UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-8064

MAY 20 1997

S. K. Gambhir, Division Manager
Production Engineering
Omaha Public Power District
Fort Calhoun Station FC-2-4 Adm.
P.O. Box 399
Hwy. 75 - North of Fort Calhoun
Fort Calhoun, Nebraska 68023-0399

SUBJECT: PUBLIC MEETING CONDUCTED ON MAY 5, 1997

Dear Mr. Gambhir:

This refers to the meeting conducted at the Fort Calhoun Station on May 5, 1997. This meeting related to the extraction steam line break that occurred on April 21, 1997.

Topics discussed included an overview of the event and current plant status, damage assessment, erosion/corrosion self-assessment, and corrective actions.

This meeting was beneficial in providing us a better understanding of the root cause of the event and your subsequent corrective actions.

In accordance with Section 2.790 of the NRC's "Rules of Practice," Part 2, Title 10, Code of Federal Regulations, a copy of this letter will be placed in the NRC's Public Document Room.

Should you have any questions concerning this matter, we will be pleased to discuss them with you.

Sincerely,

Dwight D. Chamberlain

for Arthur T. Howell III, Director
Division of Reactor Safety

Docket No.: 50-285
License No.: DPR-40

Enclosures:
1. Attendance List
2. Licensee Presentation

cc w/enclosures:
James W. Tills, Manager
Nuclear Licensing
Omaha Public Power District
Fort Calhoun Station FC-2-4 Adm.
P.O. Box 399
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Cheryl Rogers, LLRW Program Manager
Environmental Protection Section
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Lincoln, Nebraska 68509-5007

bcc to DCD (IE45)

bcc distrib. by RIV:

Regional Administrator	DRS-PSB
DRP Director	MIS System
Branch Chief (DRP/B)	RIV File
Project Engineer (DRP/B)	Branch Chief (DRP/TSS)
Resident Inspector	K. Perkins, Director, WCFO
B. Henderson, PAO	C. Hackney, RSLO

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RIV:DRP/B		C:DRP/B		D:DRS							
DNGraves;df*		WDJohnson*		ATHowell							
5/ /97		5/ /97		5/20 /97							

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ENCLOSURE 1

OPPD/NRC PUBLIC MEETING
MAY 5, 1997

ATTENDANCE LIST

Extraction Steam Line Break, Root Cause Analysis, and Corrective Actions

Name	Organization	Position Title
David Graves	NRC-RIV	Sr. Project Engineer
Jeffrey Shackelford	NRC-RIV	SRA/Team Leader
Ken Brockman	NRC-RIV	Deputy Director, DRP
Arthur Howell	NRC-RIV	Director, DRS
Ellis Merschoff	NRC-RIV	Regional Administrator
Clifford Clark	NRC-RIV	Reactor Inspector
Wayne Walker	NRC-RIV	Senior Resident Inspector
Vincent Gaddy	NRC-RIV	Resident Inspector
Hank Sterba	OPPD	Corp. Comm.
Steve Gebers	OPPD	Mgr., Radiation Protection
Owen "Jay" Clayton	OPPD	Mgr., Emergency Planning
Russ Spies	ABB/CE	ABB/CE Resident Site Mgr.
Dean Ross	OPPD	Corp. Comm.
Delores Jacobberger	OPPD	Corp. Comm.
Mary Tesar	OPPD	Mgr., Corrective Action
Jospeh Gasper	OPPD	Mgr., Nuclear Projects
Carl Stafford	OPPD	Principal Reactor Engineer
Dave Herman		Student
James Tills	OPPD	Mgr., Nuclear Licensing
Bob Lisowyj	OPPD	Principal Eng. Metallurgical
Ralph Phelps	OPPD	Mgr., Station Engineering
Sudesh Gambhir	OPPD	Div. Mgr., Eng. & Ops. Spt.
James Chase	OPPD	Plant Manager
Gary Gates	OPPD	Vice President
Jack Skiles	OPPD	
Duane Booth	OPPD	
Harry Faulhaber	OPPD	
Merl Core	OPPD	
Mark Ellis	OPPD	
Clarence Brunnert	OPPD	
Rich Clemens	OPPD	
John Herman	OPPD	
Gary Cavanaugh	OPPD	
Bill Hansher	OPPD	
Bill Ponec	OPPD	
Judy Ploth	OPPD	
Randy Lewis	OPPD	
Dick Andrews	OPPD	

