

APR 15 1991

Docket Nos. 50-498
50-499
License Nos. NPF-76
NPF-80

Houston Lighting & Power Company
ATTN: Donald P. Hall, Group
Vice President, Nuclear
P.O. Box 1700
Houston, Texas 77251

Gentlemen:

This refers to the meeting conducted in the Region IV office on March 19, 1991. This meeting, requested by Houston Lighting & Power Company, related to activities authorized by NRC License Nos. NPF-76 and NPF-80 for South Texas Project, Units 1 and 2, respectively, and was attended by those on the attached Attendance List.

The subjects discussed at this meeting are described in the enclosed Meeting Summary.

It is our opinion that this meeting was beneficial and has provided a better understanding of current engineering and technical support initiatives and issues at South Texas Project.

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,

Original Signed By:
Samuel J. Collins

Samuel J. Collins, Director
Division of Reactor Projects

Enclosure:
Meeting Summary w/attachments

cc w/enclosure: (see next page)

RIV:DRP/DK
WBJones;df
4/11/91

C:DRP/DK
ATHowe
4/15/91

D:DRP
S0Col11ns
4/15/91

9104220118 910415
PDR ADOCK 05000498
P PDR

IF45

111

Houston Lighting & Power Company

-2-

cc w/enclosure:
Houston Lighting & Power Company
ATTN: Manager, Nuclear Licensing
P.O. Box 289
Wadsworth, Texas 77483

City of Austin
Electric Utility Department
ATTN: J. C. Lanier/M. B. Lee
P.O. Box 1088
Austin, Texas 78767

City Public Service Board
ATTN: R. J. Costello/M. T. Hardt
P.O. Box 1771
San Antonio, Texas 78296

Newman & Holtzinger, P. C.
ATTN: Jack R. Newman, Esq.
1615 L Street, NW
Washington, D.C. 20036

Central Power and Light Company
ATTN: D. E. Ward/T. M. Puckett
P.O. Box 2121
Corpus Christi, Texas 78403

INPO
Records Center
1100 Circle 75 Parkway
Atlanta, Georgia 30339-3064

Mr. Joseph M. Hendrie
50 Bellport Lane
Bellport, New York 11713

Bureau of Radiation Control
State of Texas
1101 West 49th Street
Austin, Texas 78756

Judge, Matagorda County
Matagorda County Courthouse
1700 Seventh Street
Bay City, Texas 77414

Licensing Representative
Houston Lighting & Power Company
Suite 610
Three Metro Center
Bethesda, Maryland 20814

Houston Lighting & Power Company

-3-

Houston Lighting & Power Company
ATTN: Rufus S. Scott, Associate
General Counsel
P.O. Box 61867
Houston, Texas 77208

bcc to DMB (1E45)

bcc distrib. by RIV:
R. D. Martin
DRP
DRS
DRSS-RPEPS
RIV File

Resident Inspector
Section Chief (DRP/D)
R. Bachmann, OGC
Lisa Shea, RM/ALF
Project Engineer (DRP/D)

MEETING SUMMARY

Licensee: Houston Lighting & Power Company (HL&P)
Facility: South Texas Project (STP)
License Nos.: NPF-76 and NPF-80
Docket Nos.: 50-498 and 50-499
Subject: CURRENT ENGINEERING AND TECHNICAL SUPPORT ISSUES AND
INITIATIVES

On March 19, 1991, representatives of STP met with Region IV personnel in Arlington, Texas, to discuss current engineering and technical support issues and initiatives. The meeting was held at the request of HL&P. The issues discussed were the design basis determination (DBD) program, probabilistic risk assessment (PRA) program, systematic problem solving process, turbine issues, Cooper-Bessemer Owners Group (emergency diesel generators), and the Unit 1 main generator failure.

NRC noted that many of the issues, including the DBD program and systematic problem solving process, are proactive efforts which could enhance operational activities at STP.

Attachments:

1. Attendance List
2. Licensee Presentation (NRC distribution only)

ATTENDANCE LIST

Attendance at the meeting between HL&P and NRC on March 19, 1991, in the Region IV office:

HL&P

S. L. Rosen, Vice President, Nuclear Engineering
M. T. Hardt, Director, Nuclear Division, City Public Service Board, San Antonio
W. Jump, Manager, Nuclear Licensing
A. W. Harrison, Acting Manager, Nuclear Licensing
R. P. Murphy, Manager, Plant Analysis Division
M. J. Berg, Manager, Design Engineering Division
V. R. Albert, Manager, Plant Systems Division
R. R. Hernandez, Manager, Structural/Support Division
C. A. Brewer, Lead Instructor, Nuclear Training Department

NRC

J. P. Jaudon, Acting Director, Division of Reactor Safety (DRS)
I. Barnes, Chief, Materials & Quality Program Section, DRS
T. Stetka, Chief, Plant System Section, DRS
A. T. Howell, Chief, Project Section D, Division of Reactor Projects (DRP)
G. Dick, Project Manager, PD IV-2, Office of Nuclear Reactor Regulation
W. B. Jones, Senior Project Engineer, Project Section D, DRP
R. J. Evans, Resident Inspector, STP, Project Section D, DRP



NRC MEETING
ENGINEERING AND
TECHNICAL SUPPORT
MARCH 19, 1991

SOUTH TEXAS PROJECT
ELECTRIC GENERATING STATION

MEETING WITH NRC ENGINEERING AND TECHNICAL SUPPORT

AGENDA

INTRODUCTION

S. L. ROSEN

DESIGN BASIS DOCUMENTATION

R. R. HERNANDEZ

PROBABILISTIC RISK ASSESSMENT

R. P. MURPHY

SYSTEMATIC PROBLEM SOLVING PROCESS

C. A. BREWER

TURBINE ISSUES

M. J. BERG

COOPER-BESSEMER OWNER'S GROUP (DIESELS)

M. J. BERG

MAIN GENERATOR FAILURE

V. R. ALBERT

CONCLUDING REMARKS

S. L. ROSEN

**DESIGN BASIS DOCUMENTATION
PROGRAM**

**BY R. R. HERNANDEZ
MANAGER**

**STRUCTURAL/SUPPORTS DIVISION
HOUSTON LIGHTING & POWER COMPANY**

STATUS OF THE DBD PROGRAM

- **PROGRAM PLAN DEVELOPED IN 1988 AND IDENTIFIED**

- 36 SYSTEM DBDs
- 8 STRUCTURAL DBDs
- 10 GENERIC TOPICS
- 27 ENHANCED DESIGN CRITERIA DOCUMENTS

ANTICIPATED COST \$12 MILLION

- **CURRENT STATUS FEBRUARY, 1991**

- 18 SYSTEM DBDs ISSUED
- 15 SYSTEM DBDs UNDER DEVELOPMENT (1991)
- 0 STRUCTURAL DBDs ISSUED
- 2 GENERIC TOPIC DBD ISSUED
- 0 ENHANCED DESIGN CRITERIA ISSUED

PROGRAM COMPLETION TARGET DECEMBER 1992

ESTABLISHING THE DESIGN BASIS DOCUMENTATION (DBD) PROGRAM

- **DBD PROGRAM PURPOSE**

- **PROVIDE A COMPREHENSIVE DESIGN BASIS INFORMATION SOURCE SO THAT THE DESIGN BASIS CRITERIA AND REGULATORY COMMITMENTS ARE NOT UNKNOWINGLY MODIFIED OR VIOLATED**

