



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

TERA

MAR 7 1980

MEMORANDUM FOR: D. G. Eisenhut, Acting Director  
Division of Operating Reactors

FROM: L. C. Shao, Chairman  
PWR Pipe Crack Study Group

SUBJECT: SUMMARY OF MEETING OF THE PWR PIPE  
CRACK STUDY GROUP ON FEBRUARY 5, 1980

The PWR Pipe Crack Study Group met on February 5, 1980 to discuss the progress and schedule of the study group effort. The meeting agenda is enclosed and a summary of the major areas is provided below.

The first area discussed by the group was the collection of foreign experience data. Lawrence Livermore Laboratories (LLL) has been contracted to assist the study group in obtaining and assembling foreign experience data. The initial effort in obtaining this information will be by a combination of questionnaire and telephone calls.

The second area discussed by the group was the progress of each of the subtask efforts, see attached agenda. Tables listing all of the domestic PWR pipe cracking experience were provided by subtask group 1. These tables will be integrated with a table of vital systems, developed by subtask group 2, to establish a priority for evaluating the safety consequences of cracking in PWR plants.

Significant discussion was generated in the meeting about whether to include water hammer loads in the mechanistic evaluation of cracking. Concerns about including water hammer loads arose from the fact that these loads are difficult to quantify and that currently a staff program (task A-1) studying these loads is in progress. A decision was made by the group to include these loads, if definable, in the mechanistic evaluation of systems where historically these loads have occurred. If necessary additional work in the area will be recommended for the long term program.

The remaining subtask, groups reported that their efforts were progressing within the target schedules and that no major problems have been encountered.

The next PCSG meeting to review progress of the subtasks efforts is scheduled for March 5, 1980.

A handwritten signature in cursive script, appearing to read "L C Shao".

Larry C. Shao, Chairman  
PWR Pipe Crack Study Group

cc: See attached list

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AGENDA

- I. Introduction
- II. Foreign Experience Review Status
- III. Sub-Task Group Status
  - Sub-Task 1 - Defining the Cracking Mechanism - W. Hazelton
  - Sub-Task 2 - Significance of Cracking - V. Panciera
  - Sub-Task 3 - Determination Cause of Cracking - R. Gamble
  - Sub-Task 4 - ISI and Leak Detection - C. Cheng
  - Sub-Task 5 - Review ongoing Programs and Recommended  
New Programs - J. Muscara
  - Sub-Task 6 - Report Organization - S. Bush
- IV. Technical Discussion
- V. Summary











