approx. 38% thru wall
	@ 10:00 approx. 1" long	Approx. 20% thru wall
KR-1-16	12" Pipe/Elbow	
	Pipe Side of Weld	
	Indications 360° intermittent	Approx. 35% thru wall
KR-1-18	12" Pipe/Elbow	
	Pipe Side of Weld	
	Indications 360° intermittent	Approx. 35% thru wall
KR-1-21	12" Pipe/Elbow	
	Pipe Side of Weld	
	Indications 360° intermittent	Approx. 35% thru wall
KR-1-22	12" Pipe/Elbow	
	Pipe Side of Weld	
	Indications 360° intermittent	Approx. 35% thru wall
GR-1-41	12" Pipe/Tee	
	Pipe Side of Weld	
	@ 11:00 to 1:00 approx. 6" long	Approx. 12% thru wall
	@ 9:00 approx. 3" long	Approx. 8% thru wall

GR-1-64	28" Elbow/Pump Intake Side Elbow Side of Weld Indications 360° intermittent	Approx. 33% thru wall
GR-1-54	28" Pipe/Elbow Indications 360° intermittent both sides of the weld	Approx. 45% thru wall
GR-1-58	28" Elbow/Pump Intake Side Pipe Side of Weld Indications 360° intermittent	Approx. 45% thru wall
GR-1-1	28" Pipe/Pump Discharge Side Pipe Side of Weld @ 2:00 to 5:00 approx. 21" long @ 6:30 to 8:00 approx. 10-1/2" long @ 10:00 approx. 1" long	 Approx. 6% thru wall Approx. 8% thru wall Approx. 10% thru wall
GR-1-2	28" Pipe/Valve Pipe Side of Weld Indication 360° intermittent	Approx. 15% thru wall
GR-1-3	28" Pipe/Valve Pipe Side of Weld Indications 360° intermittent	Approx. 33% thru wall
KR-1-2	28" Pipe/Elbow Pipe Side of Weld @ 11:30 to 12:30 approx. 7" long @ 2:00 to 8:00 approx. 42" long Elbow Side of Weld @ 2:30 to 3:30 approx. 7" long	 Approx. 6% thru wall Approx. 15% thru wall Approx. 8% thru wall
KR-1-3	28" Pipe/Tee Pipe Side of Weld Indication 360° intermittent	Approx. 43% thru wall
GR-1-60	28" Pipe/Elbow Pipe Side of Weld @ 4:00 approx. 3" long Elbow Side of Weld @ 11:30 to 1:30 approx. 14" long @ 10:00 approx. 3" long	 Approx. 29% thru wall Approx. 18% thru wall Approx. 36% thru wall
KR-1-25	28 Pipe/Tee Pipe Side of Weld @ 8:00 to 3:00 approx. 49" long	 Approx. 14% thru wall
KR-1-15	22" End Cap Pipe Side of Weld @ 5:00 to 7:00 approx. 12" long Cap Side of Weld Indications 360° intermittent	 Approx. 14% thru wall Approx. 27% thru wall

GR-1-46	12" Pipe/Elbow	
	Pipe Side of Weld	
	Indications 360° intermittent	Approx. 20% thru wall
DSRHR 1-4	24" Pipe/Elbow	
	Elbow Side of Weld	
	@ 11:00 to 2:00 approx. 18" long	Approx. 30% thru wall
	@ 8:30 approx. 1" long	Less than 10% thru wall
DSRHR 1-4A	24" Elbow/Elbow	
	Upstream Side of Weld	
	Indication 360° intermittent	Approx. 44% thru wall
DRHR-1-4	24" Pipe/Elbow	
	Pipe Side of Weld	
	@ 7:00 approx. 1" long	Less than 10% thru wall
	@ 9:00 approx. 1" long	Less than 10% thru wall
	@ 10:30 approx. 1" long	Less than 10% thru wall
DSRHR-1-5	24" Pipe/Elbow	
	Elbow Side of Weld	
	@ 2:00 approx. 7" long	31% thru wall
	@ 8:00 to 12:00 approx. 25" long	31% thru wall
DSRHR-1-8B	24" Pipe/Elbow	
	Pipe Side of Weld	
	@ 12:00 to 3:00 approx. 20" long	Approx. 41% thru wall
	Elbow Side of Weld	
	@ 1:00 to 3:00 approx. 14" long	Approx. 31% thru wall
DRHR-1-8	24" Pipe/Valve	
	Pipe Side of Weld	
	@ 11:00 approx. 5" long	Approx. 25% thru wall
DSRHR-1-9	20" Pipe/Elbow	
	Elbow Side of Weld	
	@ 7:00 to 11:00 approx. 28" long	Approx. 29% thru wall
DSRHR-1-10	20" Pipe/Elbow	
	Pipe Side of Weld	
	@ 12:00 approx. 3" long	Approx. 30% thru wall
	@ 10:30 approx. 3" long	Approx. 12% thru wall
	Elbow Side of Weld	
	@ 12:00 approx. 6" long	Approx. 23% thru wall
DSRHR-1-11	20" Pipe/Elbow	
	Elbow Side of Weld	
	@ 6:00 to 9:00 approx. 19" long	Approx. 24% thru wall
DRHR-1-15	24" Pipe/Valve	
	Pipe Side of Weld	
	@ 6:00 approx. 8" long	Approx. 30% thru wall
DRHR-1-17	24" Pipe/Valve	
	Pipe Side of Weld	
	Indications 360° intermittent	Approx. 31% thru wall

DRHR-1-18	24" Pipe/Tee	
	Pipe Side of Weld	
	@ 12:00 to 3:00 approx. 20" long	Approx. 16% thru wall
	@ 7:00 approx. 4" long	Approx. 20% thru wall
DRHR-1-20	20" Elbow/Valve	
	Elbow Side of Weld	
	Indications 360° intermittent	Approx. 43% thru wall
DRHR-1-5	24" Elbow/Valve	
	Elbow Side of Weld	
	Indication 360° intermittent	Approx. 36% thru wall