- **SOUTH TEXAS PROJECT DBD PROGRAM SCOPE**

- **INCORPORATES SAFETY-RELATED SYSTEMS, SELECT NONSAFETY-RELATED SYSTEMS, AND SPECIAL GENERIC TOPICS**
- **ENHANCED TO INCORPORATE THE BASIS FOR THE UFSAR CHAPTER 15 SAFETY EVALUATIONS INTO AN ACCIDENT ANALYSIS DBD (23 MODULES)**
- **INCLUDES HISTORICAL EVOLUTION OF SYSTEMS**
- **PROVIDES LICENSING COMMITMENTS FOR SYSTEMS AND GENERIC TOPICS**

DBD INPUTS

- UFSAR (LICENSING SECTION)
- DESIGN CRITERIA DOCUMENTS
- VENDOR INFORMATION
- CALCULATIONS
- DESIGN DRAWINGS
- MEETING MINUTES
- CORRESPONDENCE
- EQUIPMENT SPECIFICATIONS
- WESTINGHOUSE RELATED INFORMATION

INTEGRATION INTO PLANT ACTIVITIES

- INFORMATION UTILIZED BY PLANT PERSONNEL IN SUPPORT OF PERMANENT OR TEMPORARY MODIFICATIONS/EVALUATIONS OF NONCONFORMANCES, SAFETY EVALUATIONS, OR JUSTIFICATIONS FOR CONTINUED OPERATION
- EMPHASIS PLACED ON PROVIDING AN EXPLANATION AS TO "WHY" THE SYSTEM EXISTS IN ITS PRESENT FORM
- INFORMATION AUGMENTS THE EXISTING DESIGN CRITERIA DOCUMENTS AND SUPERSEDES THE CURRENT SYSTEM DESCRIPTIONS WHEN ISSUED AS REV. 0
- PROVIDES A COMMUNICATION BRIDGE BETWEEN DESIGN ENGINEER AND PLANT PERSONNEL
- DBDs DISTRIBUTED AS "CONTROLLED DESIGN DOCUMENTS" THROUGHOUT SITE AND A/E'S OFFICE (BECHTEL AND WESTINGHOUSE)

MAINTENANCE AND CONTROL OF DBDS

- ISSUED AND REVISED AS "CONTROLLED" DESIGN DOCUMENTS THROUGH THE RECORDS MANAGEMENT SYSTEM
- MAINTAINED BY COGNIZANT ENGINEERING DISCIPLINE
- ITEMS REQUIRING ADDITIONAL INFORMATION ARE CATEGORIZED AS "OPEN ITEMS" AND EVALUATED TO DETERMINE THEIR SAFETY SIGNIFICANCE
- "OPEN ITEMS" ARE SCHEDULED FOR RESOLUTION BASED ON SAFETY SIGNIFICANCE
- ALL "OPEN ITEMS" ARE TARGETED TO BE DISPOSITIONED BY DECEMBER 1992
- SOUTH TEXAS PROGRAM REVISED TO BE CONSISTENT WITH NUMARC GUIDELINES
- FORMAL TRAINING ON PROGRAM OBJECTIVES AND THE NECESSITY OF MAINTAINING DBDS IS BEING PROVIDED TO PLANT ORGANIZATIONS

ADDITIONAL ENHANCEMENTS TO THE DBD PROGRAM

- PLANS ARE IN DEVELOPMENT TO REVIEW PLANT OPERATING AND EMERGENCY OPERATING PROCEDURES AGAINST ISSUED DBDs
- WALKDOWNS OF SELECTED SYSTEMS WILL BE PERFORMED IN 1991 TO PARTIALLY VALIDATE DBD INFORMATION. RESULTS WILL BE EVALUATED
- DEVELOPMENT OF "NEW LOOK TURBINE GENERATOR INFORMATION MANUAL" INITIATED IN 1991
- DEVELOPMENT OF A PROGRAM TO ESTABLISH HIERARCHY OF DESIGN DOCUMENTS
 - ASSIST IN ESTABLISHING CONTROLLING SOURCE OF DESIGN INFORMATION
 - IDENTIFY OTHER DESIGN DOCUMENTS WHICH ARE REQUIRED TO BE MAINTAINED AS PART OF THE CONFIGURATION MANAGEMENT PROCESS

CONCLUSIONS

- MAINTAINING DESIGN INTEGRITY IS A STATION GOAL
- IN ORDER TO BE CONTROLLED, THE DESIGN BASIS MUST FIRST BE UNDERSTOOD
- THE DESIGN BASIS MUST ALSO BE ACCESSIBLE TO ALL
- THE DBD PROGRAM SERVES TO CLEARLY ESTABLISH THE DESIGN BASIS FOR THE SOUTH TEXAS PROJECT

PROBABILISTIC RISK ASSESSMENT (PRA) PROGRAM

BY R. P. MURPHY

MANAGER

PLANT ANALYSIS DIVISION

HOUSTON LIGHTING & POWER COMPANY

CURRENT STATUS OF PRA PROGRAM

- ON APRIL 14, 1989 HL&P SUBMITTED TO THE NRC THE "SOUTH TEXAS PROJECT PROBABILISTIC SAFETY ASSESSMENT SUMMARY REPORT" WHICH UTILIZES CURRENT METHODS AND INFORMATION.
- THE SOUTH TEXAS PROJECT ELECTRIC GENERATING STATION (STPEGS) PROBABILISTIC SAFETY ASSESSMENT (PSA) CONSISTS OF A LEVEL I PROBABILISTIC RISK ASSESSMENT (PRA) INCLUDING EXTERNAL EVENTS AND AN UNCERTAINTY ANALYSIS.
- THE ASSESSMENT INCLUDED SUBSTANTIAL UTILITY PERSONNEL INVOLVEMENT AND INDEPENDENT IN-HOUSE REVIEW.
- DOCUMENTATION FOR THE "FRONT END" ANALYSIS AS SUBMITTED SATISFIES GL 88-20 REQUIREMENTS.
- INCLUDES THE ABILITY TO ADDRESS CURRENT PHENOMENOLOGICAL ISSUES.
- THE PLANT ASSESSMENT HAS RESULTED IN CHANGES IN DESIGN AND PROPOSED PROCEDURES.
- DETAILED DOCUMENTATION IS CURRENTLY UNDER REVIEW BY THE NRC AND SANDIA NATIONAL LABORATORY.
- THE PRA AND PRA METHODOLOGY HAS BEEN/AND WILL BE USED FOR RISK-BASED APPLICATIONS SUCH AS THE EVALUATION OF PLANT SPECIFIC STPEGS TECHNICAL SPECIFICATIONS.

