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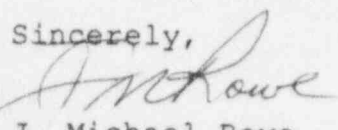
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Subject: Docket #50-184

Gentlemen:

Transmitted herewith is Operations Report No.48 for the NBSR. The report covers the period January 1, 1995 to December 31, 1995.

Sincerely,

  
J. Michael Rowe  
Chief, Reactor Radiation Division

Enclosure

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**NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY REACTOR  
(NBSR)**

Docket #50-184

Facility License No. TR-5

Operations Report

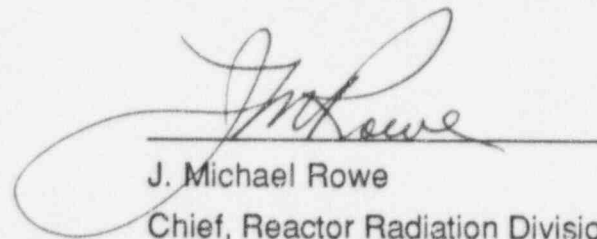
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January 1, 1995 – December 31, 1995

This report contains a summary of activities connected with the operations of the NBSR. It is submitted in fulfillment of section 7.8(3) of the NBSR Technical Specifications and covers the period from January 1, 1995 to December 31, 1995.

Section numbers in the report (such as 7.8(3)(a)) correspond to those used in the Technical Specifications.

March 28, 1996



J. Michael Rowe  
Chief, Reactor Radiation Division

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### 7.8(3)(a) Summary of Plant Operations

The reactor was shutdown for most of the year for major upgrade and installation of the new liquid hydrogen cold source. The reactor was restarted on September 25, 1995 following extensive preoperation testing of all systems and the liquid hydrogen cold source. Reactor power was gradually increased with full power of 20 MW achieved on October 5, 1995. For the balance of the year, the reactor was critical for 1725 hours and the energy produced was 32804 MWH.

Operationally, the new cold source functioned flawlessly, and met or exceeded all predictions. Highlights of significant reactor work are listed below, some of which took place the previous year but are included here for completeness.

- Complete redesign and installation of significant portions of the primary cooling system.
- Installation of three new main and two auxiliary plate-type heat exchangers.
- Complete redesign and installation of significant portions of the secondary cooling system including new water filtration components.
- Complete redesign and installation of significant portions of auxiliary cooling systems.
- Design and installation of new process instrumentation for primary, secondary and auxiliary cooling systems and for the cold source.
- Upgrade of portions of the reactor control room.
- Reconfiguration of primary ion-exchangers.
- Overhaul, redesign and rebuilding of the refueling plug including design of new helium seals.
- Replacement and recalibration of control rods.
- Extensive inspection of reactor internals.
- Replacement of the entire reactor heavy water and repackaging of the old tritiated water.
- Design and installation of custom shielding throughout the process room that resulted in significant reduction in radiation levels.
- Disposal of large quantities of low level waste including the old heat exchangers, piping, valves, resins and aluminum cutting from fuel elements.
- Major items of maintenance including refurbishing the confinement building, cooling tower, air supply system, CO<sub>2</sub> supply system, helium system, emergency and backup electrical supplies; replacement of all valve diaphragms and sealing of thermal shield

cooling coils.

- Extensive rewrite of operating procedures and development of comprehensive reactor testing programs.
- Extensive training of operations personnel on the new system and associated procedures.

In general, upgraded systems and components, functioned well and in most cases were superior to the ones replaced.

### **7.8(3)(b) Unscheduled Shutdowns**

1. There were (3) scrams due to commercial power interruptions. The reactor was returned to power.
2. There was (1) major scram due to radio being keyed near RM 4-1 (Stack Monitor). The reactor was returned to power.
3. There was (1) reactor rundown with subsequent shutdown due to loss of suction of the D2O storage tank pump giving thermal column low flow rundown. D2O storage tank level instrument malfunctioned indicating sufficient D2O. Heavy water was added and the reactor was returned to power. Later that day the reactor was shutdown and the D2O storage tank level instrument (LIA-3) was replaced, calibrated, and returned to service.

