



UNITED STATES  
NUCLEAR REGULATORY COMMISSION

REGION IV

611 RYAN PLAZA DRIVE, SUITE 400  
ARLINGTON, TEXAS 76011-8064

APR 22 1994

Dockets: 50-498  
50-499  
Licenses: NPF-76  
NPF-80

Houston Lighting & Power Company  
ATTN: William T. Cottle, Group  
Vice President, Nuclear  
P.O. Box 289  
Wadsworth, Texas 77483

SUBJECT: MARCH 16, 1994, MANAGEMENT MEETINGS

This refers to the two meetings conducted at the NRC's request at the Region IV office on March 16, 1994. These meetings related to recent standby diesel generator (SDG) problems and a solid state protection system actuation which occurred during surveillance testing. The NRC staff requested these meetings because of the overall significance of these events. These meetings were open to the public and were attended by those on the attached Attendance lists.

The SDG presentation focused on the mechanical failure of SDG 22 and the previous failure in 1989, spurious starts on SDG 21, and the failure of SDG 11 to obtain the required frequency and voltage. It was found that your presentation appropriately addressed the immediate operability concerns the NRC staff had and that the root causes of the failures were being thoroughly evaluated. During the discussion, your staff committed to provide NRC with your plans and schedule for implementing the continuing actions from the SDG 22 failure for the other five SDGs installed at South Texas Project as soon as those plans are finalized. If your understanding of this commitment differs from ours, please contact me immediately.

The Safety Injection Actuation presentation focused on the improper conduct of the solid state protection system surveillance test which resulted in a loss of shutdown cooling with the plant in midloop operation. Your presentation addressed both the operator performance and management oversight weaknesses. The NRC staff noted that the significance of this event was realized in the causes and corrective actions which were identified.

In addition to this meeting, the NRC staff performed a review for each of these events at the site. The results of the inspection activities are documented in NRC Inspection Reports 50-498/94-09, 50-499/94-09; 50-498/94-12, 50-499/94-12; and 50-498/94-13, 50-499/94-13.

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Houston Lighting & Power Company

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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 and its enclosure will be placed in the NRC's Public Document Room.

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

Sincerely,



A. Bill Beach, Director  
Division of Reactor Projects

Attachments:

1. Attendance Lists
2. Licensee Presentations

cc w/attachments:

Houston Lighting & Power Company  
ATTN: James J. Sheppard, General Manager  
Nuclear Licensing  
P.O. Box 289  
Wadsworth, Texas 77483

City of Austin  
Electric Utility Department  
ATTN: J. C. Lanier/M. B. Lee  
721 Barton Springs Road  
Austin, Texas 78704

City Public Service Board  
ATTN: K. J. Fiedler/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: G. E. Vaughn/T. M. Puckett  
P.O. Box 2121  
Corpus Christi, Texas 78403

INPO  
Records Center  
700 Galleria Parkway  
Atlanta, Georgia 30339-5957

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

Bureau of Radiation Control  
State of Texas  
1100 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  
ATTN: Rufus S. Scott, Associate  
General Counsel  
P.O. Box 61867  
Houston, Texas 77208

Shaw, Pittman, Potts & Trowbridge  
ATTN: Joseph R. Egan, Esq.  
2000 N Street, N.W.  
Washington, D.C. 20037

APR 22 1994

E-Mail report to D. Sullivan (DJS)

bcc to DMB (IE45)

bcc distrib. by RIV:

L. J. Callan

Branch Chief (DRP/A)

MIS System

RIV File

R. Bachmann, OGC, MS: 15-B-18

Resident Inspector

Lisa Shea, RM/ALF, MS: MNBB 4503

DRSS-FIPB

Project Engineer (DRP/A)

Branch Chief (DRP/TSS)

|                     |                   |                    |                 |                 |
|---------------------|-------------------|--------------------|-----------------|-----------------|
| RIV:DRP/A <i>df</i> | C:DRP/A <i>df</i> | C:DRS/EB <i>df</i> | D:DRS <i>df</i> | D:DRP <i>df</i> |
| WBJones;df          | WDJohnson         | TFWesterman        | TPGwynn         | ABBeach         |
| 4/20/94             | 4/20/94           | 4/20/94            | 4/21/94         | 4/22/94         |

APR 22 1994

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| WBJones;df          | WDJohnson         | TFWesterman        | TPGwynn         | A#Beach         |
| 4/20/94             | 4/20/94           | 4/20/94            | 4/21/94         | 4/22/94         |

## SOUTH TEXAS PROJECT MANAGEMENT MEETING

DISCUSSIONS ON THE FEBRUARY 10, 1994  
LOSS OF SHUTDOWN COOLING

MARCH 16, 1994

ATTENDANCE

| <u>NAME</u>          | <u>TITLE/ORGANIZATION</u>                  |
|----------------------|--|
| L.J. CALLAN          | RA, RIV                                    |
| J. MONTGOMERY        | DRA, RIV                                   |
| A.B. BEACH           | DIRECTOR, DIV REACTOR PROJECT              |
| TP GWYNN             | DIRECTOR, DIV REACTOR SAFETY               |
| JL PELLET            | CHIEF, OPERATIONS BRANCH, DRS              |
| M.A. SATORUS         | PROJECT ENG, DRP                           |
| R.M. GALLO           | NRR, OPERATOR LICENSING BRANCH             |
| D. Skay              | URR, project manager                       |
| G.L. Constable       | Chief, Plant Support Branch, DRS, NRC/IE   |
| D.P. LOVELESS        | Senior Resident Inspector                  |
| TED H. CLONINGER     | HLSP, V.P. - NUC. ENGINEERING              |
| BRUCE C. MARKENZIE   | HLSP CORR. ACTION GROUP                    |
| Henry H. Butterworth | HLiP Plant Operations Manager              |
| J.J. Shopp           | HESP, GM - Nuclear                         |
| J. Groth             | HLSP, VP - Nuclear                         |
| W.T. Cottle          | HLSP, Gp VP - Nuclear                      |
| P.W. GOLDF           | CITY OF AUSTIN                             |
| Ken Fiedler          | City Public Service, San Antonio           |
| CHRIS A. JOHNSON     | CENTRAL POWER & LIGHT, like SEP Activities |



**SOUTH TEXAS PROJECT MANAGEMENT MEETING**  
**DISCUSSIONS ON STANDBY DIESEL GENERATOR**  
**INITIATIVES**

**MARCH 16, 1994**

**ATTENDANCE**

| <u>NAME</u>             | <u>TITLE/ORGANIZATION</u>                     |
|-------------------------|---|
| <u>L. J. CALLAN</u>     | <u>NRC/RIV RA</u>                             |
| <u>A. PHIL BEACU</u>    | <u>NRC/RIV DIRECTOR, DRP</u>                  |
| <u>T. P. GUYAN</u>      | <u>NRC/RIV DIRECTOR, DRP</u>                  |
| <u>T. F. WESTERMAN</u>  | <u>NRC/RIV Chief, Eng Branch</u>              |
| <u>M. A. SATORIUS</u>   | <u>PROJECT ENG.</u>                           |
| <u>D. P. LOVELESS</u>   | <u>NRC/RIV REACTOR PROJ. A</u>                |
| <u>J. RAJAN</u>         | <u>NRC/RIV Senior Resident</u>                |
| <u>D. SHRY</u>          | <u>NRC/NRR Mech. Engr.</u>                    |
| <u>C. HALLER</u>        | <u>NRC/NRR <sup>NRR</sup> project manager</u> |
| <u>W. H. A. LAMBERT</u> | <u>MAR Associates, INC</u>                    |
| <u>T. J. JORDAN</u>     | <u>COOPER-BESSEMER</u>                        |
| <u>S. A. HUNT</u>       | <u>HL&amp;P/Manager, Systems Engineering</u>  |
| <u>T. E. FRYAR</u>      | <u>HL&amp;P/Diesel Systems Engineer</u>       |
| <u>D. G. FISHER</u>     | <u>HL&amp;P/System Consulting Engineer</u>    |
| <u>J. J. SHIPPARD</u>   | <u>HL&amp;P / SED</u>                         |
| <u>T. H. CLONINGER</u>  | <u>HL&amp;P</u>                               |
| <u>J. T. COLLIS</u>     | <u>HL&amp;P - V.P. Elec. Engr.</u>            |
| <u>P. W. GOLOE</u>      | <u>HL&amp;P</u>                               |
| <u>B. F. MANN</u>       | <u>CITY OF AUSTIN</u>                         |
|                         | <u>HL&amp;P STP</u>                           |