PROGRAMMATIC REQUIREMENTS **FOR PRA ANALYSES**

- **CONSULTANT QA PROGRAM AND PROCEDURES**
- **HL&P QA PROGRAM AND PROCEDURES**
 - **COMPUTER ENVIRONMENT CONTROL**
 - **MODEL CONTROL**
 - **COMPUTER CODE VERIFICATIONS**
 - **PERFORMANCE OF ENGINEERING CALCULATIONS**
 - **USER QUALIFICATION**
 - **PLANT & PROCEDURE MODIFICATIONS**
 - **ERROR HANDLING**

PROGRAMMATIC REQUIREMENTS **FOR PRA ANALYSES**

- PLANT MODEL VALIDATION
 - AS BUILT CONFIGURATION
 - UNIT 1 VS. UNIT 2
 - PEER REVIEW
 - SUPPORT ANALYSES

INDIVIDUAL PLANT EXAMINATION (IPE)

- GENERIC LETTER 88-20 SPECIFIES THAT AN IPE INCLUDING A SYSTEMS ANALYSIS AND CONTAINMENT PERFORMANCE ANALYSIS BE SUBMITTED WITHIN 3 YEARS (AUGUST, 1992)
- THREE APPROACHES AVAILABLE INCLUDE IDCOR (IPEM), LEVEL I PRA PLUS CONTAINMENT ANALYSIS OR ANY OTHER METHOD SUBMITTED AND APPROVED BY NRC
- MUST REFLECT CURRENT PLANT DESIGN
- FOLLOW SUBMITTAL GUIDANCE OF NUREG-1335
- SUBSTANTIAL UTILITY INVOLVEMENT
- PLAN SUBMITTED SPECIFYING THE APPROACH AND SCHEDULE FOR COMPLETION

COMPLETION OF THE STPEGS CONTAINMENT PERFORMANCE ANALYSIS

- WILL BE COMPLETED BY AUGUST 29, 1992.
- IN-HOUSE UTILITY STAFF WILL BE RESPONSIBLE FOR THE ANALYSIS.
- DETAILED IMPLEMENTATION PLAN AND SCHEDULE IS NOW BEING PREPARED.
- AN STP SPECIFIC CONTAINMENT PERFORMANCE ANALYSIS WILL BE INCLUDED BECAUSE OF THE UNIQUE PLANT DESIGN.
- CONSULTANT WILL BE RETAINED TO PROVIDE ANALYSES FOR CONTAINMENT FAILURE CHARACTERIZATION AND TO PROVIDE AN OVERVIEW FUNCTION AND OUTSIDE REVIEW.
- THE MAAP AND/OR THE STCP (SOURCE TERM CODE PACKAGE) COMPUTER CODES WILL BE UTILIZED TO ANALYZE FOR SUCCESS CRITERIA AND PROVIDE INPUT FOR ACCIDENT MANAGEMENT CONSIDERATIONS.

PRA APPLICATIONS

PRA APPLICATION HAVE INCLUDED:

- EVALUATION OF STPEGS SPECIFIC TECHNICAL SPECIFICATIONS.
 - HL&P HAS SUBMITTED AN ANALYSIS OF 22 STPEGS TECHNICAL SPECIFICATIONS TO THE NRC FOR REVIEW.
 - PROPOSED CHANGES INCLUDE ALLOWED OUTAGE TIME (AOT) FROM 3 TO 10 DAYS AND SURVEILLANCE TEST INTERVAL (STI) FROM 31 TO 92 DAYS.
 - NRC REVIEW OF PROPOSED CHANGES IS CURRENTLY BEGINNING AND IS EXPECTED TO BE COMPLETE THIS YEAR.
- PLANT MODIFICATIONS AND PROPOSED MODIFICATIONS.
 - RCP SEAL COOLING; CONTAINMENT AND CVCS ISOLATION VALVES; RHR AUTO-CLOSURE INTERLOCK.
- FMEA ON MAIN TURBINE AND SUPPORT SYSTEMS.

UTILITY INVOLVEMENT IN PRA

- CURRENT PRA STAFFING LEVEL PROVIDES FOR FOUR FULL TIME ENGINEERING PERSONNEL.
- FOR THE LEVEL 1 PRA, PERSONNEL EXPERIENCE LEVEL EXCEEDED FOUR YEARS ON THE STPEGS PSA, SIX YEARS IN PERFORMING PRA, AND 11 YEARS IN NUCLEAR POWER ENGINEERING.
- FOR THE PSA, BACKGROUNDS INCLUDED LICENSING, DESIGN ENGINEERING, THERMAL-HYDRAULIC ANALYSIS, ACCIDENT ANALYSIS, NUCLEAR NAVY, AND PERFORMANCE OF PRA ON OTHER PLANTS, INCLUDING ZION, INDIAN POINT, AND SEABROOK.
- DIRECT, FULL-TIME SUPPORT OF THE PSA COMPLETION ACTIVITIES IS ESTIMATED TO HAVE BEEN 15 MAN-YEARS.

**SYSTEMATIC PROBLEM SOLVING
PROCESS**

BY C. A. BREWER

LEAD INSTRUCTOR

NUCLEAR TRAINING DEPARTMENT

HOUSTON LIGHTING AND POWER COMPANY

SYSTEMATIC PROBLEM SOLVING PROCESS

PROGRESS REPORT

- FIRST FORMAL CLASS OFFERED - 12/08/88
- CLASSES PRESENTED TO DATE - 22
- STUDENTS COMPLETING COURSE - 334
- COMMITMENT FOR INVESTIGATORS TO ATTEND TRAINING PER
IP-1.450, STATION PROBLEM REPORTING (JULY, 1989)
- INCORPORATION OF INPO HPES CRITERIA INTO THE ROOT CAUSE
CODE TREE (MARCH, 1990)
- INCORPORATION OF "GENERIC IMPLICATIONS" INTO THE SOLUTION
SELECTION PROCESS (AUGUST, 1990)
- INSTITUTED CORRECTIVE ACTION REVIEW COMMITTEE (CARM) TO
AID THE INVESTIGATORS (JANUARY, 1991)

SYSTEMATIC PROBLEM SOLVING PROCESS **(SPSP)**

- **SPR PROCESS INPUT**
- **PROBLEM STATEMENT**
- **FACT FINDING**
 - **DATA COLLECTION**
 - **INTERVIEWING**
- **EVENTS TIME LINE AND NARRATIVE**
- **CAUSE ANALYSIS/IDENTIFY**
 - **BARRIER ANALYSIS**
 - **CHANGE ANALYSIS**
 - **E&CF CHARTING**
 - **ROOT CAUSE CODE TREE**
- **SOLUTION SELECTION/PRIORITIZATION**
 - **ROOT CAUSE(S) LISTED FOR EACH CAUSAL FACTOR**
 - **ROOT CAUSES PRIORITIZED FOR SOLUTION RECOMMENDATIONS**

SYSTEMATIC PROBLEM SOLVING PROCESS (SPSP CON'T)

- IMPLEMENTATION
 - RECOMMENDATIONS
 - IMPLEMENTATION PLAN
 - MANAGEMENT PRESENTATION
- NORMAL SPR PROCESS
 - IMPLEMENT SOLUTIONS
 - TRACK SOLUTIONS

SYSTEMATIC PROBLEM SOLVING PROCESS

- "ROOT CAUSE"

THE ABSENCE OR FAILURE OF A BARRIER, WHICH IN AND OF ITSELF IF CORRECTED, WILL (SHOULD) PREVENT RECURRENCE OF THE UNDESIRABLE EVENT.

SYSTEMATIC PROBLEM SOLVING PROCESS

• CAUSE ANALYSIS

COMBINATION OF BARRIER ANALYSIS, CHANGE ANALYSIS, EVENTS & CAUSAL FACTOR CHARTING (E&CF) AND ROOT CAUSE CODE TREE FOR DETERMINATION OF A PROBLEMS'S CAUSE(S).

