July 26, 1985

Docket No. 50-265

LICENSEE: Commonwealth Edison Company

FACILITY: Quad Cities Nuclear Power Station, Unit 2

SUBJECT: SUMMARY OF MEETING WITH COMMONWEALTH EDISON COMPANY REGARDING ITS PROPOSED LONG-TERM RESOLUTION OF INTERGRANULAR STRESS CORROSION CRACKING (IGSCC) CONCERNS FOR QUAD CITIES UNIT 2

The NRC staff met with Commonwealth Edison Company (CECo) on July 23, 1985 to hear and discuss its proposal for long-term resolution of IGSCC concerns for Quad Cities Unit 2. Enclosure 1 is a list of attendees. Enclosure 2 is selected handout material used in CECo's presentation.

CECo proposed a detailed integrated program as an alternative to complete replacement of IGSCC-susceptible pipe. The program included augmenting the existing weld overlays to "full structural" condition, applying full structural weld overlays or "pipe-lock" (if appropriate) to future flaws not currently overlaid, stress improvement (IHSI) of all accessible welds not already treated with IHSI, implementing hydrogen water chemistry, and doing some spool-piece pipe replacement where appropriate. More extensive ultrasonic (UT) examination would be employed, utilizing EPRI-developed and automated techniques to enhance flaw detection capabilities. In summary, CECo presented a table of IGSCC-susceptible weld profiles projected after implementation of the integrated program, and a comparison of total pipe replacement cost with cost of the integrated program for all IGSCC-susceptible welds.

The proposed program elicited discussion between NRC and licensee participants regarding staff concerns related to technical, regulatory and other aspects of the proposed program. As a result of the meeting, CECo apparently intends to proceed in measured steps and with due regard to NRC staff comments and admonitions.

RBBevan

Roby B. Bevan, Project Manager
Operating Reactors Branch #2
Division of Licensing

Enclosures:
As stated

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ENCLOSURE 1

ATTENDANCE LIST FOR JULY 23, 1985 MEETING
WITH COMMONWEALTH EDISON COMPANY ON

QUAD CITIES, UNIT 2 PIPE REPLACEMENT

Name	Affiliation
R. Bevan	NRR/DL/ORB#2
C. Reed	CECo, VP Nuclear Operations
D. Farrar	CECo, Nuclear Licensing
B. Rybak	CECo, Nuclear Licensing
E. Zebus	CECo, Recirc Pipe Replacement
W. Johnston	NRR/DE
B. D. Liaw	NRR/DE/MTEB
R. M. Bernero	NRR/DSI
J. A. Zwolinski	NRR/DL/ORB#5
W. J. Collins	IE/DEPER
W. Hazelton	NRR/DE/MTEB
A. W. Dromerick	IE/DEPER
J. Wojnarowski	CECo, Nuclear Licensing
J. C. Renwick	CECo, Recirc Pipe Replacement
S. W. Swartz	Illinois Dept. of Nuclear Safety
J. Gavula	IMPELL
J. Famiglietti	IMPELL
J. S. Abel	CECo, Station Nuclear Engr. Dept.
R. J. Tamminga	CECo, Maint. Staff
W. W. Witt	CECo, Corp. Lev. III
D. Pitcairn	NUTECH
R. H. Buchholz	NUTECH
R. Vollmer	IE