Rich Jaworski	OPPD
Ron Short	OPPD
David Spires	OPPD
Erick Matzke	OPPD

ENCLOSURE 2

OMAHA PUBLIC POWER DISTRICT

Fort Calhoun Station
Public Meeting on the
Extraction Steam Line Rupture Event
May 5, 1997

OPPD

OPENING REMARKS INTRODUCTIONS

Gary Gates

Agenda

- Opening Remarks / Introductions
  - Gary Gates
- Overview of the Event and Current Plant Status
  - Jim Chase
- Damage Assessment
  - Ralph Phelps
- Erosion/Corrosion Self Assessment
  - Sudesh Gambhir
- Closing Remarks
  - Gary Gates

OPPD

OVERVIEW OF THE EVENT

Jim Chase

Steam Leak Sequence of Events
April 21, 1997

Time Description

2022 Loud Noise in Turbine Building heard in Control Room.

Sequence of Events

2023 Large steam leak in Turbine Building identified by Shift Crew.

Reactor promptly tripped and leak isolated.

EOP-00, "Standard Post Trip Actions" entered.

2024 Emergency Boration initiated.

2045 NOUE declared, "Increased Plant Management Awareness".

Sequence of Events

2050 EOP-00 actions completed. All nuclear safety functions met.

- EOP-01, "Uncomplicated Reactor Trip Recovery" entered.
- AOP-32 entered for "Loss of Non-Safety Related MCC-4C3".
- AOP-26 entered for "Loss of Power to Turbine Turning Gear".

2052 Emergency Response Organization (ERO) activated.

- States and Counties notified of NOUE.

Sequence of Events

2210 Technical Support Center takes Command and Control

2345 NOUE terminated. ERO deactivated.

(4/22)

0220 EOP-01 actions completed and OP-3A, "Normal Plant Cooldown", subsequently entered.

Summary of Major Operator Actions / Plant Response

- Primary (nuclear) systems responded as designed to safely shutdown plant.
  - No nuclear safety systems actuated, none were expected.
- Secondary (non-nuclear) systems responded as designed with exception of equipment affected by steam leak.
  - Loss of MCC-4C3 and Power to Turbine Turning Gear
  - DC Bus #1 Ground
  - 480V Bus 1B4C Intermittent Ground
  - Low EHC Pump Pressure

Summary of Major Operator Actions/ Plant Response (cont.)

- Isolated activated portions of Fire Protection System in Turbine Building due to spraying on electrical equipment concerns.
- Overall, Operator and ERO response to event was timely and conservative with respect to reactor safety.