SUMMARY OF PWR PIPE CRACKING

EXCLUDING S.G. FEEDWATER NOZZLE CRACKS

PLANT	SYSTEM	NO. LERS	PIPE SIZE 4"	DESCRIPTION	PROBABLE CAUSE
Arkansas 1	Containment Spray Liquid Rad Waste RHR Spent Fuel Pool	2	YES	Weld HAZ	IGSCC
		3	YES	Weld HAZ	Undetermined
		3	NO	Weld Near Pump or Valve	Vibration
		1	NO	Weld	Undetermined
Arkansas 2	CVCS Coolant Recirc. ECCS	1	NO	Weld Near Pump	Vibration
		1	NO	T or Nipple Weld	Vibration
		1	NO	Vent or Drain Line Weld	Vibration
Beaver Valley 1	ECCS	1	NO	Vent or Drain Line Weld	Vibration
Crystal River 3	Containment Spray	1	YES	Weld HAZ	IGSCC
Calvert Cliffs 1	CVCS Reactor Coolant Cleanup	4	NO	Welds Near Pumps	Vibration
		3	NO	Welds Near Pumps	Vibration
Calvert Cliffs 2	CVCS Coolant Recirc. ECCS Reactor Coolant Cleanup	5	NO	Welds Near Pumps	Vibration
		3	NO	Small T and Nipple Welds	Vibration
		1	NO	Vent or Drain Line Weld	Vibration
		3	NO	Welds Near Pumps	Vibration
D. C. Cook	RHR	2	NO YES	Welds Near Pumps Or Valves	Vibration
Farley 1	ECCS	1	NO	Weld in Vent or Drain Line	vibration
Ft. Calhoun 1	CVCS Coolant Recirc.	2	NO	Welds Near Pumps	Vibration
		1	NO	Small T and Nipple Welds	Vibration
Haddam Neck	CVCS	2	NO	Welds Near Pumps	Vibration
H. B. Robinson 2	Boron Injection	1	YES	Weld HAZ	Undetermined
Indian Point 1	Coolant Recirc.	1	NO	Small T and Nipple welds	Vibration
Indian Point 2	CVCS RHR Cont. Heat Removal	3	NO	Welds Near Pumps	Vibration
		3	NO	Welds Near Pumps or Valves	Vibration
		1	NO	Weld Near Pump	Vibration
Indian Point 3	Chem Volume Control CVCS	1	YES	Weld	Undetermined
		3	NO	Weld Near Pump	Vibration
Newsum 1	CVCS Reactor Coolant Cleanup	2	NO	Welds Near Pumps	Vibration
		1	NO	Welds Near Pumps	Vibration
Millstone 2	Liquid Rad Waste ECCS	1	YES	Weld	IGSCC
		1	NO	Vent or Drain Line Weld	Vibration
North Anna 1	CVCS Mainsteam Supply	1	NO	Weld Near Pump	Vibration
		1	NO	Instrument Line Weld	Unidentified
Oconee 2	ECCS	1	NO	Vent or Drain Line Weld	Vibration
Oconee 3	Reactor Core Isolation Cooling	1	NO	Sample Line Weld	Vibration
Palladas 1	CVCS Coolant Recirc.	1	NO	Weld Near Pump	Vibration
		2	NO	Small T or Nipple Weld	Vibration
Prairie Island 1	RHR	1	NO	Weld Near Pump or Valve	Vibration
Point Beach 1	Coolant Recirc.	1	NO	Small T or Nipple weld	Vibration
Point Beach 2	CVCS	1	NO	Weld Near Pump	Vibration
R.E. Ginna 1	Safety Injection CVCS	1	YES	Weld	IGSCC
		3	NO	Welds Near Pumps	Vibration
Salem 1	Coolant Recirc. CVCS	1	NO	Small T or Nipple Welds	Vibration
		1	NO	Weld Near Pump	Vibration
San Onofre 1	Containment Spray Coolant Recirc.	1	YES	Weld HAZ	IGSCC
		1	NO	Small T or Nipple Weld	Vibration
Surry 1	CVCS	1	NO	Weld Near Pumps	Vibration

BASED ON LER'S THROUGH SEPT. '79

POOR ORIGINAL



## SUMMARY OF PWR PIPE CRACKING

EXCLUDING S.G. FEEDWATER NOZZLE CRACKS

PLANT	SYSTEM	NO. LERS	PIPE SIZE 4"	DESCRIPTION	PROBABLE CAUSE
Surry 2	Containment Spray	1	YES	Weld HAZ	IGSCC
Three Mile Island 1	RHR	1	NO	Weld Near Pump or Valve	Vibration
	Condensate F.W.	1	NO	Socket Weld	Vibration
	Coolant Recirc.	1	NO	Small T or Nipple Weld	Vibration
	Containment Spray	1	YES	Weld HAZ	IGSCC
	Spent Fuel Pool	1	NO	Weld HAZ	IGSCC
Three Mile Island 2	RHR	1	NO	Weld Near Pump or Valve	Vibration
Trojan 1	Reactor Coolant Cleanup	2	NO	Welds Near Pumps	Vibration
Turkey Pt. 3	CVCS	1	NO	Weld Near Pump	Vibration
	Other Eng. Safety Feat.	1	NO	Drainline Weld	Vibration
Turkey Pt. 4	CVCS	3	NO	Weld Near Pump	Vibration
Yankee Rowe	CVCS	4	NO	Weld Near Pump	Vibration
	Reactor Coolant Cleanup	1	NO	Weld Near Pump	Vibration
Zion 1	CVCS	1	NO	Weld Near Pump	Vibration
Zion 2	CVCS	1	NO	Weld Near Pump	Vibration