ENCLOSURE 2

COMMONWEALTH EDISON COMPANY

QUAD CITIES NUCLEAR POWER PLANT - UNIT 2

LONG-TERM RESOLUTION OF IGSCC CONCERNS

JULY 23, 1985
BETHESDA, MD

MEETING OBJECTIVES

INFORM NRC OF INTEGRATED PROGRAM PROPOSED FOR LONG-TERM IGSCC RESOLUTION AT QUAD CITIES UNIT 2

- UPDATE NRC ON RECENT INSPECTION RESULTS AND TECHNICAL DEVELOPMENTS

- PROVIDE BASIS FOR CONSIDERING AN ALTERNATE TO COMPLETE SYSTEM REPLACEMENT

- PRESENT PROPOSED INTEGRATED PROGRAM

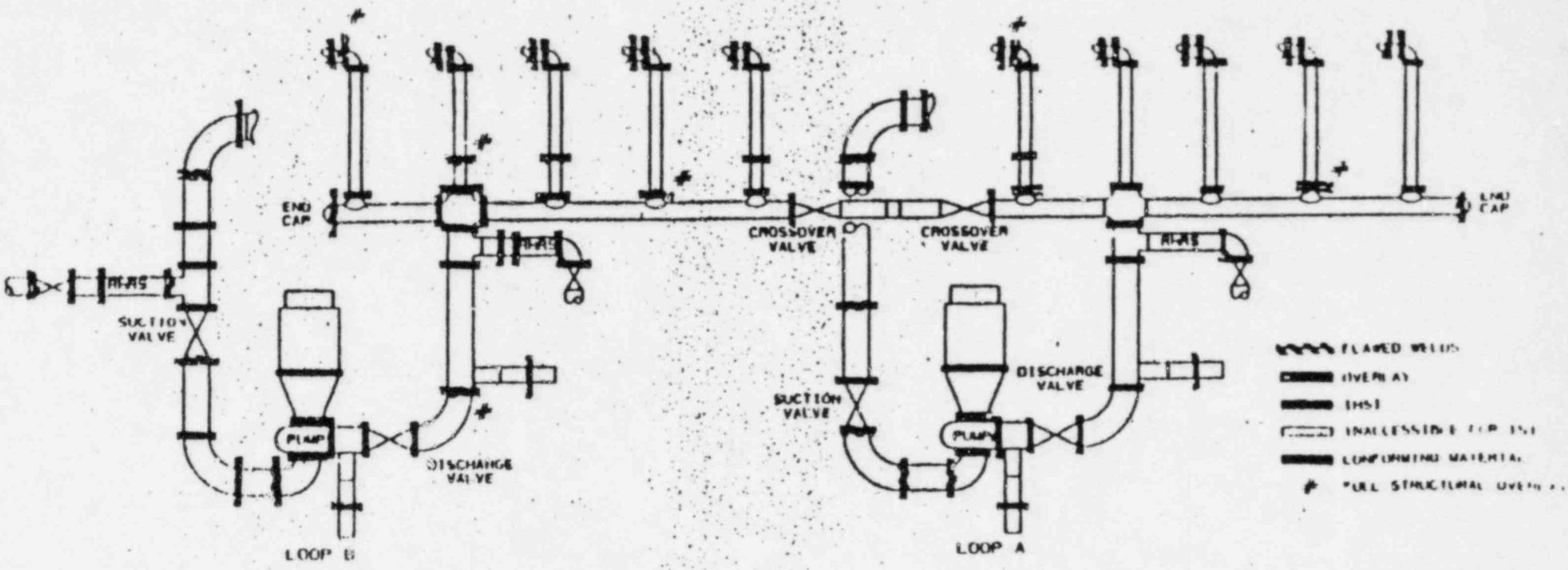
OBTAIN INITIAL NRC REACTION TO PROPOSED PLAN AND IDENTIFY ANY AREA WHERE ADDITIONAL DISCUSSION SHOULD TAKE PLACE.

MEETING AGENDA

RYBAK	o	INTRODUCTION
	o	RECENT INSPECTION/DEVELOPMENT UPDATE
RYBAK	-	UNIT 2 ISI INSPECTION RESULTS
NUTECH (PITCAIRN)	-	OVERLAY EFFECTIVENESS EVALUATIONS
EPRI (JONES)	-	HYDROGEN WATER CHEMISTRY RESULTS
EPRI (JONES)	-	OVERLAY UT INSPECTION TECHNIQUES
ZEBUS	o	PROPOSED PROGRAM FOR LONG-TERM RESOLUTION
	-	PROGRAM DESCRIPTION
	-	COST-BENEFIT SUMMARY
ALL	o	GENERAL DISCUSSION
RYBAK	o	MEETING SUMMARY

there are No inaccessible welds in the Recirc system ?