Current Plant Status

- Midloop Operations replacing 3B RCP seal
- Shutdown cooling operation

Startup Plans

- Breakers closed 0100 5/11/97

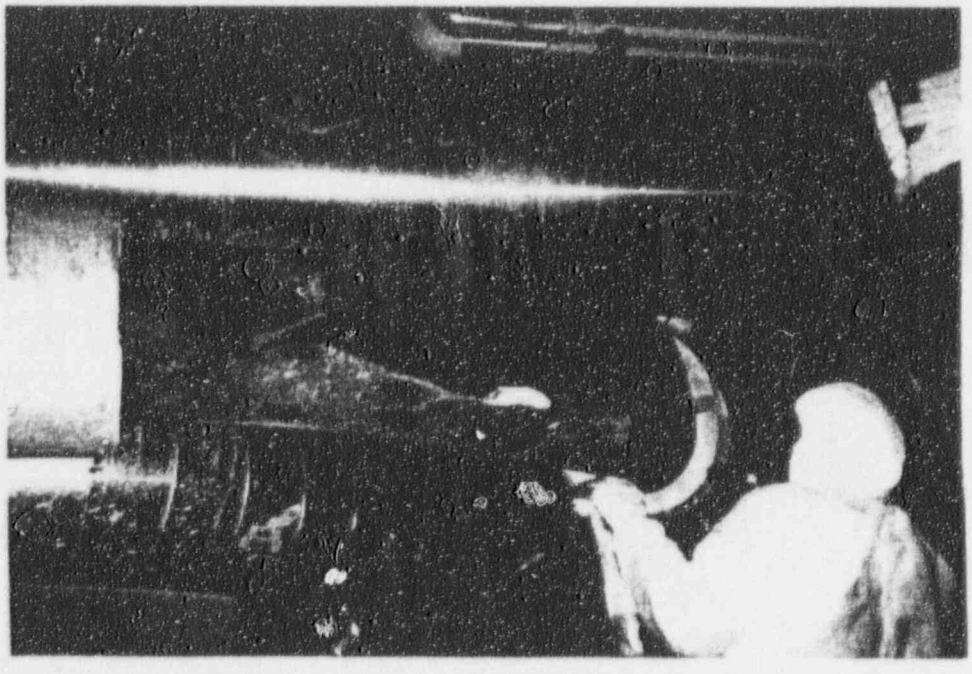
DAMAGE ASSESSMENT

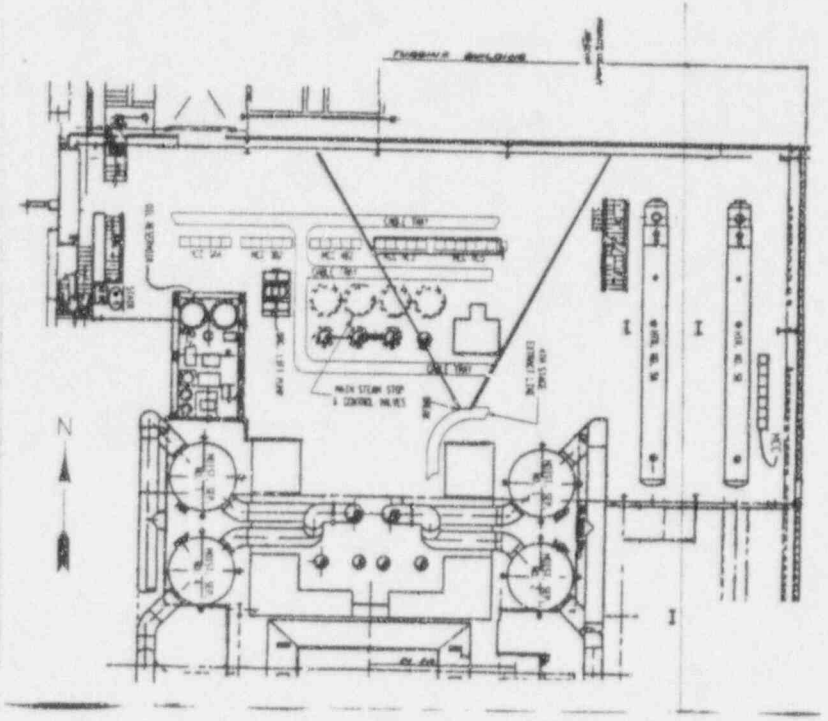
Ralph Phelps

Pipe Break Event
Recovery Actions

- Assessment of damages from the pipe break and recovery actions.

- Pipe failure analysis, erosion/corrosion program assessment, root cause analysis, and corrective actions.
  - covered later in the presentation