NAME

TITLE/ORGANIZATION

D. Johnson

HLP ST# E/M

HC DAVIS

HLP I/C

William Horvath

HLP OPS

Louis Peter

HLP Operations

Ken Fiedler

CPS, San Antonio

Henry Butterworth

HLP, FOD

BRUCE C. MACKENZIE

HLP, CAG

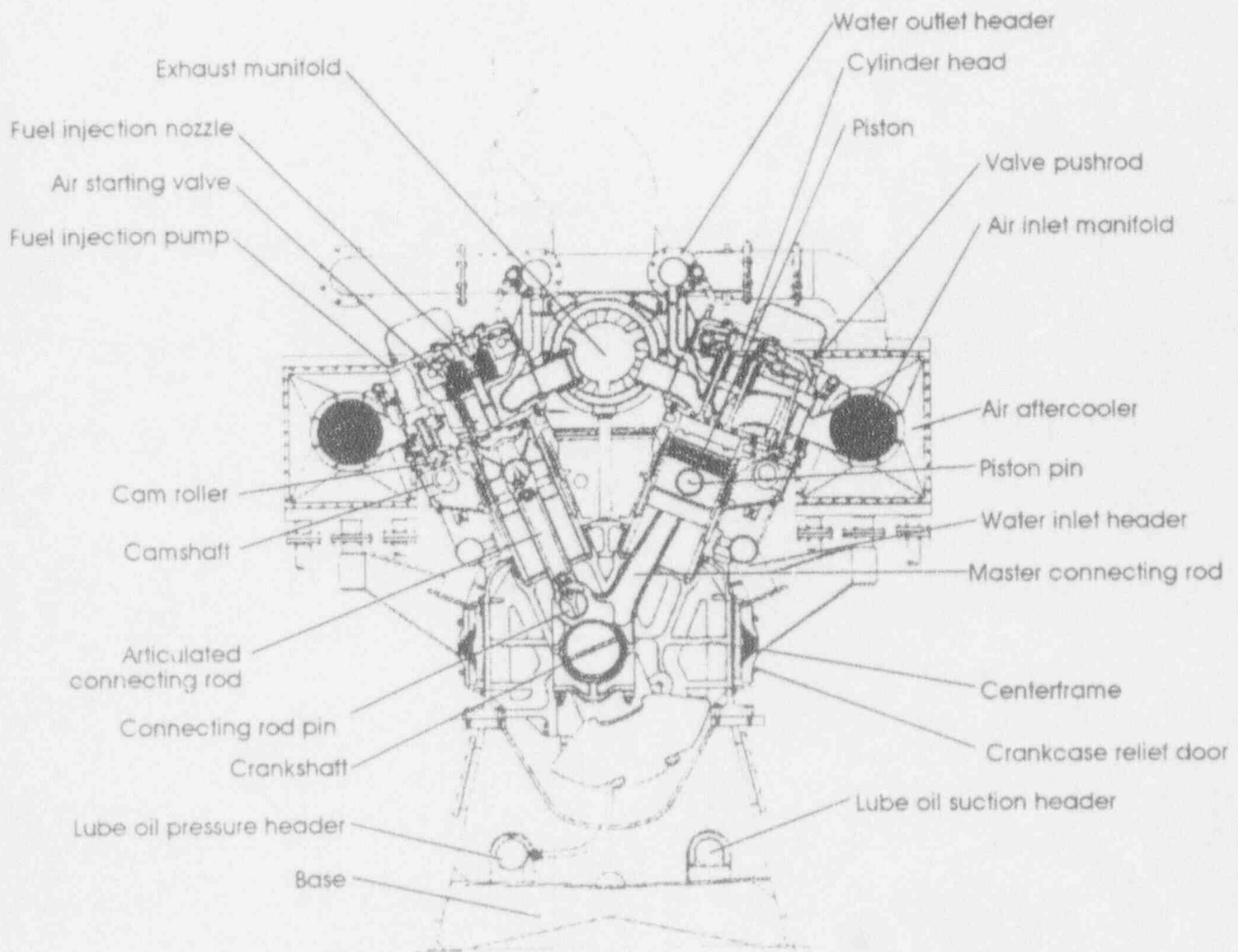
MARK A HARTSHOLD

HLP FOD

John Groth

HLP VP NVC

# South Texas Project Standby Diesel Generator Presentation To NRC Region IV Management



March 16, 1994

AGENDA

- |  |                           |
|--|---------------------------|
| I. OPENING REMARKS   | J. J. SHEPPARD            |
| II. STANDBY DIESEL GENERATOR NO. 22<br>PISTON DAMAGE                                     | G. A. HUNT<br>T. E. FRYAR |
| III. STANDBY DIESEL GENERATOR NO. 21<br>SPURIOUS AUTOSTARTS                              | D. G. FISHER              |
| IV. STANDBY DIESEL GENERATOR NO. 11<br>FAILURE TO OBTAIN REQUIRED<br>FREQUENCY & VOLTAGE | D. G. FISHER              |
| V. CLOSING REMARKS   | T. H. CLONINGER           |

OPENING REMARKS

STANDBY DIESEL GENERATOR NO. 22  
PISTON DAMAGE

## STANDBY DIESEL GENERATOR NO. 22

### EVENT

DURING THE SCHEDULED 18 MONTH SURVEILLANCE INSPECTION OF SDG NO. 22, THE PISTON IN CYLINDER NO. 4R WAS FOUND TO BE BROKEN IN THE LOWER SKIRT AREA

### INVESTIGATION PLAN

- REMOVE AND INSPECT NO. 4R PISTON
- PERFORM METALLURGICAL EXAMINATION OF PISTON
- REMOVE AND INSPECT CYLINDER LINER
- INSPECT ADJACENT AREA OF CYLINDER BLOCK AND CENTER FRAME
- INSPECT CRANKSHAFT AND BEARINGS
- INSPECT NO. 5R PISTON AND CYLINDER
- REVIEW ENGINE HISTORY

## STANDBY DIESEL GENERATOR NO. 22

### INVESTIGATION PLAN (CONT'D.)

- REVIEW OIL ANALYSIS HISTORY
- REVIEW ENGINE ANALYSIS HISTORY
- CONSULT WITH COOPER-BESSEMER AND MPR
- REVIEW VIDEO OF PREVIOUS INSPECTION OF SDG NO. 22
- REVIEW VIDEO OF PREVIOUS INSPECTION OF OTHER ENGINES

### INVESTIGATION RESULTS

- NO. 4R PISTON
  - THRUST SIDE OF PISTON FRACTURED (FIGURE 1)
  - HEAT DISCOLORATION (FIGURE 3)
  - TIN LOSS (FIGURES 2 AND 3)

STANDBY DIESEL GENERATOR NO. 22

INVESTIGATION RESULTS (CONT'D.)

- HEAVY SCORING ON THE THRUST SIDE
- SCORING AND SOME HEAT DISCOLORATION ON NON-THRUST SIDE
- NO. 4R CYLINDER LINER
  - HEAT DISCOLORATION
  - CHROME BREAKDOWN ON THRUST SIDE
  - HEAVY SCORING ON THRUST SIDE
  - SCORING ON NON-THRUST SIDE
- NO. 4R CRANKSHAFT AND BEARINGS
  - CRANKSHAFT WEB DEFLECTION SATISFACTORY
  - NO. 4R CONNECTING ROD BEARING SATISFACTORY



STANDBY DIESEL GENERATOR NO. 22

INVESTIGATION RESULTS (CONT'D.)

- CRANKSHAFT RUN OUT SATISFACTORY
- NO. 4 AND NO. 5 MAIN BEARINGS SATISFACTORY
- OIL ANALYSIS
  - HIGH PARTICULATE AFTER LAST OUTAGE DUE TO BREAK-IN WEAR
  - NO ABNORMAL TRENDS FOR NINE MONTHS PRIOR TO INSPECTION
- NO. 4R FUEL INJECTOR NOZZLE SATISFACTORY
- NO. 5R PISTON AND CYLINDER
  - CONDITION NOT SIMILAR TO NO. 4R PROBLEM
- ENGINE ANALYSIS HISTORY SATISFACTORY
- CONSULTATION WITH VENDORS
  - NO. 4R PISTON DAMAGE UNIQUE TO SDG NO. 22

## STANDBY DIESEL GENERATOR NO. 22

### INVESTIGATION RESULTS (CONT'D.)

- OTHER SDG INSPECTION VIDEOS
  - NO IMMEDIATE CONCERNS IDENTIFIED
  - MONITOR SDG NO. 13 CYLINDER NO. 8L
- CYLINDER BLOCK DIMENSIONS AND CONFIGURATION
  - LOWER BORE OF NO. 4R CYLINDER BLOCK EXCEEDS MANUFACTURERS TOLERANCE FOR OUT OF ROUNDNESS (.002" NEW)
  - NDE OF CYLINDER BLOCK AND CENTER FRAME SATISFACTORY
  - NO. 4R CYLINDER BLOCK STUD NUTS TORQUE SATISFACTORY
  - NO. 4R JACKET WATER INLET PORT BOWED OUTWARD
- RELATIONSHIP TO SDG NO. 22 FAILURE IN 1989

## STANDBY DIESEL GENERATOR NO. 22

### ROOT CAUSE ANALYSIS

- SCUFF ORIGINATED ON LOWER SKIRT - THRUST SIDE
- TIN EMBEDDED IN LINER FROM SCUFF REDUCED LUBRICATION ON THRUST SIDE OF LINER
- REDUCED LUBRICATION CAUSED CONTINUED SCUFF/LOSS OF MORE TIN
- HIGH FORCES ON THRUST SIDE RESULTED IN HIGH SECTIONAL HEATING AND MECHANICAL FORCES
- HIGH TEMPERATURES CAUSED REDUCED MATERIAL STRENGTH, THERMAL GROWTH AND THERMAL STRESSES
- REDUCED MATERIAL STRENGTH RESULTED IN THRUST SIDE FAILURE
- NON-THRUST SIDE TIN TRANSFER DUE TO THERMAL GROWTH
- INITIAL SCUFF CAUSE UNKNOWN BUT COULD BE THE RESULT OF GRIT, DIRT, PISTON/LINER IRREGULARITY OR POTENTIAL IMPACTS FROM THE 1989 EVENT

## STANDBY DIESEL GENERATOR NO. 22

### ROOT CAUSE ANALYSIS (CONT'D.)

- METALLURGICAL ANALYSIS INDICATED NO PISTON DEFECTS
- VISUAL INSPECTION INDICATED NO CYLINDER LINER DEFECTS

### ACTIONS RESULTING FROM ROOT CAUSE ANALYSIS

- NO. 4R PISTON AND LINER REPLACEMENT
- OTHER SDG NO. 22 PISTON AND LINER REPLACEMENTS
- REMOVAL OF LOWER OIL RINGS AND END CAPS ON ALL OTHER SDG NO. 22 PISTONS

### CONTINUING ACTIONS

- CONSIDERATION OF REMOVAL OF LOWER OIL RINGS AND END CAPS FROM REMAINING 5 SDGs IN FUTURE OUTAGES

SDG No. 21

STANDBY DIESEL GENERATOR NO. 21  
SPURIOUS AUTOSTARTS

## STANDBY DIESEL GENERATOR NO. 21

### EVENT

- INADVERTENT START GENERATED WHILE SDG WAS IN STANDBY (3/1/94)
  - START OCCURRED WITH PANEL RESET
  - PREVIOUS EXPERIENCE WITH INADVERTENT START SIGNAL (SIMULATED TESTING)
  - INADVERTENT START BY I&C TECHNICIAN USING FLASHLIGHT (3/5/94)

### INITIAL OBSERVATIONS

- (3/1/94 EVENT)
  - TEST-MODE START, NORMAL RUN
  - 27 (UV) AND 64F (GROUND) RELAYS FLAGGED ON COOLDOWN RESTART

## STANDBY DIESEL GENERATOR NO. 21

### INITIAL OBSERVATIONS (CONT'D.)

- (3/5/94 EVENT)
  - TEST MODE START, NORMAL RUN
  - REPEATED BY FLASHLIGHT THREE TIMES, FIBEROPTIC CABLE MOVEMENT ONCE (WITH ENGINE DISABLED)

### INVESTIGATION PLAN

- TROUBLESHOOTING
  - (3/1/94 EVENT)
    - RECORDER HOOKUP AND MONITOR
    - BENCH TESTING SUSPECT FIBER OPTIC BOARDS
    - BRIDGE/MEGGAR GENERATOR FIELD



## STANDBY DIESEL GENERATOR NO. 21

### INVESTIGATION PLAN (CONT'D.)

- (3/5/94 EVENT)
- RECORDER HOOKUP AND MONITOR
- DISABLE START LATCHES TO TRAP START SOURCE
- FIBER OPTIC BOARD AND CABLE EXAM WITH FLASHLIGHT
- MONITOR LEAKAGE CURRENTS WHILE EXAM W/ FLASHLIGHT
- VOLTAGE POINT SURVEYS
- CHECK SELECT RELAY NO CONTACT GAP
- BENCH TESTING SUSPECT FIBER OPTIC BOARDS

## STANDBY DIESEL GENERATOR NO. 21

### INVESTIGATION RESULTS

- (3/1/94 EVENT)
  - WEAK TRANSISTOR IN FIBER OPTIC BOARD G CIRCUIT 3
- (3/5/94 EVENT)
  - ABRADED FIBER OPTIC CABLE BOARD D CIRCUIT 2

### ROOT CAUSE ANALYSIS

- 03/01/94 EVENT ANALYSIS
  - FAILURE SIMILAR TO 1E FIBER OPTIC BOARDS (VARISTORS/TRANSISTORS)
  - SCOPE OF EXPOSURE FROM FAILED FIBER OPTIC BOARDS EXPANDED TO COVER NON-1E FIBER OPTIC BOARDS

## STANDBY DIESEL GENERATOR NO. 21

### ROOT CAUSE ANALYSIS (CONT'D.)

- 03/05/94 EVENT ANALYSIS
  - ROOT CAUSE ELUSIVE
  - ILLUSTRATED REQUIRED CONTROLS TO PANEL ACCESS

### ACTIONS RESULTING FROM ROOT CAUSE ANALYSIS

- REMEDIAL
  - FIBER OPTIC BOARD G REPLACED
  - DEFECTIVE FIBER OPTIC CABLE REPLACED

STANDBY DIESEL GENERATOR NO. 21

ACTIONS RESULTING FROM ROOT CAUSE ANALYSIS (CONT'D.)