- METHODS USED IN NTSB AND MANAGEMENT & OVERSIGHT RISK TREE (MORT) ANALYSIS OF EVENT ROOT CAUSES:

BARRIER ANALYSIS

- BRAINSTORMING FOR BARRIERS (PRESENT AND MISSING) WHICH WOULD HAVE PREVENTED THE PROGRESSION OF THIS SEQUENCE EVENT WHERE "PAIN" WAS REALIZED

CHANGE ANALYSIS

- BRAINSTORMING FOR CONDITIONS WHICH MAKE THIS SEQUENCE OF EVENTS DIFFERENT FROM PREVIOUS SUCCESSFUL EVOLUTIONS

E&CF

- METICULOUS APPLICATION OF THE "WHY STAIRCASE" AT EACH "PAIN" EVENT OF THE EVENTS TIME LINE

ROOT CAUSE CODE TREE

- APPLICATION OF MORT SYSTEM TO THE E&CF CHART FOR CODIFICATION/TRENDING OF ROOT CAUSE(S).

SYSTEMATIC PROBLEM SOLVING PROCESS

- **CHANGE ANALYSIS**

- **CONSIDER PROBLEM
FREE SITUATION**
 - **COMPARE**
 - **LIST ALL DIFFERENCES**
 - **ANALYZE DIFFERENCES FOR EFFECT**
 - **EVALUATE DIFFERENCES WITH RESPECT TO BARRIERS**
- **CONSIDER PROBLEM
SITUATION**