### **7.8(3)(c) Tabulation of Major Items of Plant Maintenance**

Note: Several of these items are covered by an Engineering Change Notice (ECN).

1. Completed repairs to and installed refueling plug and associated components.
2. Installed lower outer plug with new stainless steel flex hoses.
3. Completed changing valve diaphragms of all diaphragm valves with the exception of the experimental demin system IX resin drain valve- resin was not changed.
4. Assembled and tested all primary and secondary piping involved in system modifications.
5. Changed out primary system D2O.
6. Reinstalled all four shim arm drive mechanisms.
7. Modified leak detection system for current piping configuration.
8. Replaced fuel element drop out chute extension.
9. Installed coupling guards on all four main D2O pumps.

10. Replaced primary purification system pre-filters four times and the after filters twice.
11. Removed recombiner condenser from system.
12. Replaced recombiner granules using 14# of alumina palladium pellets.
13. Replaced regulatig rod drive "B" with "A".
14. Replaced helium gas holder diaphragm
15. Replaced CO2 gas holder diaphragm and lubricated guide shaft.
16. Completed installing custom shielding around #1 & #2 IX columns, and pre-filter and after-filter.
17. Installed vent line for DWV-290 back to emergency cooling tank.
18. Completed ECN-402 on #4 main D2O pump. (Installed "O" ring between shaft sleeve and shaft to stop leakage).
19. Installed primary purification pre and after filter dp gauges.
20. Installed additional hose clamp on each of four fingers of outlet distribution tree of #3 and #4 IX columns.
21. Removed RT-3 rabbit tube irradiation facility.
22. Installed, after inspecting, reactor inlet strainer.
23. Added resin and deuterized #1 and #2 IX columns.
24. Replaced strip heater in helium sweep system.
25. Installed butterfly valve (DWV-19) in place of reactor vessel outlet strainer.
26. Replaced 40# air regulator at reducing station #7 in process room
27. Replaced lower shutter box on BT-8.
28. Installed vent line on D2O purge tank between drain valve and helium return valve.
29. Replaced seal o-rings and quad rings on DWV-4 operator.
30. Replaced DWV-22 with new variable pneumatic valve and removed DWV-184 (up-stream isolation) from system.
31. Installed DWV-134 (reactor pump up isolation valve) in D2O system.
32. Rebuilt Shrader air valve for FTV-1 positive lock.
33. Installed flow control valve to cryogenic facility (DWV-23).
34. Continued thermal shield tube sealing as necessary.
35. Loaded resin into #1 & #2 thermal shield IX columns.
36. Dis-assembled, cleaned and re-assembled thermal shield heat exchanger (HE-6).
37. Installed bypass line with valve (TSV-15) around primary (thermal shield side) of thermal shield heat exchanger.
38. Completed installation of custom shielding around both thermal shield IX columns and



- the pre and after filter housings.
39. Insulated exterior and installed pad heaters on the thermal shield storage tank.
  40. Completed instalation of custom shielding around both storage pool IX columns and the pre and after filter housings.
  41. Removed operators from SPV-1 & 2 (storage pool pump discharge valves are not automatic).
  42. Replaced resin of storage pool IX column.
  43. Cleaned screens on fingers of inlet distribution tree of storage pool IX column.
  44. Changed pre-filters three times and after filters once of storage pool purification system.
  45. Reworked storage pool external filtering system.
  46. Replaced refueling canal light with new one.
  47. Bored (4) 6" holes between the two suction sumps at secondary inlet headers.
  48. Replaced suction, discharge, and check valves on all 6 secondary main pumps.
  49. Replaced inlet and outlet isolation valves of SCV-1 & 2 with new butterfly valves.
  50. Replaced reset relay in #2, #3, #5, and #6 secondary pump controllers.
  51. Installed motor operated valve (SCV-50) at inlet header to HE-1 A & B.
  52. Rebuilt secondary shutdown pump using new impeller, mechanical seal and casing o--ring.
  53. Overhauled and aligned #2 secondary pump.
  54. Replaced air operator diaphragms of SCV-1, 2, & 3.
  55. Replaced coupling hardware of #6 secondary pump.
  56. Installed soft starts on all 6 secondary pumps.
  57. Performed alignment of all 6 secondary pumps.
  58. Refurbished and adjusted SCV-1.
  59. Disassembled and cleaned secondary system 456 strainer twice.
  60. Disassembled and inspected secondary system 123 strainer.
  61. Replaced packing of secondary system 456 strainer.
  62. Switched from Calgon control of secondary water chemistry to Betz Water Management Group.
  63. Replaced secondary blowdown float type flowmeter with a digital/flow totalizing type.
  64. Replaced cooling tower fill support channels and angles as needed.
  65. Backwashed water softener and regenerated demin station IX twice.
  66. Replaced refrigeration unit on CO2 bulk tank.
  67. Refurbished truck door sill plates.