- ADDITIONAL CORRECTIVE ACTIONS BEING EVALUATED
  - ENHANCE FIBER OPTIC BOARD PM PROGRAM
  - LIMIT ACCESS TO SDG CONTROL PANELS
  - WARNING SIGNS ON PANEL DOORS
  - REDUCE INTERIOR BULB WATTAGE
  - EVALUATE MODIFICATION OF SDG START CIRCUIT TO REMOVE FIBER OPTIC BOARDS
  - IMPROVE CONTROL PANEL ENVIRONMENT
  - INSTALL T-MOD FOR CONTINUED MONITORING

STANDBY DIESEL GENERATOR NO. 11  
FAILURE TO OBTAIN REQUIRED  
FREQUENCY & VOLTAGE

## STANDBY DIESEL GENERATOR NO. 11

### EVENT

- SDG NO. 11 FAILED TO DEVELOP REQUIRED VOLTAGE DURING TEST
  - 02/03/94
  - 03/01/94
- ENGINE RUN, COOLDOWN, AND SHUTDOWN OTHERWISE NORMAL
- TEST FAILED, DECLARED VALID FAILURE

### INITIAL OBSERVATIONS

- BOTH EVENTS IDENTICAL
  - NO VOLTAGE OR FREQUENCY INDICATION REMOTE OR LOCAL
  - UV RELAYS/LOCKOUTS FLAGGED
  - ERFDADS COMPUTER RECORDED 55V GENERATOR OUTPUT

## STANDBY DIESEL GENERATOR NO. 11

### INVESTIGATION PLAN

- 02/03/94 EVENT TROUBLESHOOTING
  - GENERATOR FIELD LOOP CONTINUITY
  - FIELD FLASH POWER
  - K1 CONTACTOR
  - VOLTAGE REGULATOR MODULE, DIODES, SCRS
  - GENERATOR PTs AND DRAWER
  - FIELD FLASH CIRCUIT COMPONENTS
- 7 SUCCESSFUL STARTS BETWEEN 02/03/94 AND 03/01/94
- 03/01/94 EVENT TROUBLESHOOTING
  - SAME PLAN AS PREVIOUS
  - CYCLIC TESTING OF FIELD FLASH CIRCUIT

## STANDBY DIESEL GENERATOR NO. 11

### INVESTIGATION PLAN (CONT'D.)

- K1 CONTACTOR SHOP TESTING (CYCLIC)
- K1 CONTACTOR DISASSEMBLY / FAILURE ANALYSIS
- TEST RUN WITH FIELD FLASH DISABLED, (2/3/94) FAILURE SIMULATED

### INVESTIGATION RESULTS

- 02/03/94 EVENT INSPECTION RESULTS
  - VR1 RELAY CONTACTS
  - K1 INSPECTION / TEST SATISFACTORY
  - 14FFX1/2 RELAYS CYCLIC TESTS / EXPANDED SCOPE
- 03/01/94 EVENT INSPECTION RESULTS
  - K1 CONTACTOR INTERMITTENT FAILURE
  - K1 CONTACTOR RESET COIL DAMAGED



## STANDBY DIESEL GENERATOR NO. 11

### ROOT CAUSE ANALYSIS

- K1 CONTACTOR FAILURE INTERMITTENT
- K1 CONTACTOR HISTORY
- VR1 RELAY
- TEST RUN DEMONSTRATED SUFFICIENT RESIDUAL CORE MAGNETISM TO 'BOOTSTRAP' THE VOLTAGE REGULATOR

### ACTIONS RESULTING FROM ROOT CAUSE ANALYSIS

- REMEDIAL
  - VR1/2 RELAY REPLACED (2/3/94 EVENT)
  - K1 CONTACTOR REPLACED
  - COMPLETE FIELD FLASH CIRCUIT COMPONENT REPLACEMENT (OVERHAUL)

## STANDBY DIESEL GENERATOR NO. 11

### CONTINUING ACTIONS

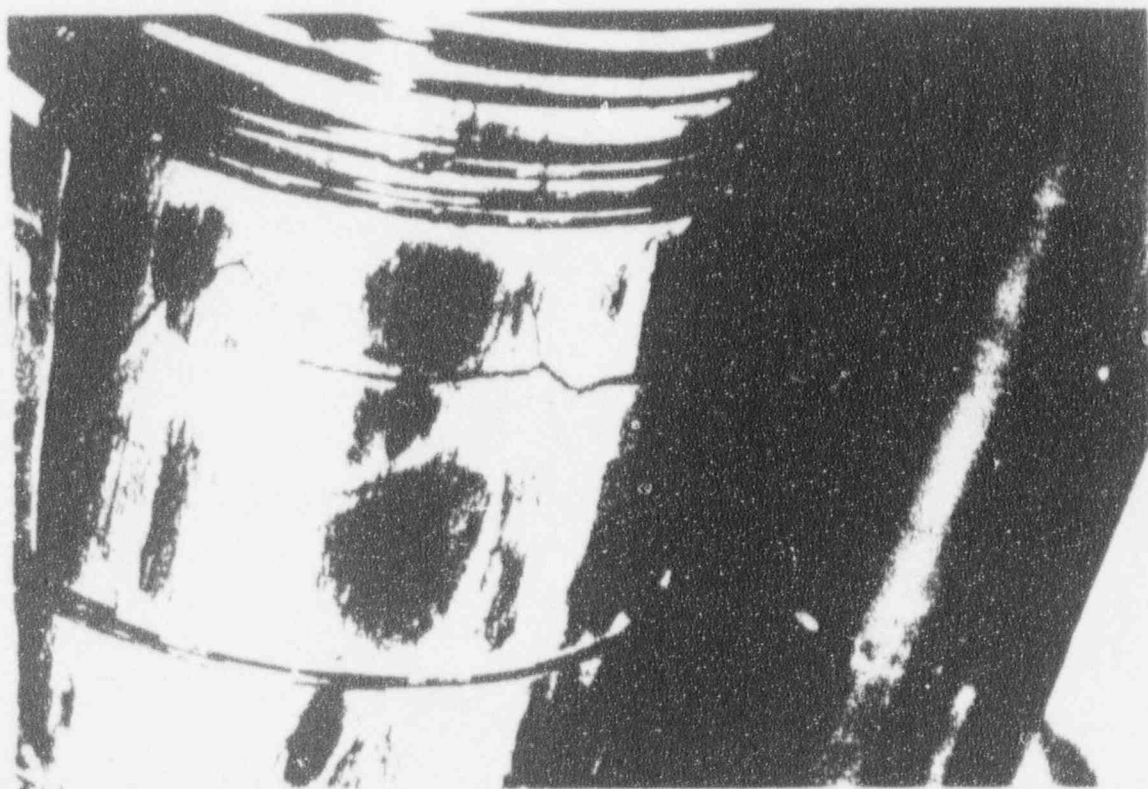
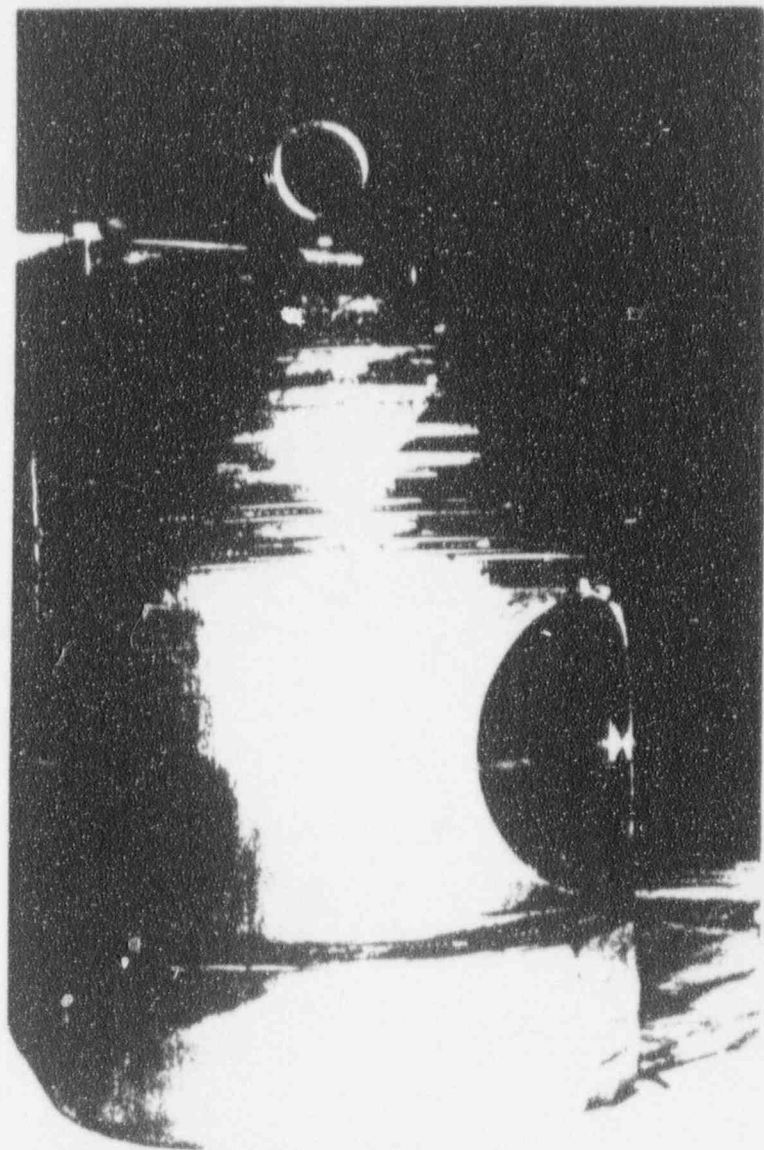
- K1 CONTACTOR PM ENHANCEMENT
- FIELD FLASH CIRCUIT PM GENERATION
- INDEPENDENT ASSESSMENT OF CONTROL PANEL INSTALLATION (MPR ASSOCIATES)
- EVENTS OF 02/03/94 AND 03/01/94 ARE COMMON / LER