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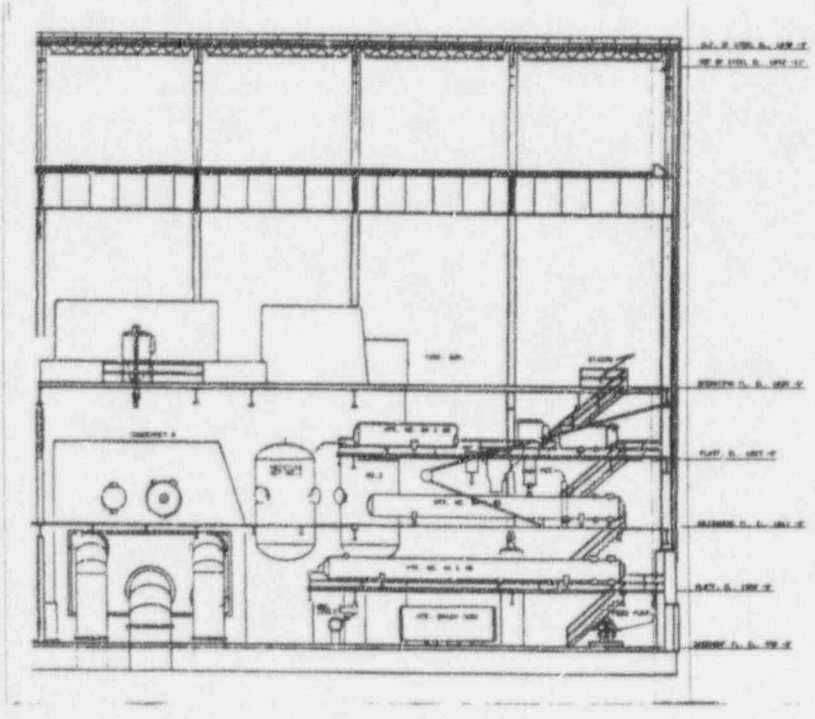
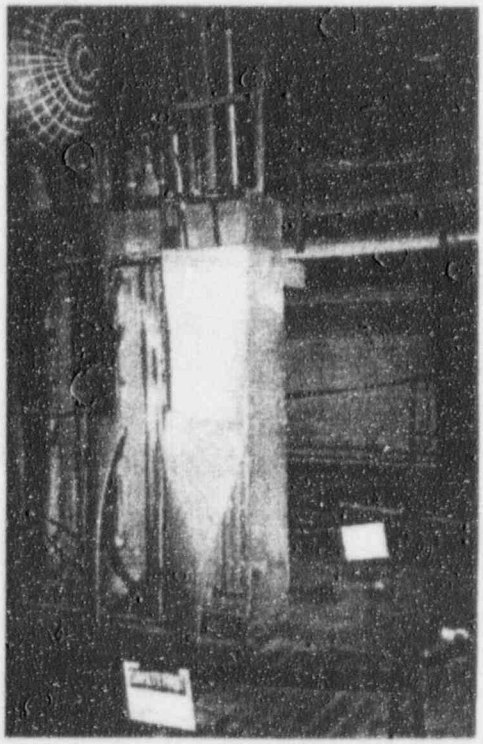
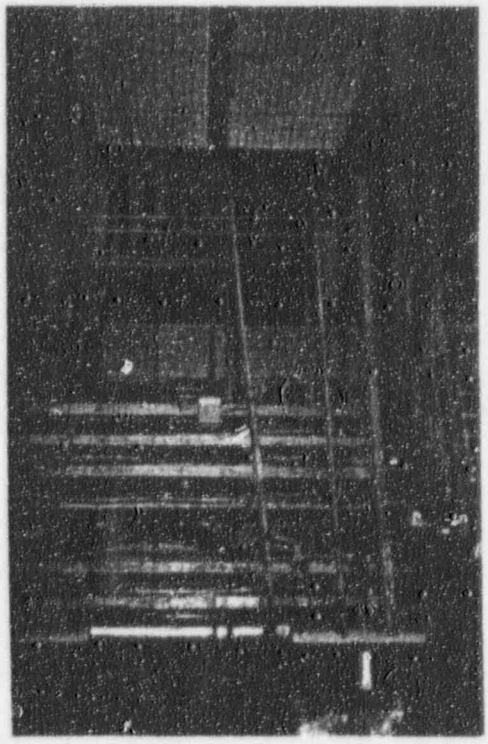
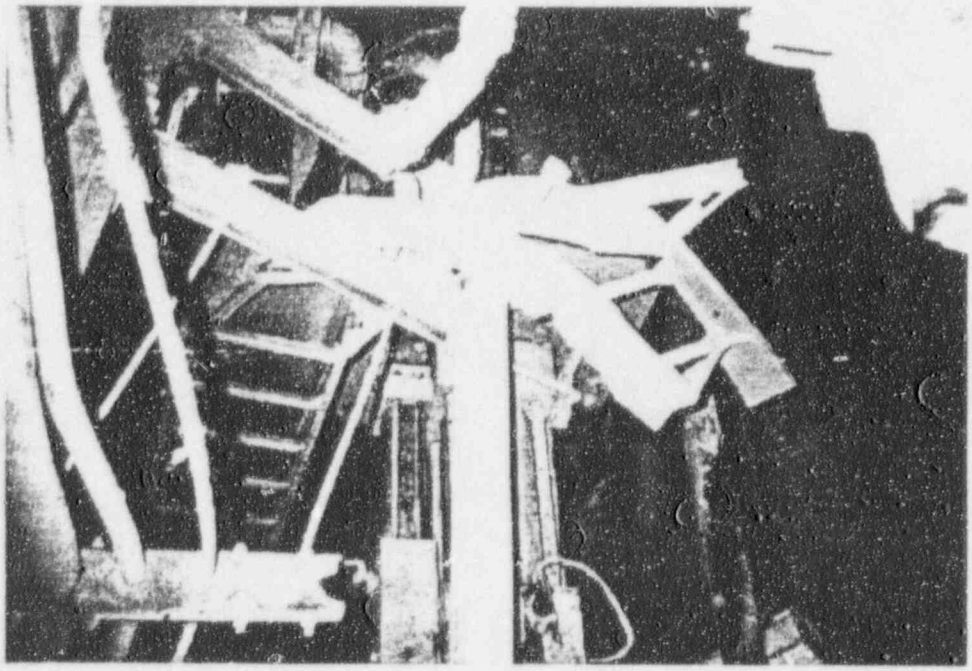