QUAD CITIES UNIT 2
RECIRCULATION SYSTEM
CURRENT PLANT STATUS



UNIT 2 IGSCC-RELATED ISI INSPECTION RESULTS
(CONTINUED)

SUMMARY CONCLUSIONS

- PERFORMED 100% INSPECTION IN 1983
- APPROXIMATELY 25% INSPECTED IN 1985 AND RESULTS INDICATE NO ADDITIONAL IGSCC
- IGSCC SITUATION HAS STABILIZED AT QUAD CITIES UNIT 2
  (despite apparent change due to change in identifying and reporting)
- <10% IGSCC FLAWED WELDS IN QUAD CITIES UNIT 2

Dave Pelcain

OVERLAY EFFECTIVENESS EVALUATIONS

NUTECH OVERLAY DESIGN BASIS

- WELD OVERLAY DESIGNED TO PROVIDE AT LEAST FULL IWB-3640 MARGINS.

- MATERIAL IS PROVEN TO ARREST IGSCC PROPAGATION.

- DEMONSTRATED BENEFICIAL RESIDUAL STRESSES FROM WELD OVERLAY PROCESS. ARRESTS IGSCC PROPAGATION BEFORE FLAW REACHES DEPOSITED MATERIAL.

- ACTUAL SHRINKAGES MEASURED AND ANALYZED FOR EFFECT ON PIPING SYSTEM AND UNREPAIRED FLAWED WELDS.

- CONSERVATIVE ANALYSES PERFORMED TO ADDRESS LOW FRACTURE TOUGHNESS WELD METAL ISSUE OF EXISTING WELD OVERLAYS.

NUTECH WELD OVERLAY PROCESS SPECIFICATION

- USE OF CONTROLLED WELD METAL
  - CONTROLLED DELTA FERRITE (>7.5 FN) - MEASURED IN FIRST LAYER
  - LOW CARBON GRADES OF TYPE 308 OR 308L
- AUTOMATIC GTAW PROCESS USED
- TIGHTLY CONTROLLED WELDING PARAMETERS ASSURE HEAT INPUT NECESSARY TO ACHIEVE RESIDUAL STRESS IMPROVEMENT
- OTHER CONTROLS ON WELDER QUALIFICATION, SIZE AND SHRINKAGE MEASUREMENTS, EXAMINATION AND IN-PROCESS INSPECTIONS
- CONTROLS RESULT IN ASSURANCE THAT DESIGN BASIS IS MET

LABORATORY AND IN-PLANT VERIFICATION

- BENEFICIAL RESIDUAL STRESS IMPROVEMENT DEMONSTRATED IN GEORGIA POWER / NRC / NUTECH TESTS ON 12-INCH PIPE
  - CONFIRMS ANALYTICALLY PREDICTED RESIDUAL STRESS IMPROVEMENT
  - BENEFITS DUE TO WELD METAL SHRINKAGE AND "IHSI EFFECT" FROM WELDING HEAT
- EPRI SPONSORED PROGRAMS AT NDE CENTER IN 1983/1984 ON LARGE DIAMETER PIPE VERIFY ANALYSES USING WELDS II PROGRAM
- TESTS ON 28-INCH PIPE BY GEORGIA POWER SHOW SAME EFFECT AND ABILITY OF WELD OVERLAY TO ARREST EVEN DEEP CRACKING DUE TO RESIDUAL STRESS EFFECT
- FULL-SCALE EPRI PIPE TESTS AT GE AND BATELLE-NORTHWEST DEMONSTRATE THE EFFECTIVENSS OF THE WELD OVERLAY AS A LONG-TERM REPAIRS FOR IGSCC
  - CURRENTLY INDICATE LIFE OF AT LEAST 5 FUEL CYCLES WITH EXPERIEMENT PROGRESSING
  - ANTICIPATE CONFIRMATION OF AT LEAST 15 FUEL CYCLES BY MID-1986

(next page is discussion, ~~Ewald~~ describes further the lab & inplant verification - accelerated tests.