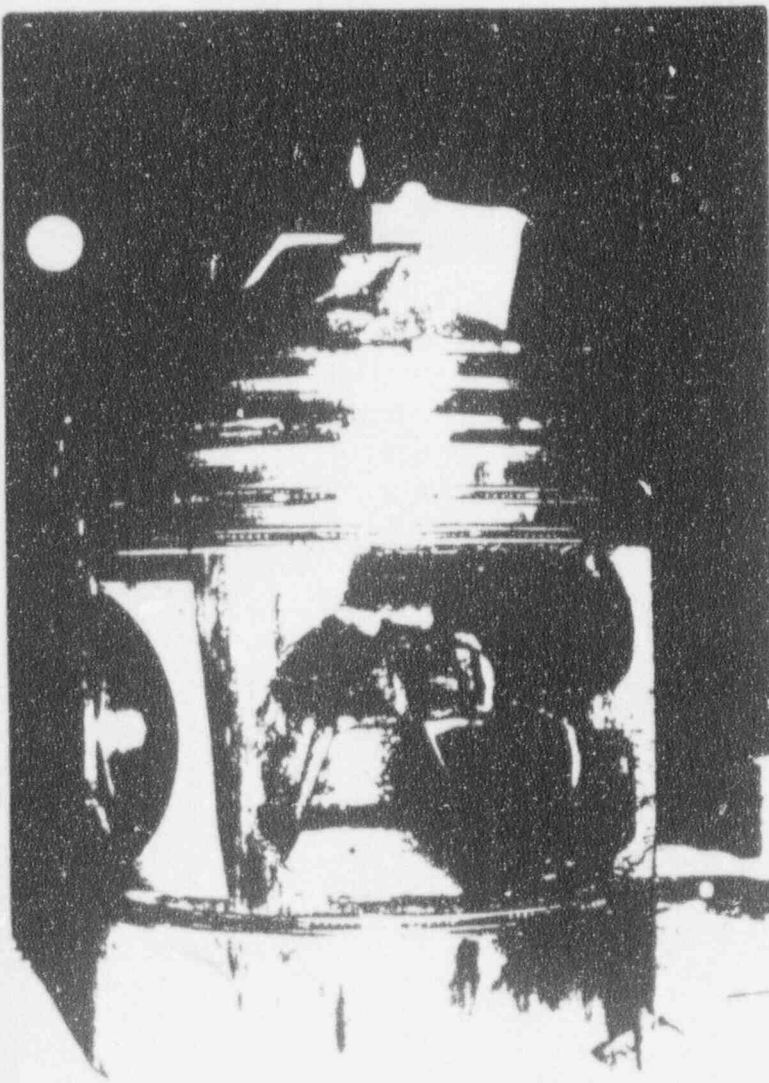
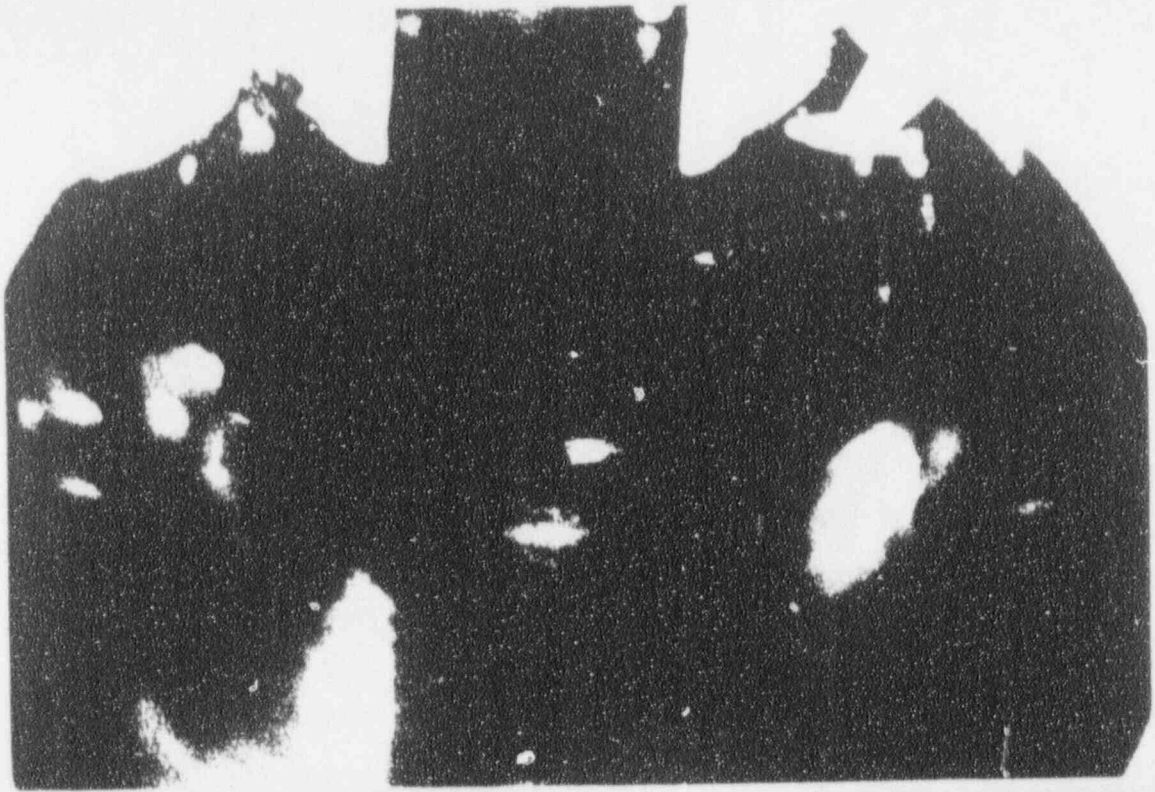
CLOSING REMARKS

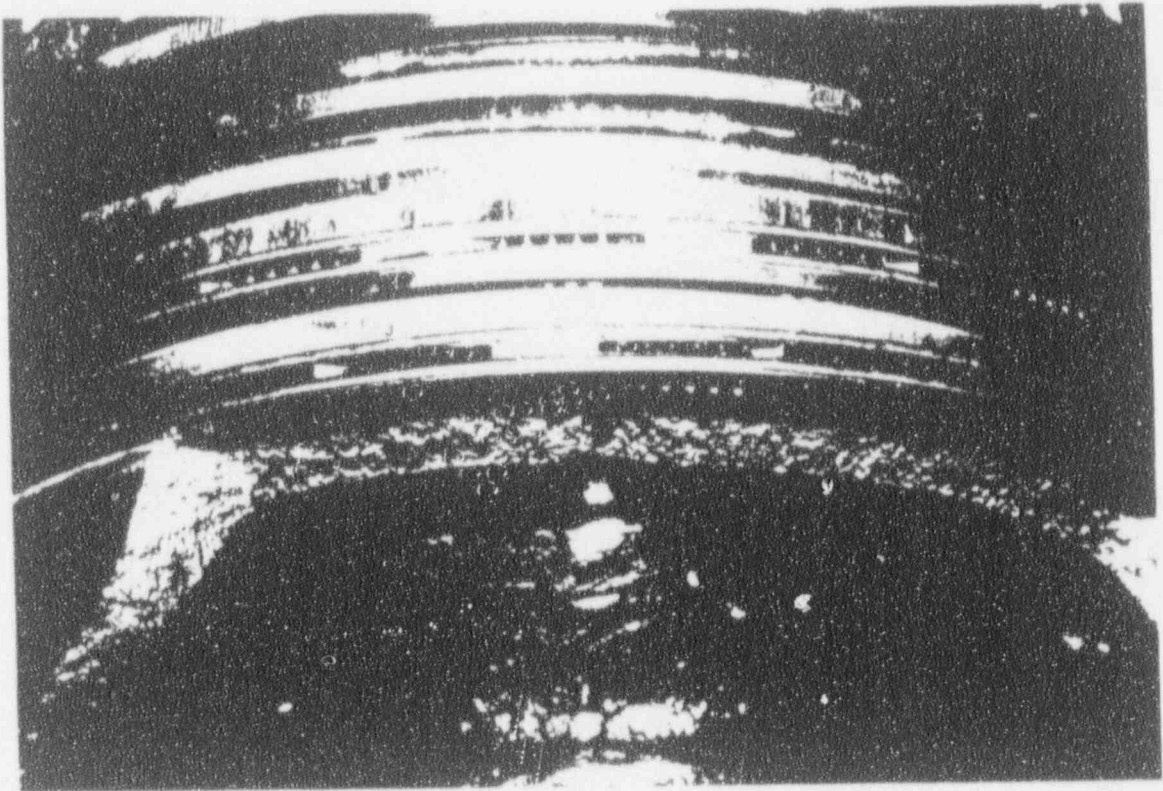
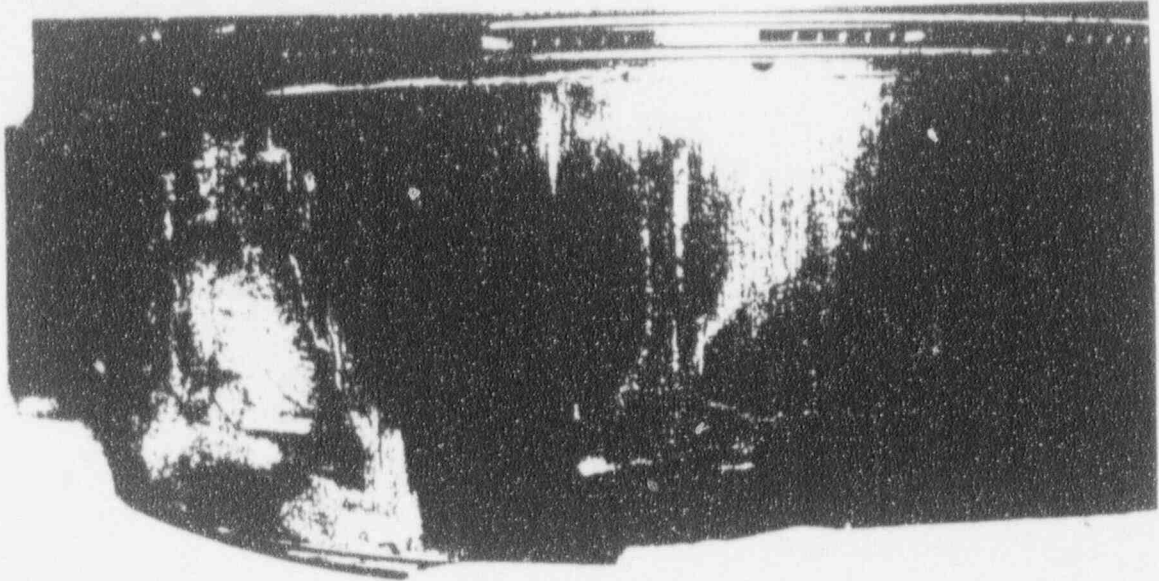