Events and Casual
Factor Charting

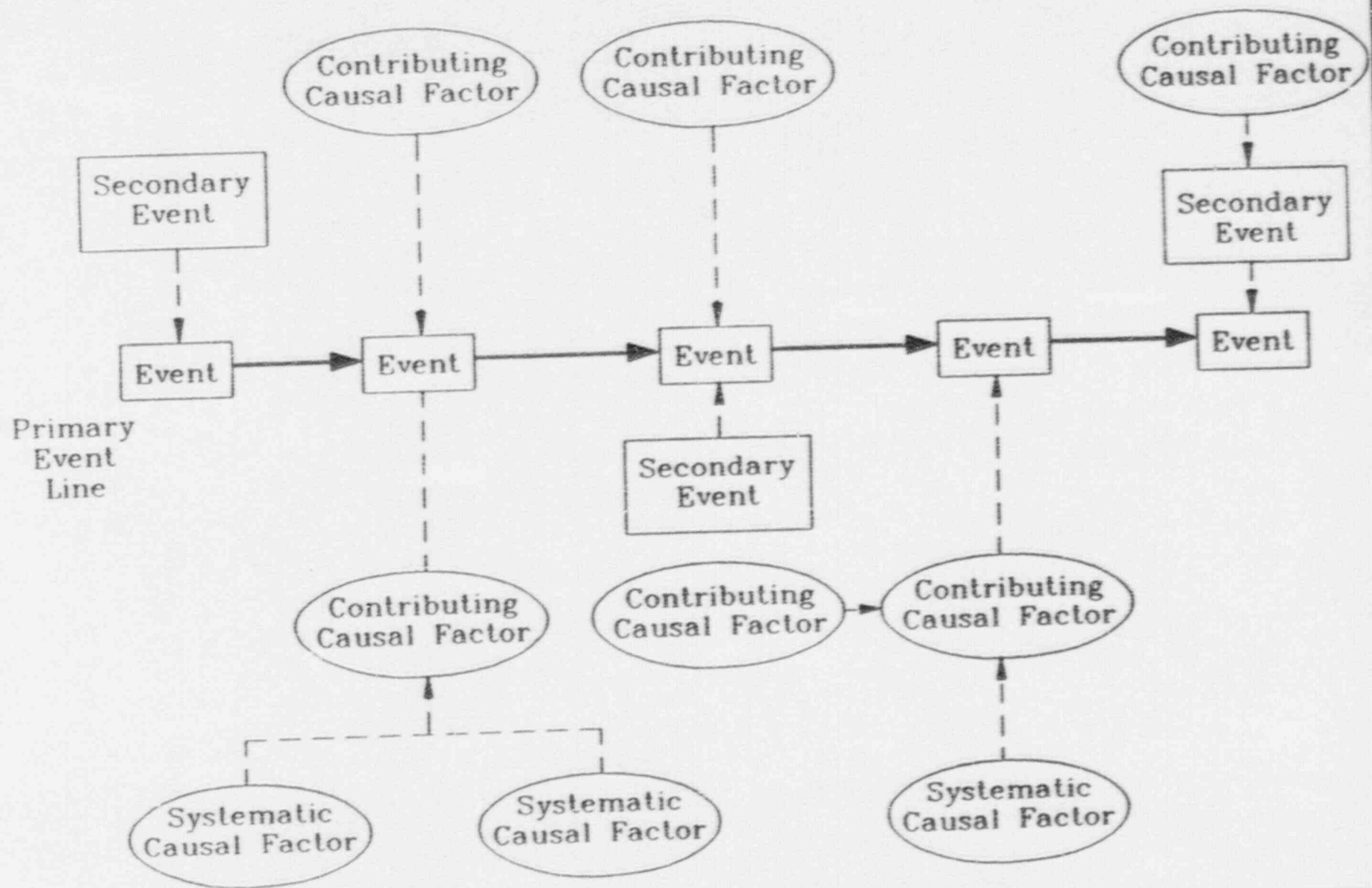


FIGURE 1

SOLUTION SELECTION & PRIORITIZATION PROCESS

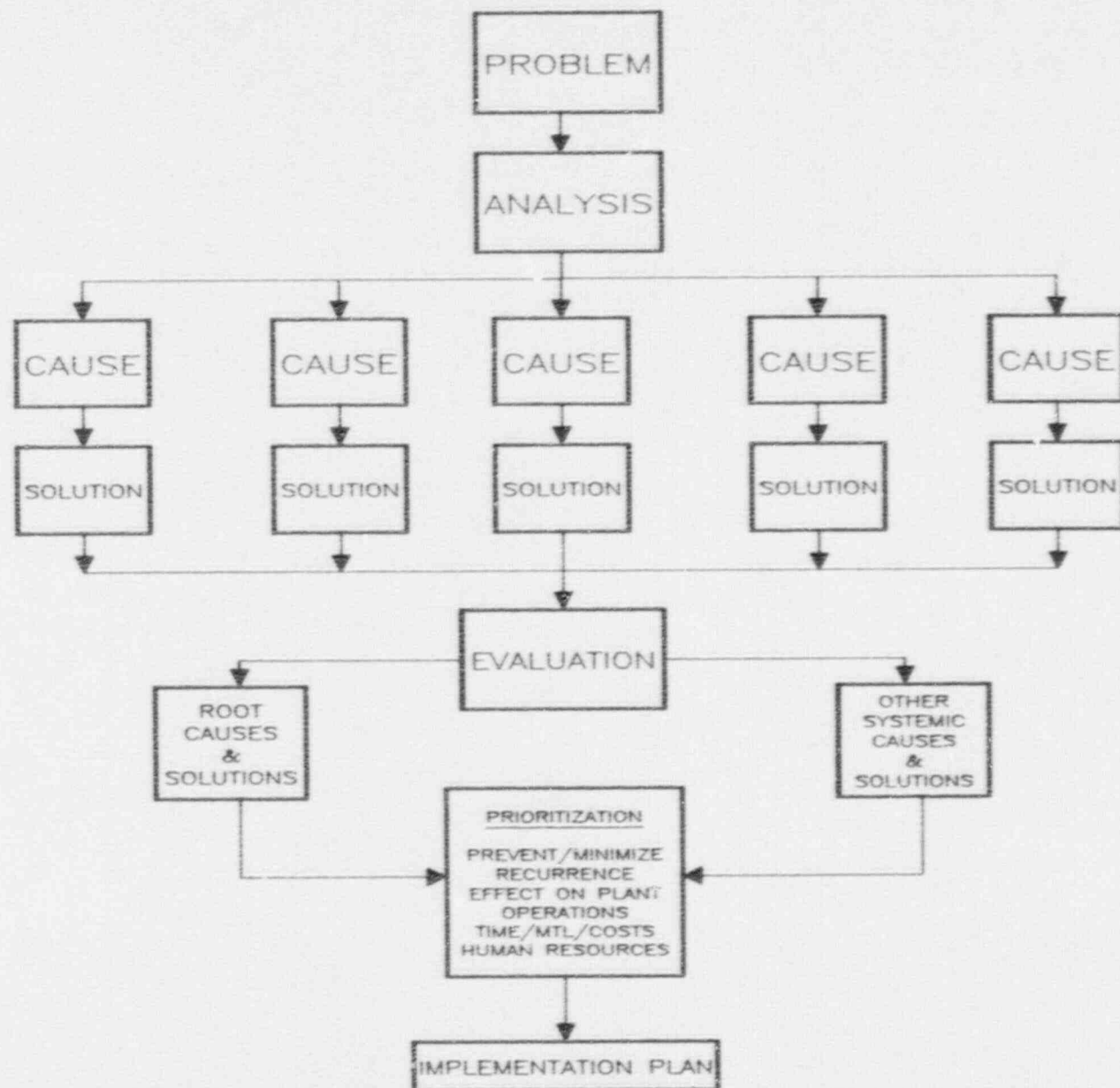


FIGURE 2

TURBINE ISSUES

BY M. J. BERG

MANAGER

MECHANICAL/NUCLEAR DIVISION

HOUSTON LIGHTING & POWER COMPANY

LOW PRESSURE TURBINE PROBLEMS

DISC CRACKING

- THE FIRST KNOWN OCCURANCE OF DISC CRACKING OCCURRED IN 1969. CRACKS WERE FIRST IDENTIFIED ON A WESTINGHOUSE TURBINE IN 1979.
- THE DISCS ARE NUMBERED ONE TO SIX FROM THE CENTER OF THE ROTOR AND MOVING AXIALLY TO THE END OF THE SHAFT.
- STEAM ENTERS THE LP TURBINE AT THE NUMBER ONE DISC AREA AND FLOWS AXIALLY OUTWARD TOWARD THE NUMBER SIX DISC.
- THE KEY IS DRILLED INTO THE DISC AND STEPPED SHAFT AFTER THE DISC HAS BEEN HEATED AND PLACED ON THE SHAFT AND ALLOWED TO COOL.
- THIS DESIGN IS CALLED "SHRUNK ON DISC" AND LIGHT DISC AND KEYWAY DESIGN.
- CRACKS HAVE BEEN DETECTED BY ULTRASONIC TESTING ON TWO OF THREE UNIT 2 LOW PRESSURE TURBINE ROTORS IN THE BORE OF THE NUMBER ONE DISC.
- THE CRACKS MEASURE 1/4" AND 3/8" AND PROPAGATE OUTWARD FROM THE AREA OF THE KEY IN THE DISC.
- HIGH STRESSES IN THE DISC BORE ARE CREATED DUE TO THIS SHRUNK ON INTERFERENCE FIT.

LOW PRESSURE TURBINE PROBLEMS

- THE KEY AND KEYWAY CAUSE STRESS CONCENTRATIONS AND CREATE A CONDITION FOR STRESS CORROSION CRACKING (SCC).
- BECAUSE OF THE CRACK, THE UNIT 2 LP TURBINE #21 ROTOR HAD TO BE REPLACED WITH THE STP SPARE ROTOR.
- HL&P IS PERFORMING A DESIGN REVIEW WITH WESTINGHOUSE TO DETERMINE ROOT CAUSE AND LONG TERM FIX. THE DESIGN, METALLURGICAL AND ENGINEERING EVALUATIONS ARE CONTINUING.
- ONE OPTION PROPOSED BY WESTINGHOUSE IS TO REPLACE THE LIGHT DISC AND KEYWAY WITH AN IMPROVED HEAVY DISC AND KEY PLATE. THIS DESIGN REDUCES THE SUSCEPTIBILITY TO SCC.
- A SECOND OPTION IS TO REPLACE THE ROTORS WITH A DESIGN THAT COMPLETELY ELIMINATES THE SHRUNK ON DISCS CALLED FULL INTEGRAL ROTOR.
- A THIRD OPTION IS TO REPLACE THE ROTORS WITH A DESIGN BY ANOTHER MANUFACTURER WHICH HAS A WELDED ROTOR DESIGN.

**COOPER-BESSEMER OWNERS' GROUP
(DIESELS)**

**BY M. J. BERG
MANAGER**

**MECHANICAL/NUCLEAR DIVISION
HOUSTON LIGHTING & POWER COMPANY**

COOPER-BESSEMER OWNERS' GROUP

- USERS GROUP FORMED IN 1988 TO EXCHANGE INFORMATION BETWEEN TECHNICAL PERSONNEL
- HOWEVER, THE NEED FOR FUNDING GENERIC PROJECTS BECAME APPARENT
- SEVERAL MEETINGS IN 1988 AND 1989, INCLUDED DISCUSSIONS TO ESTABLISH OWNERS' GROUP
- UTILITY EXECUTIVES AGREED TO FORM AN OWNERS' GROUP
- IN FEBRUARY 1990, A CHARTER WAS APPROVED AND CANDIDATES FOR PROJECT MANAGER WERE INTERVIEWED
- TECHNICAL COMMITTEE MEETING WAS HELD IN JUNE 1990 IN CONJUNCTION WITH EPRI EDG CONFERENCE
- STEERING COMMITTEE APPROVED AND FUNDED GENERIC PROJECTS IN AUGUST 1990

COOPER-BESSEMER OWNERS' GROUP

- **OWNERS' GROUP OBJECTIVES**

- **PROVIDE A FORUM FOR JOINT DISCUSSION AND RESOLUTION OF GENERIC TECHNICAL ISSUES**
- **PROVIDE A MECHANISM FOR ESTABLISHING GENERIC POSITIONS FOR INTERACTION BETWEEN UTILITIES, THE OWNERS' GROUP, COOPER-BESSEMER, AND NRC**
- **PROVIDE A METHOD FOR ASSIGNING TASKS, COORDINATING COMPLETION SCHEDULES, AND ALLOCATING COSTS FOR RESOLUTION OF GENERIC ISSUES**
- **IMPROVE COMMUNICATION BETWEEN MEMBERS**