BASED ON LER'S THROUGH SEPT. '79

SYSTEM SUMMARY  
SMALL (<4") PWR PIPE CRACKS

LERs THROUGH 9/79

SYSTEM	PLANTS	LER CITATIONS	LEAKAGE	CRACK LOCATION	PROBABLE CAUSE
CVCS	Arkansas #2	1	YES	MOST CRACKS IN WELDS LOCATED NEAR PUMPS	FATIGUE CAUSED BY VIBRATION
	Calvert Cliffs #1	4	YES		
	Calvert Cliffs #2	5	YES		
	Haddam Neck	2	YES		
	Ft. Calhoun #1	2	YES		
	Ind. Pt. #2	3	YES		
	Ind. Pt. #3	1	YES		
	Kewaunee #1	2	YES		
	No. Anna #1	1	YES		
	Palisades #1	1	YES		
	Pt. Beach #2	1	YES		
	R. E. Ginna #1	3	YES		
	Salem #1	1	YES		
	Surry #1	1	YES		
	Turkey Pt. #3	1	YES		
	Turkey Pt. #4	3	YES		
Yankee Rowe	4	YES			
Zion #1	1	YES			
Zion #2	1	YES			
COOLANT RECIRC.	Arkansas #2	1	YES	IN WELDS AT SMALL "T's" AND NIPPLES ETC.	VIBRATION
	Calvert Cliffs #2	3	YES		
	Ft. Calhoun #1	1	YES		
	Palisades #1	2	YES		
	Pt. Beach #2	1	YES		
	Salem #1	1	YES		
	TMI #1	1	YES		
	Indian Pt. #1	1	YES		
San Onofre #1	1	YES			
RHR	Arkansas #1	3	YES	MOST CRACKS IN WELDS NEAR PUMPS OR VALVES	VIBRATION
	D.C. Cook #1	2	YES		
	Ind. Pt. #2	3	YES		
	Prairie Is. #1	1	YES		
	TMI #2	1	YES		
TMI #1	1	YES			
REACTOR COOLANT CLEAN-UP	Cal. Cliffs #1	3	YES	MOST CRACKS IN WELDS IN LINES LOCATED NEAR PUMPS	FATIGUE CAUSED BY VIBRATION
	Cal. Cliffs #2	3	YES		
	Kewaunee #1	1	YES		
	Trojan #1	1	YES		
	Yankee Rowe	1	YES		
Trojan #1	1	YES			
ECCS	Arkansas #2	1	YES	MOST CRACKS IN WELDS OF VENT OR DRAIN LINES	VIBRATION
	Beaver Valley #1	1	YES		
	Cal. Cliffs #2	1	YES		
	Farley #1	1	YES		
	Millstone #2	1	YES		
Oconee #2	1	YES			
MAIN STEAM SUPPLY	No. Anna #1	1	YES	CRACKS IN WELD IN INSTRUMENT LINES	NOT DETERMINED
CONDENSATE FEEDWATER	TMI #1	1	YES	CRACK IN SOCKET WELD	VIBRATION

SYSTEM SUMMARY  
SMALL (<4") PWR PIPE CRACKS

LERs THROUGH 9/79

SYSTEM	PLANTS	LER CITATIONS	LEAKAGE	CRACK LOCATION	PROBABLE CAUSE
OTHER ENG'D SAFETY FEATURES	TURKEY PT. #3	1	YES	CRACK IN DRAIN LINE WELD	VIBRATION
REACTOR CORE ISOLATION COOLING	Oconee #3	1	YES	CRACK IN WELD IN SAMPLE LINE	VIBRATION
SPENT FUEL POOL	Arkansas #1	2	YES	IN WELDS	NOT DETERMINED IGSCC
	TMI #1	1	YES	HAZ	
CONTAINMENT HEAT REMOVAL	Indian Pt. #2	1	YES	VENT TO PUMP WELD	VIBRATION