## Damaged Piston Photograph Legend

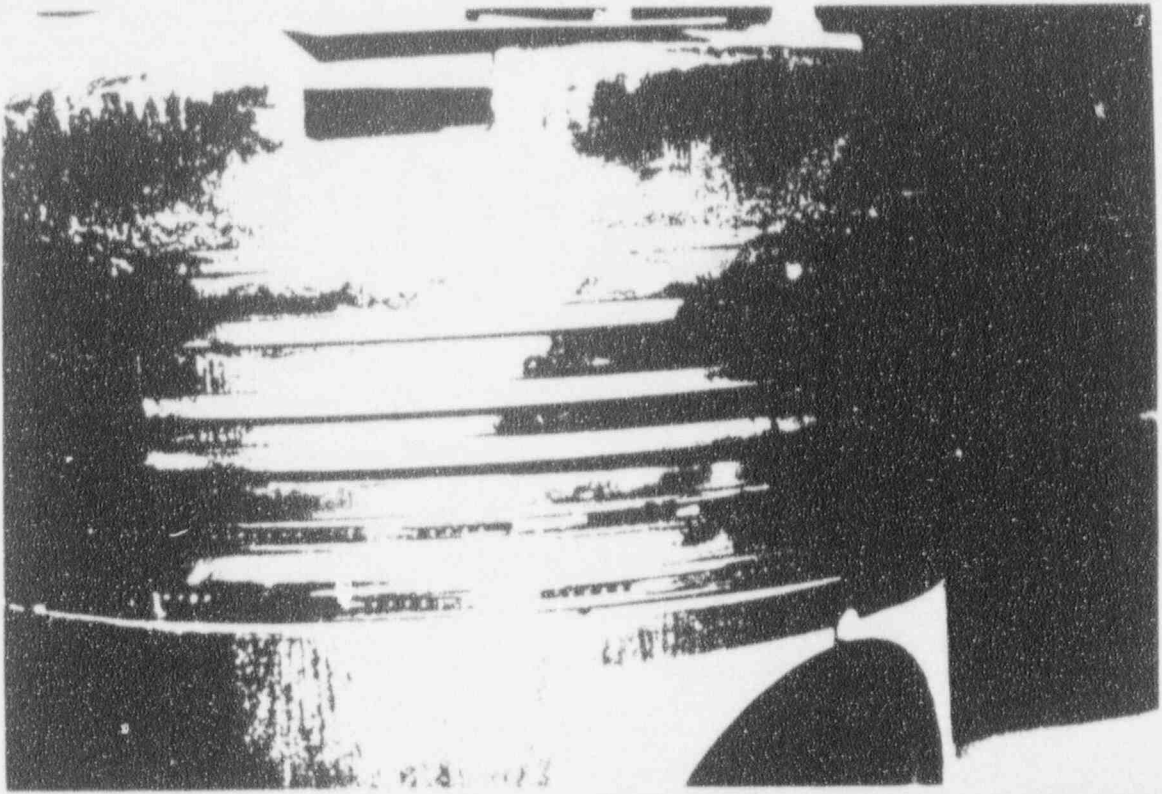
1. Damage to #4R piston as viewed from thrust side (piston laying on side). Heat discoloration and tin loss apparent from lower piston skirt.
2. #4R piston as viewed from the non-thrust side (piston upright). Tin loss on non-thrust side visible.
3. #4R piston thrust side damage between #6 & #7 oil control rings with fractured pieces installed (piston laying on side). Heat discoloration, tin loss and scuffing visible.
4. View of the thrust side #4R cylinder liner. Scuffing visible.
5. Damage to #4R piston as viewed from thrust side (piston upright). Heat discoloration of piston skirt remaining intact is visible. No damage to piston pin boss and bushing are visible from this picture.
6. Damaged #4R piston and three fractured pieces from between the #6 & #7 oil control rings (piston laying on side). Relative damage visible with respect to the lower skirt and the area between the #6 & #7 oil control rings. Note that piston pin is installed with no visible sign of damage.
7. Lower #4R piston skirt damage on the thrust side at about the 2 o'clock position. Heat discoloration, tin loss and scuffing are all visible.
8. View from the bottom of the fractured #4R piston at the #6 ring land area. Fracture of the piston at the #6 oil control ring land, but below the oil drain hole, is visible.
9. #4R piston upper ring land area as viewed from the non-thrust side (piston upright). Some carbon build-up above the top compression ring is visible with relatively insignificant amounts of carbon down to the fourth (and last) compression ring. No carbon is visible below that point. None of the rings were found stuck due to carbon.
10. #4R piston damage as viewed from thrust side with piston pin installed (piston upright). The lower (#7) oil control ring fracture area is visible.
11. #4R piston damage as viewed from thrust side with piston pin removed (piston upright). Full view of damage to the thrust side is visible.
12. #4R piston pin exhibited no sign of abnormal wear.
13. #4R Piston pin bushing as viewed from the center exhibited no sign of abnormal wear.
14. #4R piston pin bushing as viewed from the side exhibited no sign of abnormal wear.