COOPER-BESSEMER OWNERS' GROUP

- GENERIC TECHNICAL ISSUES
 - FUEL INJECTION SYSTEM LEAKS
 - COMMON SPARE PARTS DATABASE
 - REPLACEMENT PARTS EQUIVALENCY
 - SPARE PARTS QUALITY CLASSIFICATION
 - TECHNICAL MANUAL REVISION
 - INFORMATION CLEARING HOUSE

COOPER-BESSEMER OWNERS' GROUP

- **CURRENT ONGOING ISSUES WITH DIESELS AT THE SOUTH TEXAS PROJECT**
 - **FAILURE OF FUEL INJECTION PUMP HOLD DOWN STUDS**
 - **CRACKING OF FUEL INJECTION PUMP DELIVERY VALVE HOLDERS AND FUEL INJECTION NOZZLE HOLDERS**
 - **CAM LOBES AND CAM FOLLOWER ROLLERS OF TWO INTAKE VALVES AND ONE FUEL INJECTION PUMP WERE NOTED TO HAVE SLIGHT GALLING DUE TO LACK OF LUBRICATION DURING FAST STARTS**
 - **FUEL CAM LOBE ROTATED ON THE CAMSHAFT DUE TO HYDRAULIC LOCK**
 - **ONE POWER PISTON WAS FOUND TO HAVE SCUFFING ON THE LOWER PORTION OF THE PISTON SKIRT**
 - **CRACKING OF FUEL INJECTION NOZZLE TIP**

MAIN GENERATOR FAILURE

BY V. R. ALBERT

MANAGER

PLANT SYSTEMS DIVISION

HOUSTON LIGHTING & POWER COMPANY

DESCRIPTION OF EVENT

- AT 14:49:22 ON NOVEMBER 24, 1990, THE CONTROL ROOM RECEIVED A STATOR COOLING SYSTEM TROUBLE ALARM.
- AT 14:49:23, THE TURBINE GENERATOR TRIPPED ON 64R/G1 RUNNING GROUND FAULT.
 - AN AUTOMATIC REACTOR TRIP OCCURRED.
 - ALL SYSTEMS OPERATED AS REQUIRED.
- STATOR COOLING WATER TANK PRESSURE INCREASED FROM 2-6 PSIG NOMINAL TO APPROXIMATELY 34 PSIG DURING THE TRANSIENT.
- GENERATOR HYDROGEN PRESSURE DECREASED FROM 71-75 PSIG NOMINAL TO APPROXIMATELY 65 PSIG DURING THE TRANSIENT.
- SUBSEQUENT REVIEW OF PRE-TRIP OPERATING PARAMETERS REVEALED NO OTHER ABNORMAL INDICATIONS.

INITIAL INVESTIGATION (ROTOR IN PLACE)

UNIT 1

- BOTTOM STATOR COIL #23 END WINDING WAS FOUND MELTED AT THE COIL HEADER CAP ASSEMBLY ON THE TURBINE END OF THE MACHINE.
- THE BLOCKING AND BRACING SYSTEM ON THE TURBINE END OF THE STATOR WINDINGS WAS FOUND TO BE LOOSE. A NUMBER OF AREAS EXHIBITED SIGNIFICANT DUSTING.
- THE NATURAL FREQUENCY OF THE UNIT 1 TURBINE END OF THE STATOR END WINDING STRUCTURE WAS TESTED AND DETERMINED TO BE 110 HZ (INDICATING THAT THE END WINDING STRUCTURE HAD DEVELOPED LOOSENESS).

UNIT 2

- THE NATURAL FREQUENCY OF THE UNIT 2 TURBINE END OF THE STATOR END WINDING STRUCTURE WAS TESTED AND DETERMINED TO BE 135 HZ (WHICH IS THE EXPECTED CONDITION FOR A LIKE NEW MACHINE).
- VISUAL INSPECTION OF THE UNIT 2 STATOR END WINDINGS INDICATED MINIMAL DUSTING (INDICATING NO PROBLEM OR CONCERN).

INITIAL INVESTIGATION (ROTOR IN PLACE) (CON'T)

RESULT

- BASED ON THE DIFFICULTY OF ACCOMPLISHING AN IN-PLACE REPAIR OF THE COIL HEADER CAP, THE RESULTS OF THE PREVIOUS INSPECTIONS, AND THE POTENTIAL FOR OTHER HIDDEN DAMAGE, A DECISION WAS MADE TO PULL THE UNIT 1 ROTOR.

DETAILED INVESTIGATION (ROTOR REMOVED)

- ARC DAMAGE.
 - MELTING OF ONE STATOR COIL END TURN HEADER CAP ASSEMBLY
 - MELTING OF STATOR COOLING WATER HEADER CAP INLET NIPPLE AND RING HEADER NIPPLE
 - COPPER DEBRIS IN GENERATOR AND WATER SUPPLY HEADER
 - CARBON SOOT IN THE AREA SURROUNDING THE FAILED COIL
- EVIDENCE OF ABNORMAL VIBRATION ON THE TURBINE END OF THE GENERATOR.
 - END TURN BASKET LOOSENESS - RESULTS OF IMPACT TEST FOR NATURAL FREQUENCY.
 - "DUSTING" AND "GREASING" OF END TURN COIL SUPPORTS, STRAIN BLOCKS, AND DIAMOND SPACERS.
 - 18 CRACKED END TURN SERIES CONNECTION SOLDER JOINTS.
 - 6 CRACKED STATOR COIL HEADER CAP FERRULES.
- NONDESTRUCTIVE EXAMINATION OF SUSPECT LOCATIONS BY VISUAL, EDDY CURRENT, ULTRASONIC AND REPLICATION METHODS.
- METALLURGICAL EVALUATION OF THE FAILED AND CRACKED STATOR COIL HARDWARE.

DETAILED INVESTIGATION (ROTOR REMOVED) (CON'T)