HYDROGEN WATER CHEMISTRY UPDATE (7/85)

- VERIFICATION PROGRAM AT DRESDEN-2
  - CYCLE 9 EXAMINATION RESULTS INDICATE NO FUEL PERFORMANCE PROBLEMS AFTER ONE HWC CYCLE
  - HYDROGEN INJECTION AND WATER CHEMISTRY CONTROL CONTINUED INTO CYCLE 10
  - UPGRADED INJECTION SYSTEM PERFORMING WELL AND WATER QUALITY CONTINUES EXCELLENT

  OPERATING IN IGSCC-IMMUNITY REGIME CLOSE TO 100% OF TIME AT POWER

- SHORT-TERM INJECTION TESTS AT OTHER PLANTS
  - PEACH BOTTOM 3
  - PILGRIM
  - SEVERAL SWEDISH PLANTS

  ALL PLANTS TESTED HAVE ACHIEVED IGSCC-IMMUNE CONDITIONS DURING POWER OPERATION

- HWC IS PRACTICAL MEANS TO MITIGATE IGSCC, and any BWR can get into area where H_2 water chem can protect SS, carbon steel, inconel,

OVERLAY INSPECTION PROGRAM UPDATE

PROGRAM OBJECTIVE

DEVELOP A TECHNICAL BASIS FOR NDE OF WELD OVERLAY REPAIRED JOINTS

APPROACH

DEMONSTRATE NDE TECHNIQUES CAPABLE OF PROVIDING DETAILED AND ACCURATE INFORMATION TO SUPPORT ANALYSIS OF WELD OVERLAY REPAIRED JOINTS FOR LONG TERM SERVICE

EXAMINATION OBJECTIVES

- DETERMINE WHETHER THE OVERLAY IS FREE OF UNACCEPTABLE FABRICATION FLAWS TO JUSTIFY STRUCTURAL CREDIT FOR STRENGTH OF OVERLAY METAL
- MONITOR AT LEAST THE UPPER PORTIONS OF THE ORIGINAL PIPE WALL AND OVERLAY METAL
- CHARACTERIZE REMAINING, SOUND PORTION OF PIPE WALL IN DETAIL SUFFICIENT TO SUPPORT ANALYSIS OF LONG TERM OPERATION OF THE JOINT

MANUAL UT RESULTS

- DETECTION, LENGTH, AND DEPTH MEASUREMENT CAPABILITIES ARE DEMONSTRATED FOR DEEP CRACKS, USING MANY DIFFERENT INSTRUMENTS AND TRANSDUCERS
- DETECTION OF SHALLOW, TIGHT CRACKS IS DIFFICULT

AUTOMATED UT RESULTS

- DETECTION, LENGTH, AND DEPTH MEASUREMENT CAPABILITIES ARE DEMONSTRATED FOR DEEP CRACKS, USING TWO DIFFERENT SYSTEMS AND VARIOUS TRANSDUCERS
- EXCELLENT POTENTIAL FOR MONITORING CRACKS
- DETECTION OF SHALLOW CRACKS NOT RELIABLE

SURFACE CONDITION

- SOME DEGREE OF SURFACE SMOOTHING IS REQUIRED FOR ANGLE BEAM EXAMINATION
- EXTREME SMOOTHING PROVIDES LIMITED BENEFIT
- IF NECESSARY, NORMAL BEAM EXAMINATIONS COULD BE PERFORMED ON THE UNPREPARED SURFACE

CONCLUSIONS

- CRACKS REACHING TO WITHIN THE UPPER 25 PERCENT OF THE ORIGINAL PIPE WALL, AND POSSIBLY SHALLOWER CRACKS ALSO, CAN BE EFFECTIVELY DETECTED AND SIZED