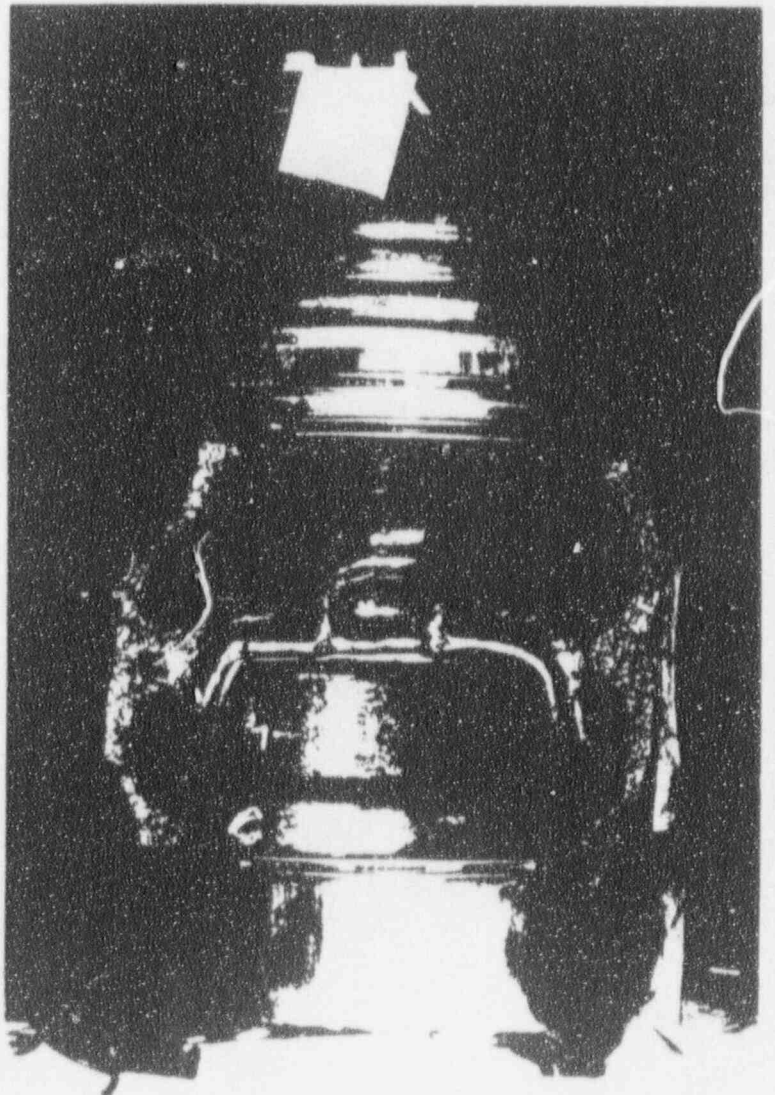




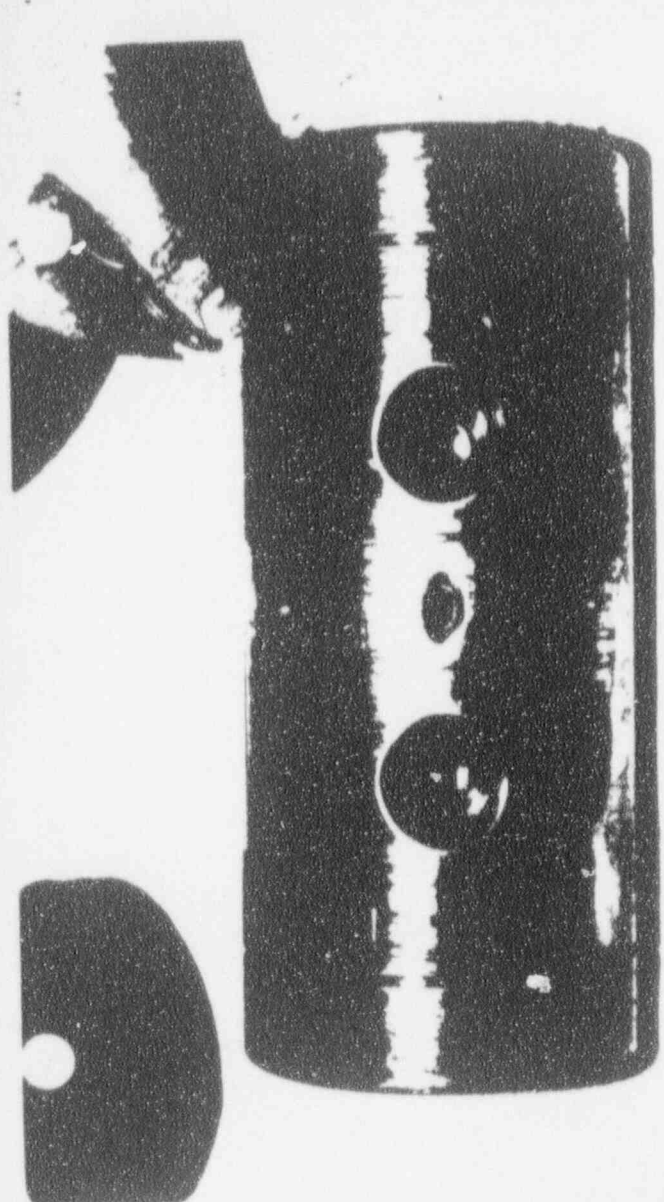
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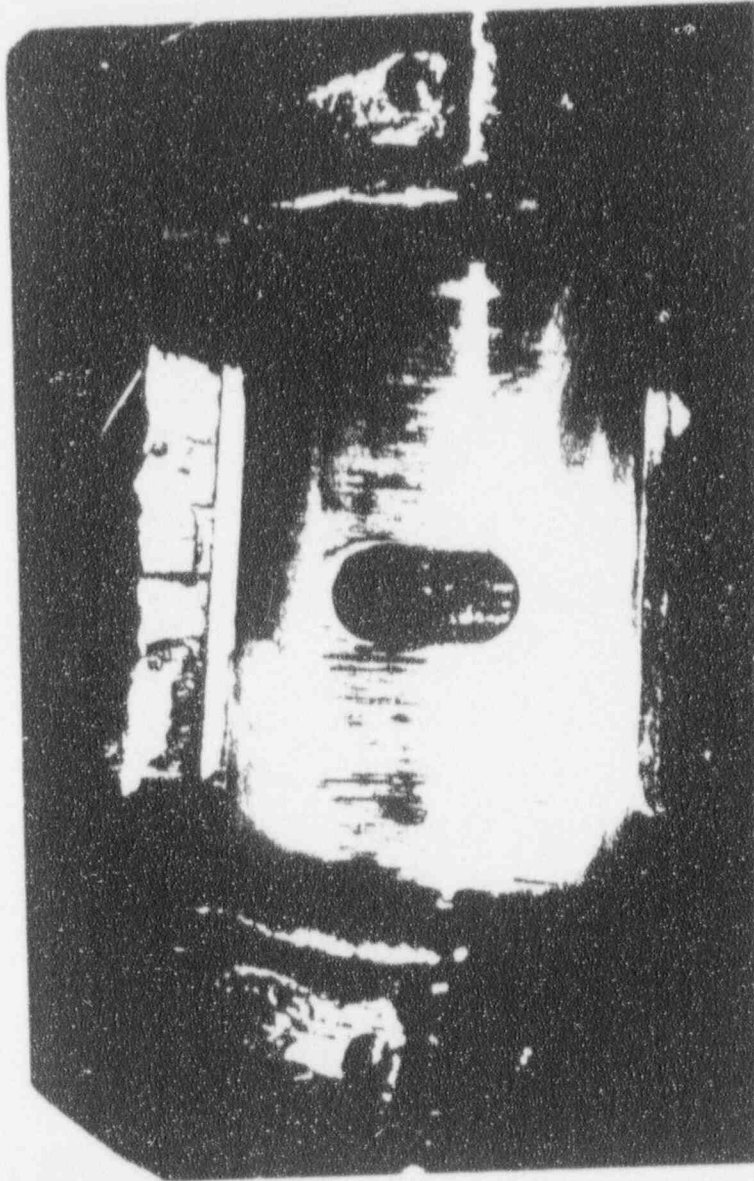
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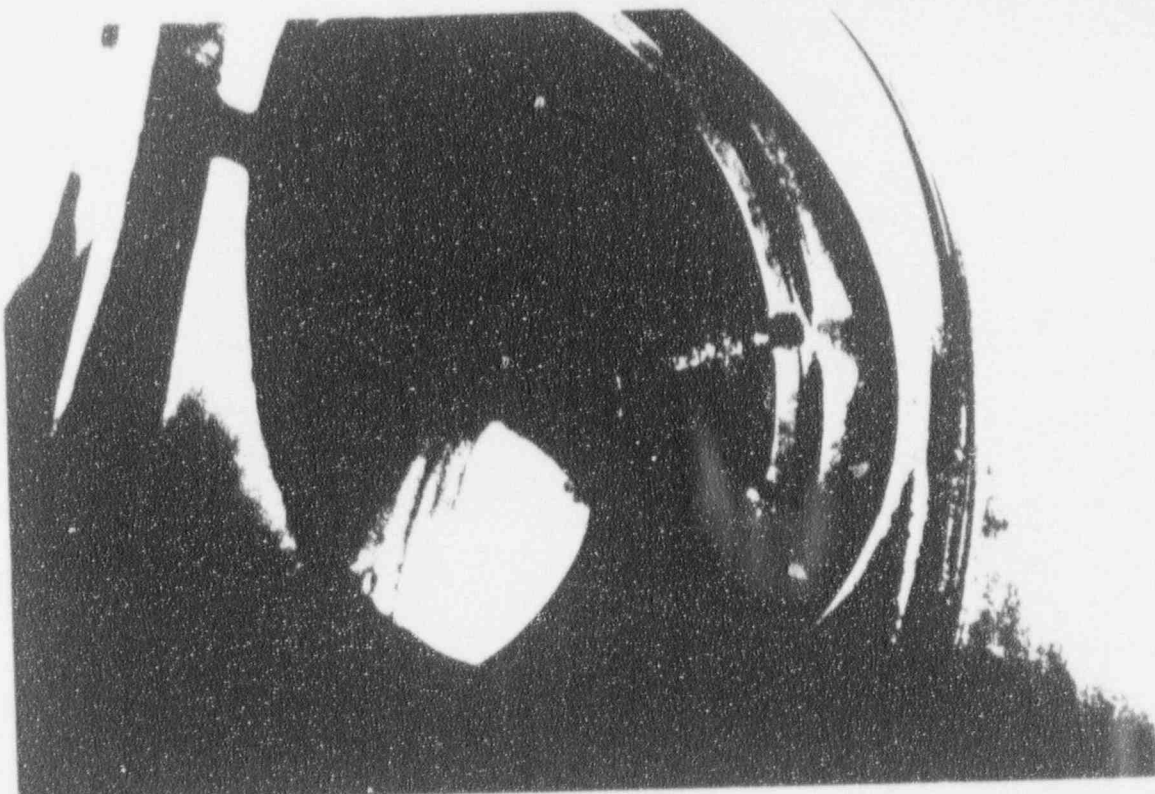
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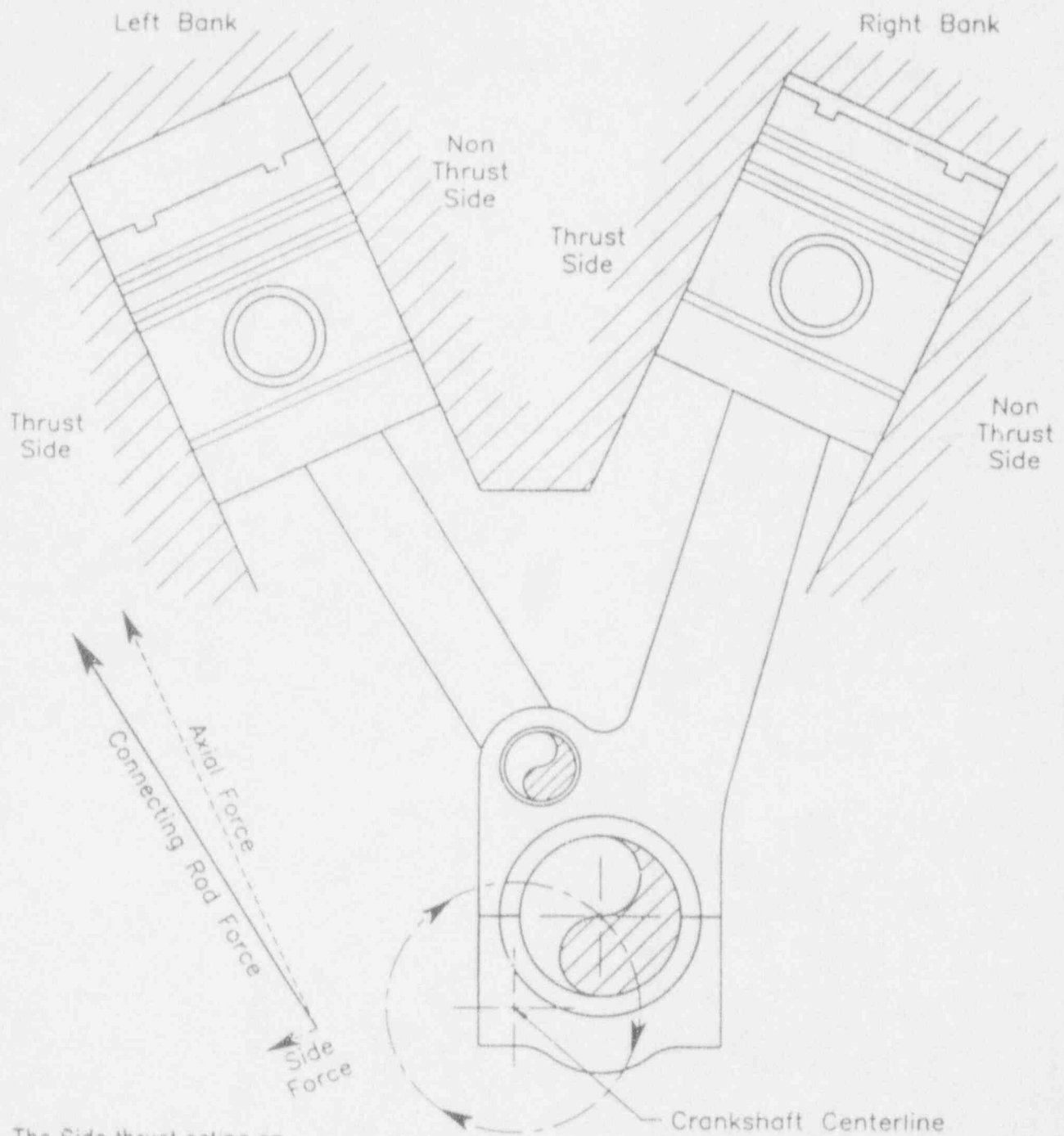
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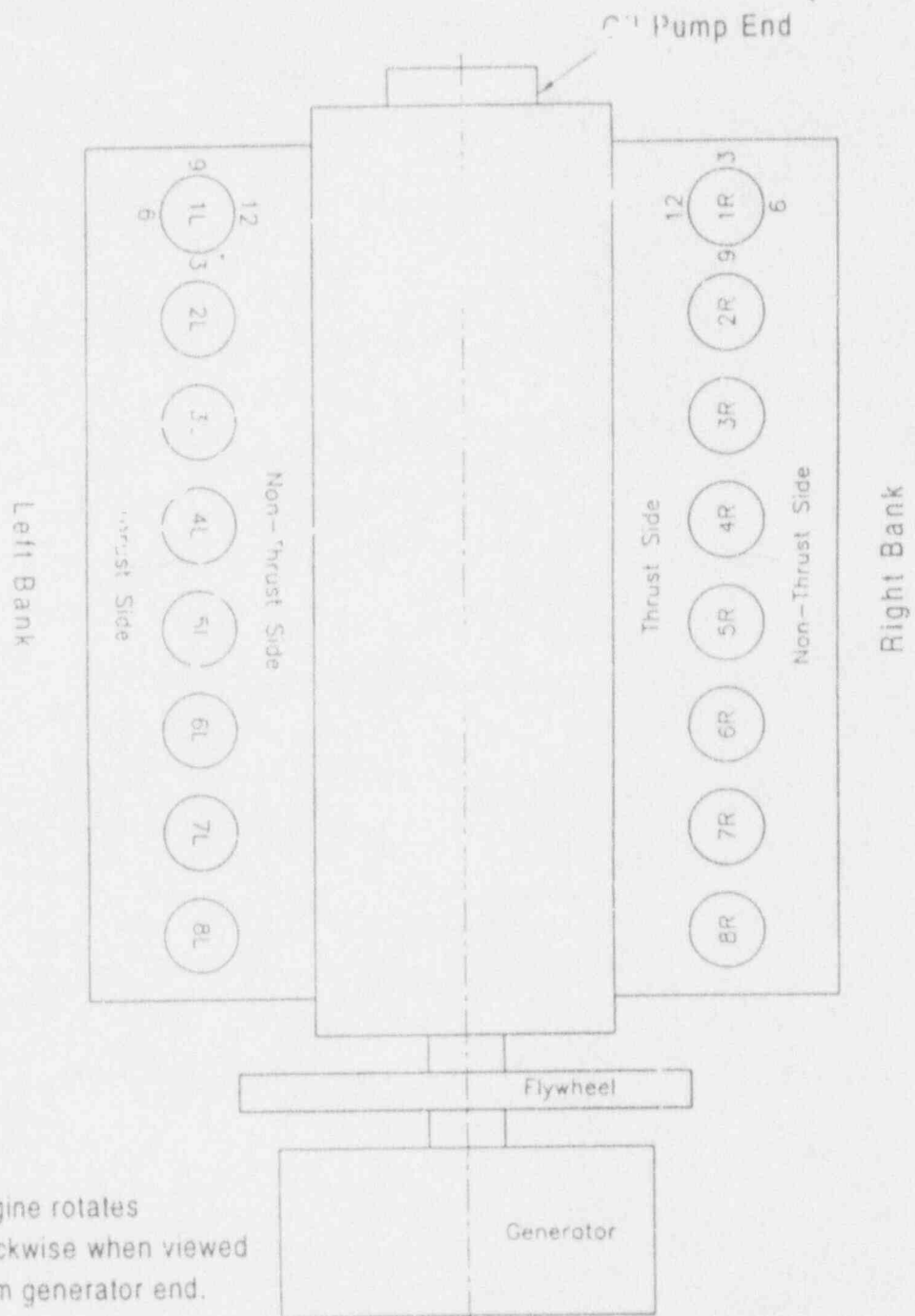
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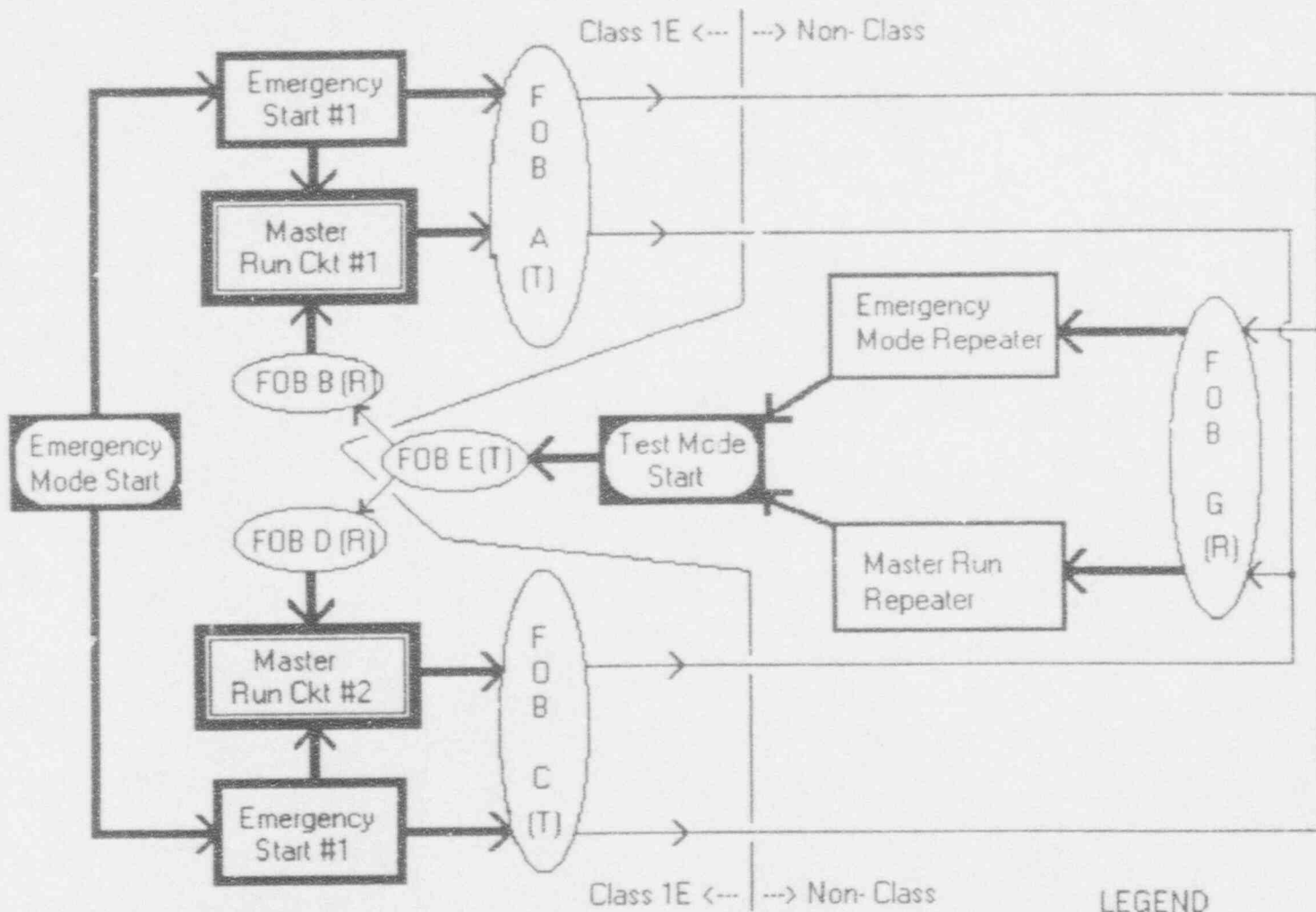
The Side thrust acting on the piston pin is transferred to the piston and is reacted by an equal and opposite force from the cylinder.