Damage Assessment

- Scope
- Assessment teams
- Equipment repair / troubleshooting
- Safe reliable plant operation / personnel safety

On-Going Actions

- Continuing Walkdowns
- Trending
- Station Reliability Committee

UPPD

SELF-ASSESSMENTS and CORRECTIVE ACTIONS

Sudesh Gambhir

Overview

- Program History
- Fourth Stage Extraction Steam Piping
- Erosion/Corrosion Program Assessment
- Pipe Failure Analysis
- Root Cause Analysis
- Corrective Actions

PROGRAM HISTORY

Program History

Pre - 1987	Recognized need for Erosion Corrosion Program at FCS
1987	Erosion Corrosion program initiated • Used EPRI report NP-3944 as a guide.
1988	Incorporated EPRI CHEC Computer model
1988	Upgraded program procedures
1990	Developed program basis document • Defines requirements, program objectives and responsibilities.
1993	Incorporated EPRI CHECMATE model
1995	Converted to EPRI CHECWORKS model

Inspection History

Date	Inspections 1phase/2phase	Replacements	Basis[1]
1987 RFO	188 (79/109)	18	EPRI NP-3944
1988 RFO	104 (57/47)	15	EPRI CHEC
1990 RFO	125 (62/63)	6	EPRI CHEC
1992 RFO	81 (59/22)	8	EPRI CHEC
1993 RFO	99 (58/41)	4	EPRI CHECMATE
1995 RFO	78 (45/33)	8	EPRI CHECWORKS
1996 RFO	73 (35/38)	4	EPRI CHECWORKS
1997 FO	18 (3/15)[2]	8	Expert Technical Panel
Totals	766	71	