SUMMARY OF BWR SAFE-END AND PIPE CRACKING

PLANT	SYSTEM	NO. LERS	PIPE SIZE	MATERIAL	DETECTION METHOD	DESCRIPTION
BIG ROCK POINT	EMERGENCY CONDENSER	1	6"	UT	VISUAL AND RT	INLET PIPE
BRUNSWICK 2	RECIRC BY-PASS	1	4"	304	UT	WELD HAZ
	RHR	2	20"	CARBON STEEL	VISUAL	SUCTION PIPE WELD HAZ
	ECCS	1	10"	304	UT	WELDED ELBOW
	CONTAINMENT INERTING LINE	1	-	-	LEAK	-
COOPER 1	RECIRCULATION	1	4"	304	PT	RECIRCULATION RISER
	RECIRC SAFE-END	1	10"	304	PT	O.D. INDICATIONS IN NOZZLE SE
	SAFE-END TO RPY	1	2"	304	VISUAL	INSTRUMENT LINE SE
DRESDEN 1	RECIRC BY-PASS	9	4" & 6"	304	VISUAL, PT, RT, UT	-
	REACTOR WATER CLEANUP	5	4" & 6"	304	VISUAL, LEAK, UT, PT	-
	DEMINEALIZER SUPPLY	1	4"	304	UT	-
	REACTOR CORE ISOLATION COOLING	1	8"	304	HYDR	-
DRESDEN 2	RECIRC BY-PASS	2	4"	304	LEAK	WELD
	ECCS	1	10"	304	LEAK, PT, UT	-
	CORE SPRAY SAFE END	1	10"	304	LEAK	IGSCC
	REACTOR CORE ISOLATION COOLING SAFE-END	1	14"	304	ISI	FURNACE SENSITIZED
	REACTOR CORE ISOLATION COOLING SAFE-END	1	14"	-	UT	FURNACE SENSITIZED
	CRD RETURN SAFE-END	1	-	-	UT	FURNACE SENSITIZED
DRESDEN 3	FEEDWATER	3	6"	-	LEAK	-
	CRD RETURN SAFE-END	1	-	304	UT	-
DUANE ARNOLD	RECIRC BY-PASS	1	4"	304	UT	WELD
	REACTOR WATER CLEAN-UP	1	4"	304	VISUAL, UT	WELD HAZ
	SAFE-END AT RPY	1	10"	INCOYEL	VISUAL, UT, RT	B NOZZLE TO SAFE-END CRACK CREVICE IGSCC
E1 HATCH 1	RECIRC BY-PASS	1	4"	304	UT AND RT	-
	RHR	1	20"	INCOYEL	PT	-
FitzPATRICK 1	RHR	1	4"	-	VISUAL	WELD HAZ
LA CROSSE	FEEDWATER NOZZLE SAFE-END	1	4"	304	LEAK AND VISUAL	IGSCC
MILLSTONE 1	RECIRC BY-PASS	2	2" & 4"	304	VISUAL AND UT	-
	RHR	1	6" to 2"	304	LEAK TEST	-
	REACTOR WATER CLEAN-UP	1	JOISTS	304	UT AND LEAK	WELD HAZ
MONTICELLO	RECIRC BY-PASS	1	4"	304	UT	PIPE ELBOW
NINE MILE POINT	ECCS	1	6"	304	UT	SAFE-END TO PIPE IGSCC
	ECCS	1	6"	304	VISUAL	CIRCUMFERENTIAL IGSCC
	REACTOR WATER CLEAN-UP	2	4" & 6"	304	VISUAL	HEAT EXH LINE & PIPE BEND
	REACTOR CORE ISOLATION COOLING	1	6"	304	PT	PIPE BEND TO SAFE-END
OYSTER CREEK 1	CRD RETURN	1	3"	316	HYDR	STUB TUBE
	CORE SPRAY	1	-	-	VISUAL	SPARGER
	CRD	1	-	304	LEAK	STUB TUBE
	SAFE-END AT RPY	1	-	304	PT	IGSCC FURNACE SENSITIZED
PEACH BOTTOM 2	ECCS	1	12" to 10" Red	CARBON STEEL	UT	ELBOW IN SPRAY PIPE
PEACH BOTTOM 3	RECIRC BY-PASS	2	4"	304	UT, PT, AND RT	-
	ECCS	2	12" to 10" Red	CARBON STEEL	UT, RT	WELD HAZ
PILGRIM 1	REACTOR WATER CLEAN-UP	1	6"	304	VISUAL	WELD
QUAD CITIES 1	RECIRC BY-PASS	2	4"	304	VISUAL, UT	-
QUAD CITIES 2	RECIRC BY-PASS	2	4"	304	UT	WELD
	REACTOR WATER CLEAN-UP	1	4"	304	VISUAL	WELD
VERMONT YANKEE 1	ECCS	1	8"	304	RT	9 FLAWS IN A AND B LOOPS