View From Generator End

Piston and Cylinder Linear Thrust and Non-Thrust Sides



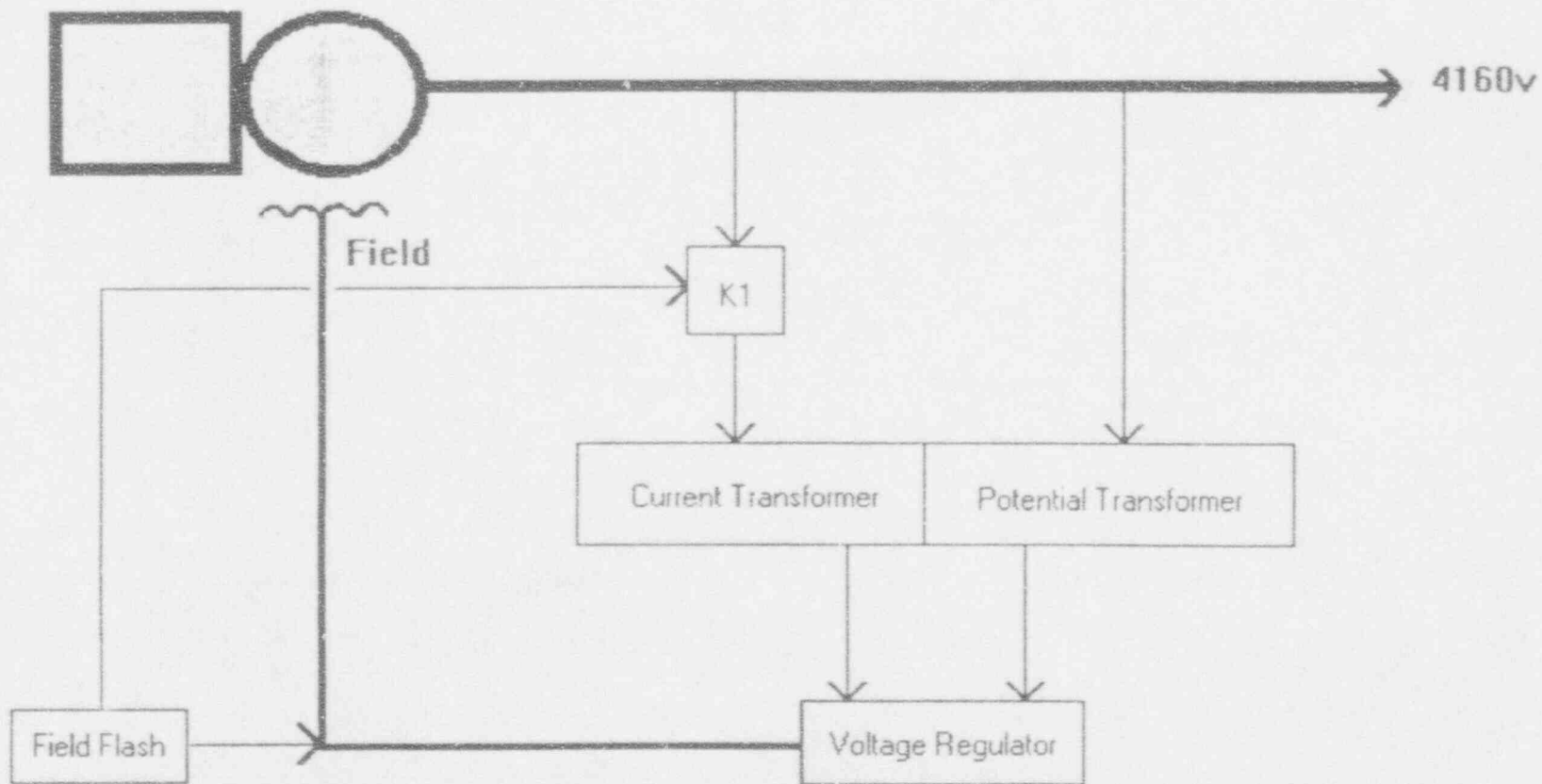
Piston and Cylinder Liner Nomenclature



**Fiber Optic Board  
Starting Circuit Interface  
Block Diagram**

**LEGEND**

- 
- FOB - Fiber Optic Board
- (T) - Transmitter
- (R) - Receiver



**Standby Diesel Generator  
Voltage Regulator / Field Flash Block Diagram**

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# **SOUTH TEXAS PROJECT**

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## **Safety Injection Actuation Presentation**

March 16, 1994



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**VISION: STP -- A WORLD-CLASS POWER PRODUCER**

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SAFETY INJECTION ACTUATION

MARCH 10, 1994

AGENDA

|  |                  |
|--|------------------|
| OPENING REMARKS                        | BILL COTTLE      |
| EVENT DESCRIPTION AND CHRONOLOGY       | HANK BUTTERWORTH |
| INVESTIGATION CONCLUSIONS              | JOHN GROTH       |
| RESPONSE TO SAFETY INJECTION ACTUATION | JOHN GROTH       |
| CONSEQUENCES OF THE EVENT              | JOHN GROTH       |
| CAUSES OF THE EVENT                    | JOHN GROTH       |
| CORRECTIVE ACTIONS                     | JOHN GROTH       |
| SAFETY SIGNIFICANCE                    | JOHN GROTH       |
| SUMMARY                                | BILL COTTLE      |



SAFETY INJECTION ACTUATION  
MARCH 10, 1994

OPENING REMARKS

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

EVENT DESCRIPTION

AND

CHRONOLOGY

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

EVENT DESCRIPTION

UNIT 1 RECEIVED AN UNANTICIPATED SAFETY INJECTION ACTUATION ON TRAINS A, B, AND C DURING RESTORATION FROM SOLID STATE PROTECTION SYSTEM LOGIC TRAIN S FUNCTIONAL TEST, 0PSP03-SP-0005S.

CHRONOLOGY

- DURING SHIFT CHANGE, THE ON COMING SHIFT SUPERVISOR WAS INFORMED OF THE SURVEILLANCE REQUIREMENT TO PERFORM FUNCTIONAL TESTING OF THE SOLID STATE PROTECTION SYSTEM LOGIC TRAINS PRIOR TO MODE CHANGE.
- PREPARATIONS WERE MADE TO PERFORM PROCEDURE 0PSP03-SP-0005S, SSPS LOGIC TRAIN S FUNCTIONAL TEST. THIS INCLUDED A PRE-JOB BRIEFING THAT WAS ESSENTIALLY ONLY A GENERAL DISCUSSION OF TEST CONDUCT AND REQUIREMENTS BY A REACTOR OPERATOR.

## SAFETY INJECTION ACTUATION

MARCH 10, 1994

### CHRONOLOGY (CONT'D)

- TEST PERFORMERS INAPPROPRIATELY TRANSITIONED FROM SOLID STATE PROTECTION SYSTEM TRAIN S TO SOLID STATE PROTECTION SYSTEM TRAIN R DURING THE INITIAL SURVEILLANCE SETUP STEPS.
- TEST PERFORMERS IDENTIFIED A PERCEIVED PROCEDURE PROBLEM UPON ENCOUNTERING A NOTE DIRECTING STEPS BE CONDUCTED IN SOLID STATE PROTECTION SYSTEM TRAIN S. BECAUSE OF THE AFOREMENTIONED FAILURE TO MAKE A LOGIC CABINET TRANSITION THIS WOULD HAVE RESULTED IN TWO TRAINS BEING TESTED CONCURRENTLY.
- TEST PERFORMERS CONFIRMED WITH AN I&C SUPERVISOR THAT TWO TRAINS ARE NOT TO BE IN TEST AT THE SAME TIME.

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

CHRONOLOGY (CONT'D)

- THE TEST PERFORMERS DISCUSSED THE PERCEIVED PROCEDURE PROBLEM WITH THE SHIFT SUPERVISOR AND MID-LOOP COORDINATOR (SRO) WHO DETERMINED THAT THE PROCEDURE WAS NOT IN ERROR AND COULD BE PERFORMED AS WRITTEN.
- UPON RETURNING TO THE SOLID STATE PROTECTION SYSTEM CABINETS THE TEST PERFORMERS REALIZED THAT THEY HAD TESTED THE WRONG TRAIN.
- DURING RESTORATION, A SAFETY INJECTION ACTUATION ON TRAINS A, B, AND C OCCURRED.
- SHUTDOWN COOLING LOST DUE TO SAFETY INJECTION SIGNAL.
- SAFETY INJECTION VALVES REPOSITIONED DUE TO SAFETY INJECTION SIGNAL, PROVIDING A GRAVITY DRAIN FLOW PATH FROM THE REFUELING WATER STORAGE TANK TO THE REACTOR COOLANT SYSTEM.