1 Selection based on engineering judgment, FCS and industry experience, and computer modeling.

2 In progress.

Actual Wear Rate Trends

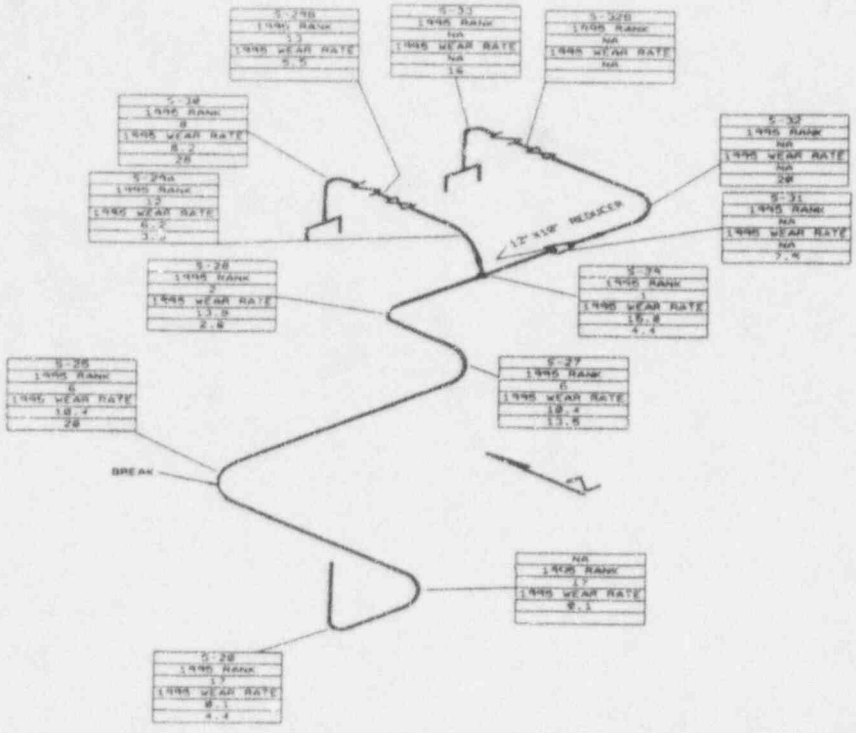
Wear Rates: inches/10,000 hours operation

Test Site	System	1990	1992	1993	1995
B-8	Blowdown	0.0024	-	-	0.002
D-193	Drain from Htr 5A	0.022	0.019	0.022	0.017
D-194	Drain from Htr 5A	0.049	0.022	0.037	0.028
D-213	Drain from Htr 5B	0.024	0.026	0.029	0.019
D-214	Drain from Htr 5B	0.045	0.045	0.022	0.023
D-258	Drain from Htr 6B	0.038	0.023	0.026	0.023
S-39	MS to Htr 6A	0.015	0.012	0.012	0.007
S-56	6th Stage Extract Stm.	0.017	0.017	0.020	0.014
S-59	6th Stage Extract Stm.	0.015	0.014	0.017	0.014
S-64	6th Stage Extract Stm.	0.019	0.020	0.020	0.027

Program History Observations

- The program has been evolving.
- Over 760 inspections and 71 replacements.
  - includes both 1 and 2 phase systems
- Inspection scope has been reduced over time.
  - due to modeling capabilities and increased experience
- Our reliance on EPRI models has increased.
  - Used primarily for ranking
- Wear rates for susceptible components have trended downward.

FOURTH STAGE EXTRACTION STEAM PIPING



Fourth Stage Extraction Steam Piping

Year	Designation	Description	1995 Predicted Wear Rate (example rank)	Actual Wear Rate
1992	S-20	12" 90° elbow	0.1 (6)	4.4
1997	S-25	12" sweep	10.4 (3)	20.0
1997	S-27	12" sweep	10.4 (3)	13.5
1997	S-28	12" 90° elbow	13.8 (2)	2.6
1993	S-29	12"-10" Tee	15.8 (1)	4.4
1997	S-29A	10" sweep	6.2 (5)	3.5
1996	S-30	10" 90° elbow	8.2 (4)	28.0

- Wear rates are in mils per year

SELF-ASSESSMENTS / CONCLUSIONS

Program Self-Assessment

- Objectives
  - Understand the Root and Contributing Causes
  - Perform Failure Analysis
  - Identify any Programmatic or Generic Concerns
  - Identify Corrective Actions

Program Self-Assessment

- OPPD's Concern
  - Why did we not anticipate the failure?
- Team Composition
  - Both Industry and EPRI participation
  - Program and Technical Expertise
  - OPPD Management and SARC Representation

Program Self-Assessment
CRITERIA USED

- NSAC 202L Revision 1 (November, 1996) "Recommendations for an Effective Flow Accelerated Corrosion Program"

- Industry Experience

Program Self-Assessment
SCOPE

- Program Plan and Controlling Procedures
- Susceptibility Evaluation
- Plant Modeling
- Program Implementation

Program Self-Assessment
SCOPE (cont.)