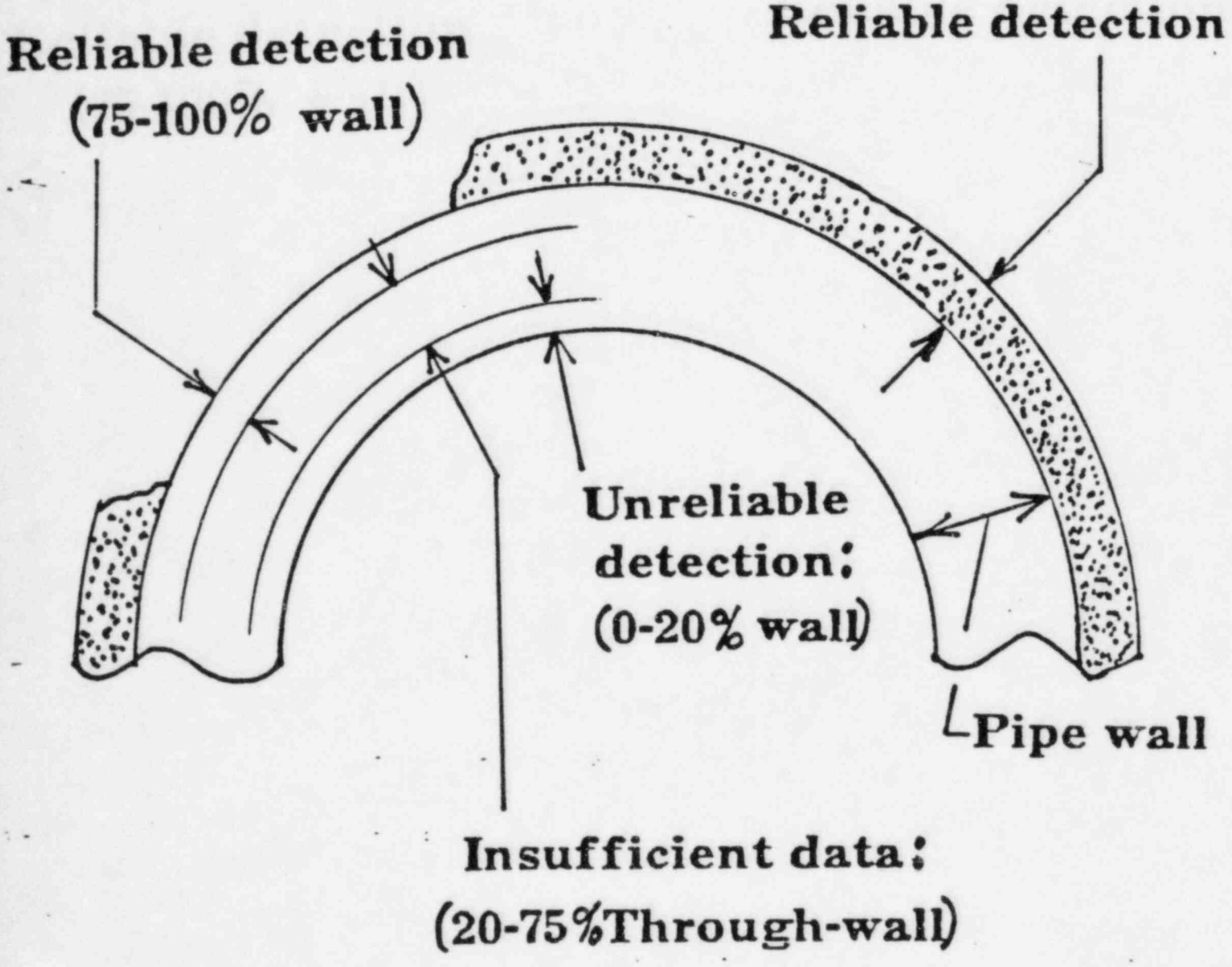
- DETECTION OF SHALLOW, TIGHT CRACKS IS PRESENTLY DIFFICULT

- CODE-UNACCEPTABLE OVERLAY FLAWS AND CRACKS PENETRATING INTO THE OVERLAY ARE GENERALLY DETECTABLE

- SURFACE PREPARATION IS REQUIRED FOR EFFECTIVE ANGLE-BEAM EXAMINATION FOR MOST FLAWS OF CONCERN

WELD OVERLAY INSPECTION

(Actual IGSCC)