SAFETY INJECTION ACTUATION

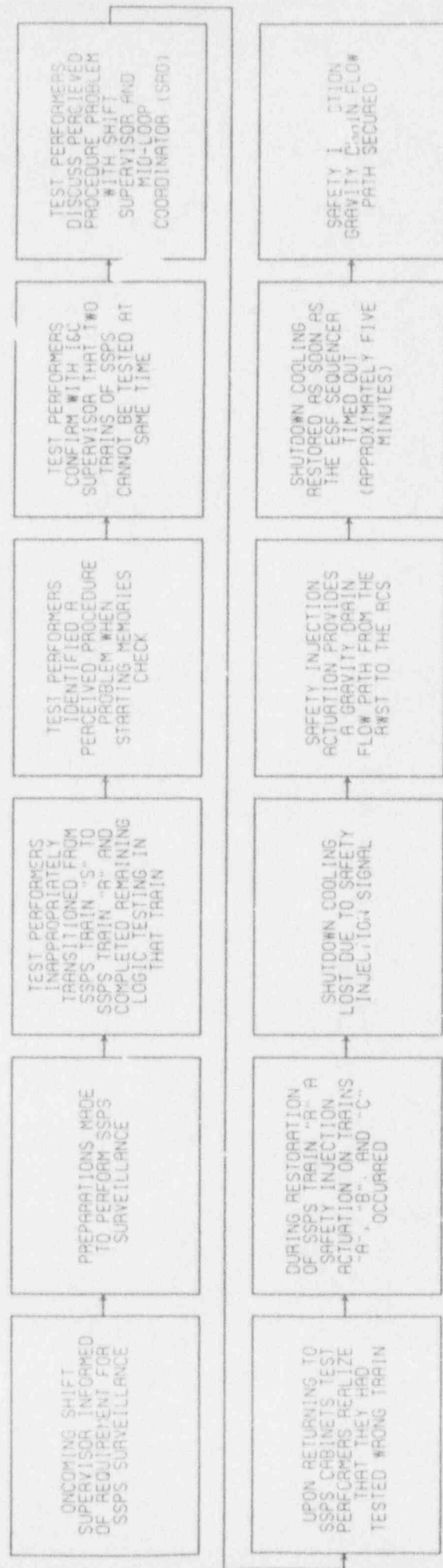
MARCH 10, 1994

CHRONOLOGY (CONT'D)

- SHUTDOWN COOLING RESTORED AS SOON AS THE ENGINEERED SAFETY FEATURES SEQUENCER TIMED OUT (APPROXIMATELY FIVE MINUTES).
- SAFETY INJECTION GRAVITY DRAIN FLOW PATH SECURED.
- EVENT REVIEW TEAM ESTABLISHED AND INVESTIGATION COMMENCED.

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

SEQUENCE DIAGRAM



SAFETY INJECTION ACTUATION  
MARCH 10, 1994

INVESTIGATION CONCLUSIONS



SAFETY INJECTION ACTUATION  
MARCH 10, 1994

INVESTIGATION CONCLUSIONS

- MANAGEMENT PERFORMANCE
  - NO PARTICIPATION OF MANAGEMENT ABOVE THE SHIFT IN THE DECISION OF WHETHER TO RUN THE TEST.
  - SHIFT MANAGEMENT DISCUSSIONS CENTERED ON "COULD" THE TEST BE RUN RATHER THAN ON "SHOULD" THE TEST BE RUN.
  - EXPECTATIONS REGARDING MID-LOOP OPERATIONS DID NOT SPECIFICALLY ADDRESS PERFORMANCE OF SURVEILLANCES.
  - THIS SURVEILLANCE WAS NOT ON THE DAILY SCHEDULE FOR MARCH 10, 1994.
  - NO DIFFERENTIATION MADE BETWEEN "REDUCED INVENTORY OPERATIONS" AND "MID-LOOP OPERATIONS."

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

INVESTIGATION CONCLUSIONS (CONT'D)

- TEST CONDUCT
  - TEST PERFORMERS VIOLATED PROCEDURAL REQUIREMENTS IN AT LEAST TWO INSTANCES, RESULTING IN PERFORMING TESTING IN THE WRONG CABINET.
  - TEST PERFORMERS DID NOT NOTIFY SHIFT MANAGEMENT UPON DISCOVERING THAT TESTING WAS PERFORMED IN THE WRONG CABINET.
  - FORMAL COMMUNICATIONS WERE NOT PRACTICED BY TEST PERFORMERS.

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

RESPONSE TO SAFETY INJECTION ACTUATION

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

RESPONSE TO SAFETY INJECTION ACTUATION

- EQUIPMENT PERFORMANCE
  - ENGINEERED SAFETY FEATURES EQUIPMENT PERFORMED, REPOSITIONED, AND STARTED AS EXPECTED.
  - ESSENTIAL CHILLER 11C STARTED, BUT TRIPPED ON LOW OIL PRESSURE DUE TO A CLOGGED FILTER.
  - TESTING IS BEING PERFORMED TO ENSURE PROPER FUNCTIONING OF THE SOLID STATE PROTECTION SYSTEM.
- CONTROL ROOM CREW PERFORMANCE
  - PERSONNEL RESPONSE TO THE SAFETY INJECTION SIGNAL WAS CRISP, CORRECT, AND THOROUGH.

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

CONSEQUENCES OF THE EVENT

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

CONSEQUENCES OF THE EVENT

- APPROXIMATELY ONE TO ONE AND ONE HALF (1 TO 1.5) INCH RISE IN REACTOR COOLANT SYSTEM LEVEL.
  - LEVEL REMAINED IN ALLOWABLE BAND FOR MID-LOOP OPERATIONS.
  - FROM INITIAL CONDITIONS, LEVEL WOULD HAVE HAD TO RISE APPROXIMATELY SIX (6) INCHES BEFORE SPILLOVER INTO THE STEAM GENERATOR WOULD HAVE OCCURRED.
- THERE WAS NO APPRECIABLE RISE IN REACTOR COOLANT TEMPERATURE. (< 1° FAHRENHEIT)

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

CAUSES OF THE EVENT

## SAFETY INJECTION ACTUATION

MARCH 10, 1994

### CAUSES OF THE EVENT

- INCONSISTENT APPLICATION OF THE MANAGEMENT CONTROLS ESTABLISHED FOR TESTING AND POWER ASCENSION.
  - INEFFECTIVE INTERFACE/INVOLVEMENT BETWEEN SHIFT MANAGEMENT AND OVERSIGHT MANAGERS.
  - LINE MANAGEMENT ABOVE SHIFT MANAGEMENT WAS NOT MADE AWARE OF SURVEILLANCES BEING PERFORMED.
- FAILURE OF TEST PERFORMERS/SHIFT MANAGEMENT TO EXECUTE KNOWN MANAGEMENT EXPECTATIONS WITH REGARD TO CONDUCT OF OPERATIONS.
  - FAILURE OF SHIFT MANAGEMENT TO BE SENSITIVE TO POTENTIAL LOSS OF SHUTDOWN COOLING DURING SURVEILLANCES.



SAFETY INJECTION ACTUATION  
MARCH 10, 1994

CAUSES OF THE EVENT (CONT'D)

- LACK OF A QUESTIONING ATTITUDE ON THE PART OF SHIFT MANAGEMENT.
- FAILURE OF TEST PERFORMERS TO KEEP SHIFT MANAGEMENT FULLY INFORMED.
- FAILURE OF TEST PERFORMERS TO MAINTAIN EXPECTED LEVEL OF FORMALITY.
- TEST PERFORMER INATTENTION TO DETAIL
  - PERFORMED 0PSP03-SP-0005S, SSPS LOGIC TRAIN S FUNCTIONAL TEST ON TRAIN R, CONTRARY TO PROCEDURAL REQUIREMENTS.
  - FAILURE TO SELF-CHECK (STAR).

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

CORRECTIVE ACTIONS

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

CORRECTIVE ACTIONS

- IMMEDIATE CORRECTIVE ACTIONS
  - SHUTDOWN COOLING RESTORED AND ENGINEERED SAFETY FEATURES SYSTEMS PLACED IN A SAFE CONDITION PENDING COMPLETION OF INVESTIGATION INTO THE SAFETY INJECTION ACTUATION.
  - INVOLVED PERSONNEL REMOVED FROM THE WATCHBILL PENDING COMPLETION OF INVESTIGATION.
  - EVENT WAS DISCUSSED WITH THE ONCOMING SHIFTS.

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

CORRECTIVE ACTIONS (CONT'D)

- ADDITIONAL CORRECTIVE ACTIONS
  - RETURNED TO POWER ASCENSION SHIFT ORGANIZATION AFTER EXITING MID-LOOP OPERATIONS.
  - CONDUCT INDIVIDUAL DISCUSSIONS OF RESPONSIBILITY WITH STARTUP DUTY MANAGERS. (PRIOR TO ASSUMING DUTIES)
  - STARTUP DUTY MANAGERS ASSIGNED FROM NUCLEAR GENERATION.
  - LESSONS LEARNED BRIEFINGS WILL BE CONDUCTED WITH ALL OPERATING CREWS. BRIEFINGS WILL BE CONDUCTED BY INVOLVED PERSONNEL. THE OPERATIONS MANAGERS WILL REINFORCE MANAGEMENT EXPECTATIONS. (PRIOR TO ASSUMING SHIFT DUTIES COMMENCING MARCH 15, 1994.)

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

CORRECTIVE ACTIONS (CONT'D)

- IMPLEMENT EXPANDED ADMINISTRATIVE CONTROLS TO SCREEN ACTIVITIES ON ACTUATION RISK SYSTEMS OR PROCEDURES. (PRIOR TO USE)
- PERFORM COMPREHENSIVE SCREENING OF SURVEILLANCE TESTS FOR ACTUATION RISK AND INCORPORATION OF REQUIREMENTS FOR PRE-TEST BRIEFINGS/SUPERVISORY OVERSIGHT BASED ON SPECIFIC RISK. (IN PROGRESS)
- IDENTIFICATION OF SCHEDULED HIGH AND MEDIUM RISK ACTIVITIES AND INCREASED MANAGEMENT ATTENTION IN THE DAILY "PLAN OF THE DAY" MEETINGS.
- REVISION OF MID-LOOP PROCEDURE TO INCORPORATE LESSONS LEARNED REGARDING SURVEILLANCE PROCEDURE PERFORMANCE AND CHALLENGES TO SHUTDOWN COOLING.
- APPROPRIATE PERSONNEL ACTION.

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

SAFETY SIGNIFICANCE

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

SAFETY SIGNIFICANCE

- MANAGEMENT VIEWS THIS ISSUE AS SERIOUS.
- THE EVENT HAD NO IMPACT ON THE PUBLIC HEALTH AND SAFETY OR ON THE INTEGRITY OF THE CORE/REACTOR COOLANT SYSTEM.
- ACTUAL SAFETY SIGNIFICANCE WAS MINIMAL.

SAFETY INJECTION ACTUATION  
MARCH 10, 1994

SUMMARY



SAFETY INJECTION ACTUATION  
MARCH 10, 1994

SUMMARY

- THE EVENT IS CONSIDERED SERIOUS BECAUSE OF THE DEFICIENCIES IN MANAGEMENT CONTROLS AND HUMAN PERFORMANCE.
- THE EVENT IS EXTREMELY DISAPPOINTING, BUT MUST BE VIEWED IN CONTEXT OF OVERALL RECENT PERFORMANCE IMPROVEMENTS.
- ACTUAL SAFETY SIGNIFICANCE WAS MINIMAL.
- COMPREHENSIVE CORRECTIVE ACTIONS HAVE BEEN TAKEN, WITH LONGER RANGE ACTIONS UNDERWAY.
- MANAGEMENT HAS AND WILL CONTINUE TO TAKE AGGRESSIVE ACTION TO REENFORCE EXPECTATIONS.