- Communication between Departments
- Training and Qualification
- Continuing Improvements
- Equipment (UT)
- Long Term Strategy to Reduce Plant Susceptibility

Program Self-Assessment
CONCLUSIONS AND RESULTS

- Eighteen Findings
  - 7 Startup
  - 11 Short and Long Term
- Thirty-one Recommendations
- Six Strengths

Program Self-Assessment
KEY ISSUES

- Past replacements not properly factored into the program.
- Missed opportunity to prevent the failure by not using industry experience (CHUG database).

Program Self-Assessment
CONCLUSIONS

- Program should be revised to comprehensively address susceptible piping.
- Program should be revised to meet industry standards in the following areas:
  - Utilization of industry experience
  - Inspection data evaluation
  - Use of analytical tools
  - Use of systematic replacements with resistant materials

Program Self-Assessment
CONCLUSIONS (cont.)

- Procedures should be revised to be comprehensive.
- Major tasks and decisions should be adequately documented.

PIPE FAILURE ANALYSIS

Pipe Failure Analysis

- Failure analysis is being performed by two independent laboratories:
  - FPI International
  - ALTRAN

Pipe Failure Analysis

- Preliminary Results - Failure Mechanism
  - Flow Accelerated Corrosion (FAC).
    - areas of smooth wear
    - areas of pitting surrounding the rupture area
    - area downstream of the rupture exhibited "tiger striped" appearance
    - appearance of scalloped areas of wear
    - the wear was concentrated in the extrados of the elbow
    - FAC possibly aggravated by low oxygen content (< 7 ppb increases erosion corrosion) FCS has < 0.2 ppb in the steam system

Pipe Failure Analysis

- Preliminary Results (cont.)
  - Indications of droplet impingement

ROOT CAUSE ANALYSIS

Root Cause

- Over-reliance on elbow radius as a predictor of relative wear rate, with insufficient consideration of plant history and industry guidance.

Contributing Causes

- Failure to include "sweep" elbows in the inspection program.
- Lack of a proceduralized methodology for selecting inspection sites.
- Incomplete utilization of plant history data (repair/replacement prior to 1988).
- Incomplete utilization of industry experience resources.
- Lack of specific guide-lines / goals / training on the comprehensiveness, updating and use of the model.
- Lack of adequate management / supervisory oversight and independent knowledge assessment.

Corrective Actions

- Pre-Startup
  - Inspect carbon steel large radius sweeps in extraction steam piping in 2nd, 4th, and 6th stages.
  - Verify that other fittings (90 degree elbows, tees, and reducers) have been recently (1990 to present) inspected.
  - Upgrade the susceptibility evaluation.

Corrective Actions

- Pre-Startup (cont.)
  - Review plant systems to ensure piping and components downstream of replaced components have been inspected.
  - Resolve configuration control issue with S-56 (tee in 6th stage extraction steam).
  - Locate / review any remaining packages from the 1996 RFO.
  - Re-evaluate components displaying significant wear.

Corrective Actions

- Pre-Startup (cont.)
  - Review high priority systems using expert technical panel and industry experience.
    - (Feedwater, Steam Dump and Bypass, Blowdown, Extraction Steam, Condensate, Heater Drains)
  - Independently verify the adequacy of inspection coverage for susceptible systems / lines.
  - Perform additional inspections and replacements as needed.