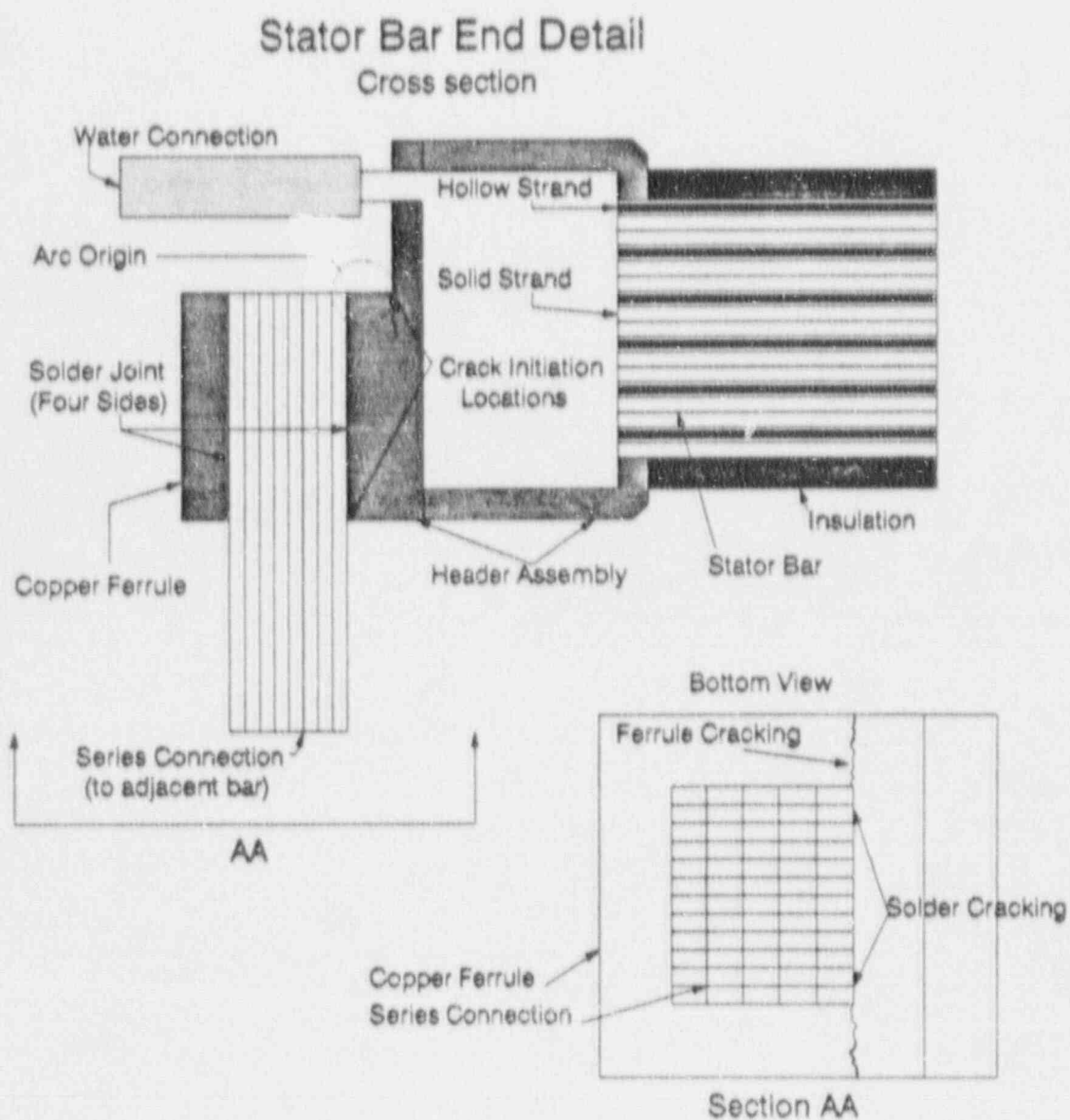
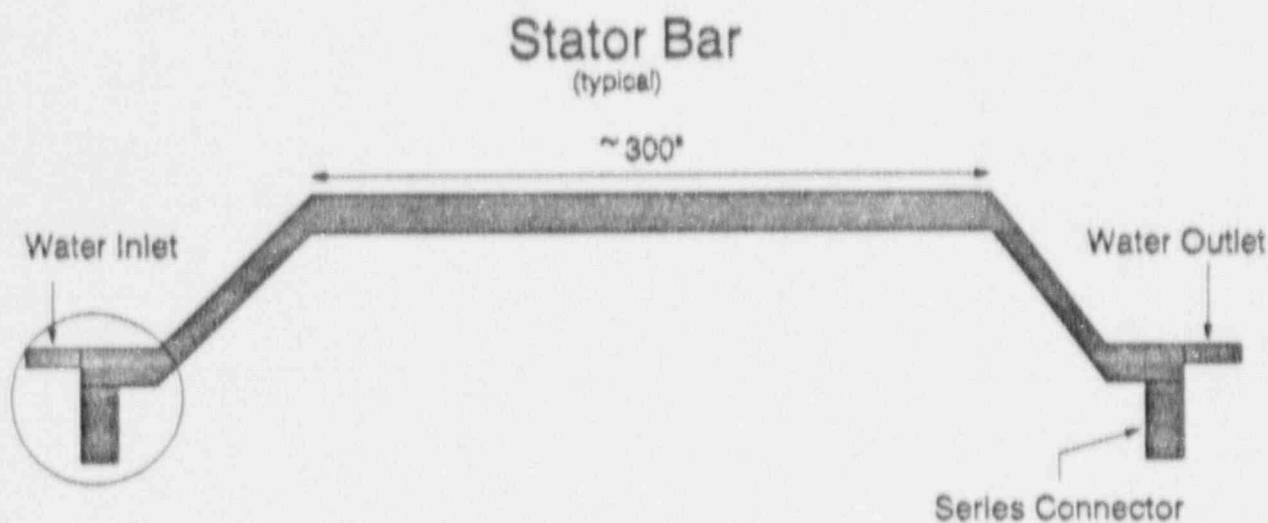
- STATOR COIL TIGHTNESS IN SLOTS WITHIN WESTINGHOUSE ACCEPTANCE CRITERIA (APPROXIMATELY 10% WERE OBVIOUSLY LOOSE).
- STATOR CORE IRON BOLT TORQUES WITHIN WESTINGHOUSE ACCEPTANCE CRITERIA.
- CORE SLOT FILLER MATERIAL (RESIN) EXUDING FROM STATOR CORE SLOTS.
- CONFORMABLE FILLER MATERIAL WAS EASILY REMOVED FROM THE SLOTS AND SHOWED MINIMAL DEGRADATION.
- LEAD CARBONATE CONTAMINATION (RESULT OF MOISTURE IN HYDROGEN COOLING GAS ACTING ON THE SOLDERED FINS OF THE HYDROGEN COOLER).

RESULT

- A VIBRATION-INDUCED FATIGUE FAILURE MECHANISM OF STATOR COIL #23 WAS CONFIRMED BASED ON THE RESULTS OF THIS DETAILED INVESTIGATION.

FAILURE MECHANISM

- END TURN STRUCTURAL BRACING LOOSENEED (INVESTIGATION IN PROGRESS TO DETERMINE MOST PROBABLE CAUSES).
- NORMAL MAGNETIC FORCES CREATED VIBRATORY STRESSES AND FURTHER DEGRADED END TURN BRACING.
- VIBRATION IS TRANSMITTED TO END TURNS OF THE STATOR COILS AS A RESULT OF THE DEGRADED END TURN STRUCTURAL BRACING.
- FATIGUE CRACK DEVELOPMENT IN END TURN HEADER CAP SERIES CONNECTION SOLDER JOINT.
- FATIGUE CRACK PROPAGATION INTO END TURN HEADER CAP FERRULE.
- COMPLETE SEPARATION OF SERIES CONNECTION FROM END TURN HEADER CAP.
- ELECTRICAL ARC WITH RESULTANT VAPORIZATION OF SURROUNDING COPPER.
- ELECTRICALLY CONDUCTIVE PATH TO GROUND AT WATER SUPPLY HEADER VIA COPPER VAPOR.
- GROUND FAULT RELAY ACTUATION AND GENERATOR TRIP.
- METALLURGICAL ANALYSES BY WESTINGHOUSE AND HL&P CONFIRM FATIGUE CRACKING MECHANISM.