BASED ON LERS THROUGH SEPT '79

POOR ORIGINAL

Table 1 - Summary of PWR Feedwater Piping Cracks

PLANT	EXTENT OF CRACKING (NOZZLE VICINITY)			PIPING COMPONENT	PROBABLE CAUSE	COMMENTS
	Max. Depth	Location max. Depth Crack	No. of Lines Cracked			
<u>Westinghouse</u>						
D. C. Cook 1/2	Thru wall	TOP	8 of 8	elbow	Corrosion Assisted Fatigue	2 cracks thru wall
Beaver Valley	0.400"	9 O'clock	3 of 3	elbow	Corrosion Assisted Fatigue	13 additional fab. related indications repaired
Kewaunee	0.050"	7 O'clock	2 of 2	pipe	Corrosion Assisted Fatigue	3" dia. aux. feed near SG inlet
Pt. Beach 1/2	0.047"	3 O'clock	2 of 2	reducer	Corrosion Assisted Fatigue	3" dia. aux. feed near SG inlet
H.B. Robinson 2	0.750"	9 O'clock	3 of 3	reducer	Corrosion Assisted Fatigue	Shallow cracking in nozzle under thermal sleeve
Salem 1	0.235"		4 of 4	elbow reducer	Corrosion Assisted Fatigue	
San Onofre 1	0.100"	lower half of reducer	3 of 3	reducer	Stress Assisted Corrosion	Multiple branched cracks evidence of some fatigue
Surry 1/2	0.080"	2 and 5 O'clock	6 of 6	reducer	Corrosion Assisted Fatigue	
Ginna	0.107"	8:30 O'clock	2 of 2	elbow	Stress Assisted Corrosion/Corrosion Fatigue	Cracks also at deep machining marks
Zion 1/2	0.088"	4 O'clock	8 of 8	elbow pipe	Corrosion Assisted Fatigue	



Table 1 - Summary of PWR Feedwater Piping Cracks

<u>PLANT</u>	<u>EXTENT OF CRACKING (NOZZLE VICINITY)</u>		<u>PIPING COMPONENT</u>	<u>PROBABLE CAUSE</u>	<u>COMMENTS</u>
	<u>Max. Depth</u>	<u>Location max. Depth Crack</u> <u>No. of Lines Cracked</u>			
<u>Combustion Engineering</u>					
Millstone 2	0.250"	12 O'clock    2 of 2	pipe	Not analyzed	
Palladas	0.170"	3 and 9 O'clock    2 of 2	pipe	Corrosion Assisted Fatigue	Cracks found also at weld vicinity of horizontal piping

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