GJD:7/85

SUMMARY
IGSCC DECISION ANALYSIS
(RECIRCULATION SYSTEM ONLY)

ALL COSTS ARE "PRESENT VALUED" IN 1985 DOLLARS (MILLIONS)

			QUAD CITIES 2 1986-87	
			CPDS	$
1.	RUN-AS-IS (OVERLAY)	MOST CRACKS	34	16
	+ HWC	FEWEST CRACKS	28	15
2.	TOTAL REPLACEMENT	LONGEST OUTAGE	120	88
		SHORTEST OUTAGE	69	66
3.	CBI PARTIAL REPLACEMENT NOW (INCLUDING SAFE-ENDS). SPOOL PIECE LATER	LONGEST OUTAGE, MOST CRACKS	231	103
		SHORTEST OUTAGE, FEWEST CRACKS	75	57
4.	CBI PARTIAL REPLACEMENT NOW (INCLUDING SAFE-ENDS). PIPELOCK LATER	LONGEST OUTAGE, MOST CRACKS	108	74
		SHORTEST OUTAGE, FEWEST CRACKS	48	50

• CPD - CRITICAL PATH DAY

INTEGRATED PROGRAM DESCRIPTION

OVERVIEW

- o BASE RESOLUTION ON WELD/SYSTEM SPECIFIC APPLICATION OF ALL AVAILABLE REMEDY TECHNIQUES, INCLUDING
  - MATERIALS REPLACEMENT
  - RESIDUAL STRESS IMPROVEMENT
  - WATER CHEMISTRY CONTROL
- o IMPLEMENT AN ISI PROGRAM ON A WELD SPECIFIC BASIS DEPENDENT ON REMEDIES APPLIED. THUS, PROVIDES A UNIFORMLY HIGH LEVEL OF ASSURANCE FOR EVERY WELD.
- o INTEGRATED PROGRAM IS DESIGNED TO APPLY TWO REMEDIES TO EACH WELD WHERE FEASIBLE.

INTEGRATED PROGRAM DESCRIPTION
(CONTINUED)

SPECIFIC ACTIONS

- ENLARGE ALL EXISTING OVERLAYS TO "FULL STRUCTURAL" (100% DEPTH X 360° CIRCUMFERENTIAL LENGTH FOR APPLIED LOAD)

- APPLY A "FULL STRUCTURAL" OVERLAY OR A PIPELOCK TO ALL EXISTING (OR FUTURE) FLAWS NOT CURRENTLY OVERLAID

- STRESS IMPROVE ACCESSIBLE WELDS NOT PREVIOUSLY TREATED WITH IHSI

i.e. places where pipingshould be replaced

- CONSIDER OPTION OF SPOOL PIECE REPLACEMENT WHERE IT PROVES TO BE COST EFFECTIVE

- IMPLEMENT HYDROGEN WATER CHEMISTRY AS AN ADDITIONAL REMEDY — A RELATIONSHIP BETWEEN ISI SAMPLE SIZE AND SYSTEM AVAILABILITY WILL BE ESTABLISHED

INTEGRATED PROGRAM DESCRIPTION (CONTINUED)