ROOT CAUSE DETERMINATION

- THE UNIT 1 GENERATOR FAILURE WAS THE RESULT OF FATIGUE CRACKING OF THE STATOR COIL FERRULE INDUCED BY EXCESSIVE END TURN VIBRATION.
- HL&P, WESTINGHOUSE AND AN INDEPENDENT CONSULTANT ARE ALL ACTIVELY WORKING TO IDENTIFY THE MOST PROBABLE CAUSES OF THE EXCESSIVE AND TURN VIBRATION.
- THE CORRECTIVE ACTIONS RECOMMENDED BY WESTINGHOUSE AND ACCEPTED BY HL&P PROVIDE AN APPROPRIATE COURSE OF ACTION REGARDLESS OF THE FINAL DETERMINATION OF ACTUAL ROOT CAUSE(S).
- THE FOLLOWING IS A LIST OF POSSIBLE ROOT CAUSES UNDER CONSIDERATION:
 1. EXCESSIVE MAGNETIC FORCES DUE TO CLOSE-IN ELECTRICAL FAULTS.
 2. THERMAL DEGRADATION OF THE END TURN WINDING STRUCTURE DUE TO THE JANUARY 20, 1989 HYDROGEN COOLING TRANSIENT.
 3. WATER INGRESS VIA HYDROGEN COOLER DIAPHRAGM RUPTURE DURING THE JANUARY 20, 1989 HYDROGEN COOLING TRANSIENT.
 4. ACIDIC CONTAMINATION FROM LEAD CARBONATE DEPOSITS ON THE TURBINE END WINDINGS.

ROOT CAUSE DETERMINATION (CON'T)

5. INADEQUATE HYDROGEN DEHYDRATION DURING OFF-LINE CONDITIONS.
6. CONTINUOUS CONDENSATION AND RE-VAPORIZATION OF MOISTURE IN THE HYDROGEN COOLING GAS DUE TO INADEQUATE HYDROGEN DEHYDRATION.
7. EXCESSIVE THERMAL RADIATION FROM THE TURBINE END BEARING BRACKET ASSEMBLY DURING THE JANUARY 20, 1989 HYDROGEN COOLING TRANSIENT.
8. DIFFERENTIAL MOVEMENT OF A TOP COIL RELATIVE TO ITS ASSOCIATED BOTTOM COIL DUE TO CONFORMABLE LAYER DEGRADATION, EPOXY DEGRADATION OF PRESTRESSED DEFLECTION SPRING (RIPPLE SPRING) RELAXATION.
9. EXCESSIVE THERMAL GRADIENTS BETWEEN TURBINE END STATOR COILS AND GENERATOR BODY HYDROGEN TEMPERATURE DURING THE JANUARY 20, 1989 HYDROGEN COOLING TRANSIENT.
10. WESTINGHOUSE LARGE GENERATOR END TURN STRUCTURAL MANUFACTURING OR DESIGN FLAW.

REPAIRS AND MODIFICATIONS CONSIDERED

OPTION 1 REPAIRS

- REMOVAL OF COPPER, CARBON AND LEAD CARBONATE CONTAMINATION
- REPLACEMENT OF FAILED STATOR COIL WITH EXISTING SPARE
- REPLACEMENT/REPAIR OF STATOR COILS WITH HEADER CAP FERRULE CRACKS
 - REPLACE FOUR (4) COILS WITH EXISTING SPARES
 - REPAIR TWO (2) COILS BY CANNIBALIZATION OF ONE ADDITIONAL SPARE
- REPAIR CRACKED END TURN SERIES CONNECTION SOLDER JOINTS
- REPLACE END TURN STRUCTURAL SUPPORTS - STRAIN BLOCKS AND DIAMOND SPACERS
- INSTALL SLOT FILLERS AND RE-WEDGE STATOR COIL SLOTS
- RE-TORQUE STATOR CORE THROUGH BOLTS AND BUILDING BOLTS
- PERFORM IMPACT TEST TO DETERMINE POST-REPAIR STATOR NATURAL FREQUENCY
- REPLACE BENT COIL DAMAGED DURING DISASSEMBLY

REPAIRS AND MODIFICATIONS CONSIDERED (CON'T)

OPTION 2 VIBRATION MINIMIZATION AND MONITORING (SEE FIGURES ATTACHED)

- END TURN WINDING IMPROVEMENT MODULES
 - RADIAL BANDING CLAMPS
 - MODIFIED PHASE END BLOCKING
 - DECOUPLED BOTTOM COIL SUPPORT RING
 - THREE PIECE BANDED DIAMOND SPACERS
- FIBER OPTIC END TURN VIBRATION MONITORING SYSTEM
 - SYSTEM NOT AVAILABLE AT TIME OF ORIGINAL GENERATOR PURCHASE
 - WESTINGHOUSE ISSUED OHM 084 ON JULY 22, 1988
 - UNIT 1 SENSORS INSTALLED IN FIRST PHASE OF MONITORING UPGRADE
 - SYSTEM ELECTRONICS INSTALLATION INTENDED AS A LATER OVERALL GENERATOR MONITORING UPGRADE

OPTION 3 A "RIGIFLEX" TYPE GENERATOR REWIND (POTENTIAL FUTURE OPTION)

REPAIRS AND MODIFICATIONS CONSIDERED (CON'T)

OPTION 4 LEAD CARBONATE CONTAMINATION MINIMIZATION

- DUAL TOWER HYDROGEN GAS DRYER (Installed)

OPTION 5 ADDITIONAL GENERATOR MONITORING INSTRUMENTATION

- HYDROGEN PURITY AND PRESSURE MONITORING UPGRADE (Approved)
- RADIO FREQUENCY MONITORING SYSTEM (Under Evaluation)
- ACTIVE SHAFT GROUNDING SYSTEM (Under Evaluation)
- GENERATOR CONDITION MONITORING SYSTEM (Under Evaluation)
- GENAID ON-LINE DIAGNOSTIC SYSTEM (Under Evaluation)

POST MODIFICATION IMPACT TESTS

- THE NATURAL FREQUENCY OF THE UNIT 1 TURBINE END OF THE STATOR END WINDING WAS DETERMINED TO BE GREATER THAN 160 HZ.
- THE NATURAL FREQUENCY OF THE UNIT 1 EXCITER END OF THE STATOR END WINDING WAS DETERMINED TO BE GREATER THAN 170HZ

LONG TERM STRATEGIC PLAN

THE FOLLOWING ARE THE FOUR PRIMARY OBJECTIVES ADDRESSED BY THE STRATEGIC PLAN:

- UNIT 1

- TO PROVIDE STRUCTURAL, MONITORING AND OPERATIONAL ENHANCEMENTS WHICH EXCEED ORIGINAL DESIGN REQUIREMENTS OF THE MAIN GENERATOR.

- UNIT 2

- TO PREVENT THE MAIN GENERATOR FROM REACHING THE DEGRADED STRUCTURAL CONDITION EVIDENT IN THE UNIT 1 NOVEMBER, 1990 GENERATOR INSPECTION.

- ROOT CAUSE ANALYSIS

- TO PROVIDE A COMPREHENSIVE ANALYSIS OF PROBABLE UNIT 1 GENERATOR FAILURE ROOT CAUSES TO ENSURE EFFECTIVE CORRECTIVE ACTION IMPLEMENTATION.

- LONG TERM FIX

- TO DETERMINE SOUND TECHNICAL RECOMMENDATIONS FOR RELIABLE AND EFFICIENT MAIN GENERATOR PERFORMANCE THROUGHOUT THE LIFE OF THE PLANT.