	Examination Site	Checworks ID	Component Description	Predicted Thickness	Measured Thickness	Status	Comments
2nd Stage Extraction Steam	S-34	5211-E02	12" - 90 deg sweep	0.251	0.263	Accepted	None
	S-35	5214-E02	12" - 90 deg sweep	0.251	0.256	Accepted	None
	S-38	5302-E01	10" - 45 deg sweep	0.304	0.284	Accepted	None
	S-42	None	10" - 90 deg sweep	Not modeled	0.312	Accepted	None
4th Stage Extraction Steam	S-25	5407-E02	12" - 90 deg sweep	0.219	0.054	Rejected	Ruptured pipe - replace sweep
	S-27	5410-E02	12" - 90 deg sweep	0.219	0.151	Rejected	Above minimum wall but below our acceptance criteria - replace sweep
	S-28	5412-E02	12" - 90 deg elbow	0.168	0.335	Accepted	None
	S-29A	5502-E01	10" - 45 deg sweep	0.271	0.317	Accepted	None
	S-29B	5505-P58	10" pipe, between Vvs	0.283			In progress
	S-32	None	10" - 90 deg sweep	Not modeled	0.044	Rejected	Below minimum wall - replace sweep
	S-32B	None	10" pipe, between Vvs	Not modeled			In progress
6th Stage Extraction Steam	S-53	None	18" - 45 deg elbow	Not modeled	0.168	Rejected	Above minimum wall but below our acceptance criteria - replace elbow
	S-54	5656-P51	18" pipe	0.253	0.107	Rejected	Below minimum wall - replace pipe
	S-54	5657-E01	18" - 45 deg elbow	0.228	0.227	Accepted	Fit-up problem with low thickness in weld area - replace elbow
	S-54	5658-E03	18" - 45 deg elbow	0.205	0.348	Accepted	None
Heater Drains	D-224	6003-E02	6" - 90 deg sweep	0.238	0.229	Accepted	None
	D-224	6005-E01	6" - 45 deg sweep	0.247	0.241	Accepted	None
	D-245	None	6" - 90 deg sweep	Not modeled	0.257	Accepted	Parallel train component to 6003-E02
	D-245	None	6" - 45 deg sweep	Not modeled	0.267	Accepted	Parallel train component to 6005-E01
	D-196	None	10" x 10" Tee	Not modeled			In progress
	D-95	6481-P51	3" pipe downstream of orifice FW-32A	0.209	0.08	Rejected all three parallel train pipes	Majority of pipe was above .2", but localized areas were below .1" - damage caused by flashing, not FAC
1st Stage Drains	S-111	None	1" pipe downstream of orifice, to 2nd Stage	Not modeled	0.14	Accepted	Pipe replaced in 1985
	S-112	None	1" pipe downstream of orifice, to 2nd stage	Not modeled	0.14	Accepted	Pipe replaced in 1985

Corrective Actions

- After Plant Restart
  - Upgrade Program plan and Implementing procedures (prior to 1998 RFO).
    - To be consistent with NSAC 202L Rev. 1
    - Revise data collection to meet industry standards.
    - Develop detailed susceptibility documentation.
    - Better define selection criteria.
  - Conduct review and upgrade of modeling (prior to 1998 RFO).

Corrective Actions

- After Plant Restart (cont.)
  - Improve incorporation of industry experience (prior to 1998 RFO).
    - increased participation in industry groups (CHUG, Owners groups, etc.)
    - make better use of industry data bases (CHUG).
    - utilize industry peers to review scope (pre-outage) and results of inspections (post-outage).
  - Conduct additional inspections to develop PASS 2 models for CHECWORKS (starting with 1998 RFO).

Corrective Actions

- After Plant Restart (cont.)
  - Apply lessons learned from the erosion corrosion assessment to other programs at FCS (in progress).
  - Evaluate on-line radiography for small bore piping.
  - Evaluate replacing high wear piping with wear resistant piping (Chrome-moly) (prior to 1998 RFO).

Corrective Actions

- After Plant Restart (cont.)
  - Evaluate additional moisture traps on extraction steam piping to reduce wear (prior to 1998 RFO).
  - Conduct another assessment of the erosion corrosion program (after the 1998 RFO).
  - Provide erosion corrosion awareness training to selected System Engineers, Operators, Maintenance and Quality Control Personnel(prior to 1998 RFO).

Corrective Actions

- After Plant Restart (cont.)
  - Work with EPRI to share experiences with the industry (on-going).
    - First set of lessons learned being posted on CHUG bulletin board
  - Work with EPRI to improve modeling for large radius sweeps (on-going).
  - Work with EPRI to better understand effects of oxygen concentration on secondary systems (on-going).

Summary

- OPPD recognizes the areas to be strengthened in our program.
- Startup corrective actions are aimed at correcting specific problems relative to the extraction steam piping and the generic impact of weaknesses on the balance of the erosion corrosion program.
- Lessons learned from this event and the program assessment will be applied to other programs at FCS.
- The information from this event will be shared with the industry.

CLOSING REMARKS

Gary Gates