IN-SERVICE INSPECTION PROGRAM

- o OVERLAID WELDS - 100% UT INSPECTION OF OVERLAY MATERIAL AND OUTER 25% OF BASE METAL FOR 2 CYCLES, THEN RETURN TO SECTION XI INSPECTION FREQUENCY
  - UTILIZE EPRI-DEVELOPED TECHNIQUES
  - CONTINUE MONITORING DEVELOPMENT OF AUTOMATED TECHNIQUES
- o PIPELOCK WELDS - INSPECT FOR 2 CYCLES ON PIPELOCK ONLY, THEN RETURN TO SECTION XI FREQUENCY
- o NON-FLAWED WELDS
  - 2 REMEDIES - RETURN TO SECTION XI INSPECTION FREQUENCY
  - 1 REMEDY - DOUBLE SECTION XI INSPECTION FREQUENCY
  - 0 REMEDIES (INACCESSIBLE WELDS) - CONTINUE AUGMENTED LEAK MONITORING

Alternate scheme, Table to get perspective on proposed program

SUMMARY OF IGSCC SUSCEPTIBLE WELD PROFILES

AFTER IMPLEMENTATION OF THE INTEGRATED PROGRAM

System Identification	Pipe Size (Inch)	Total #Welds (Flawed & Nonflawed)	#Welds IHSI (Nonflawed)	#Welds HWC (Nonflawed)	#Welds HSW (Nonflawed)	Remedies Applied (Nonflawed) 0	1	2	Overlays
RECIRCULATION SYSTEM	4	8	4	8	0	0	4	4	0
	12	54	45	45	0	0	0	45	9
	22	22	16	16	0	0	8	12	2
	28	32	22	22	0	0	0	22	10
RWCU	6	8	2	8	3	0	3	5	0
CRD	4	7	7	7	0	0	0	7	0
CORE SPRAY	10	27	25	12	0	2	13	12	0
SDC	20	18	14	2	0	2	12	2	2
RHRS (HEAD SPRAY)	4	16	15	0	0	1	15	0	0
	6	3	3	2	0	0	1	2	0
RHRS (DISCHARGE)	16	32	27	24	0	3	7	22	0
SPARE NOZZLE	6	2	2	2	0	0	0	2	0
HEAD VENT	4	3	3	3	0	0	0	3	0
JET PUMP INST.	4	4	0	4	0	0	4	0	0
	8	2	0	2	0	0	2	0	0
	12	4	0	4	0	0	4	0	0
TOTALS		242	185	161	3	8	73	138	23

REMEDIES - IHSI. HSW. HWC

TEMP $\leq$ 200°F	8	39	0
TEMP $>$ 200°F	0	34	138

Cost Summary

Comparison of Total Replacement to Integrated Program
All IGSCC Sucseptible Welds
($Millions)

	Total Outage Time (Days)	ISI ($)	HWC ($)	Direct Cost ($)	Total Cost Before Present-Value ($)	Total Cost "Present-Valued" (1985 $)	ALARA (mrem)
TOTAL REPLACEMENT (incl. IHSI & Safe Ends)	190[1]	63	0	0	57.1	120.1	130.3	1900
INTEGRATED PROGRAM Total # welds = 242 # welds to upgrade = 8 # welds to IHSI = 136	36[2]	11.9	0.4	12.6	4.0	28.9	17.5	650

NOTES: (1) Outage time = 240 days less normal refueling outage (50 days) = 190 days.

(2) All outages to end of plant life.
Assumes some simultaneous work of multiple crews in the drywell.
First outage = 58 days less normal refueling outage (50 days) = 8 days.

MEETING SUMMARY

- PROPOSED PROGRAM ADDRESSES STAFF CONCERNS REGARDING LONG TERM IGSCC RESOLUTION BY MEANS OTHER THAN PIPE REPLACEMENT

- INTEGRATED APPROACH ALLOWS SELECTION OF MOST PRUDENT COST EFFECTIVE (DOLLARS AND REM) RESOLUTION ON WELD SPECIFIC BASIS

- CURRENTLY PROJECTION OF REMEDY DISTRIBUTION

  - 80% OF WELDS >200°F HAVE 2 REMEDIES

  - 100% OF WELDS >200°F HAVE AT LEAST 1 REMEDY

- WILL SUBMIT PROPOSED PLAN TO NRC FOR INFORMATION