68. Painted interior of both air receivers on B-2 level with Extend.
69. Installed new air compressor and air drier to supplement plant air.
70. Relocated plant air "Porostone" filter to downstream of PAV-1 where air comes into building 235. Also added an automatic blowdown solenoid for excess moisture removal.
71. Replaced 4 cells in the station battery.
72. Replaced battery banks of both emergency diesel generators.
73. Installed new diesel fuel day tank at floor level for emergency diesel generators.
74. Drained, flushed, and refilled both emergency diesel generator cooling systems.
75. Repaired momentary DC Ground Alarm.
76. Replaced Failed +10 Volt Nuclear Power Supply.
77. Repaired Reactor Delta-T Recorder.
78. Checked Calibration of PIA-3 & -4 Channels.
79. Repaired Area Radiation Recorder, RR-1.
80. Repaired No. 1 Sump Pump & 1K Tank Automatic Pump-over Failures.
81. Repaired Area Radiation Monitor Channel.
82. Repaired Wind Speed Recorder.
83. Corrected CO2 System Annunciator Wiring Error.
84. Corrected No. 1 Sump Hi Level Alarm.
85. Replaced Failed D2O Storage Tank Level Channel LIA-3 Transmitter.
86. Repaired Storage Pool Area Monitor.
87. Repaired 1K Waste Tank Recorder.
88. Troubleshoot Erratic Emergency Tank Level Indication.
89. Replaced K-103C Scram Relay Following Failure of No. 2 Clutch Power to De-energize.
90. Rewired Grounded DWV-6 Limit Switch.
91. Replaced Failed K-103C Scram Relay.
92. Repaired Experimental Demin. Valve Controller.
93. Repaired Failed DWV-5 Valve Controller.
94. Repaired Failed He Gas Holder Level Controller.
95. Rewired Intermediate Range Period Recorder.
96. Repaired HE-1A & -1B Primary Flow Recorder.
97. Repaired NC-4 Log N Channel Following Erratic Indication.
98. Repaired RM3-1 Channel.
99. Repaired HE-1A & -1B Secondary Flow Indication.



100. Replaced +10 Volt Nuclear Power Supply.
101. Repaired Failed NC-1 Period Amplifier.
102. Repaired Cold Source D2O Outlet Temperature Channel.
103. Corrected HE-1A Secondary Outlet Temperature Channel TI-13 Wiring Error.
104. Freed Stuck NC-6 Detector.
105. Repaired BTUR Recorder.
106. Corrected Period Bypass Alarm Wiring Error.
107. Corrected HE-1A & -1B and Secondary Header Temperatures Wiring Errors.
108. Repaired RM3-1 Channel.
109. Repaired BTUR Recorder.
110. Repaired NC-5 Automatic Control Channel.
111. Corrected Annunciator AN4-43 Clutch Power Off Wiring Error.
112. Repaired RM3-1 Channel.
113. Repaired RM3-3 Channel.
114. Repaired Reactor Inlet Temperature Controller TRCA-3.
115. Recalibrated Storage Tank Level Channel LIA-3.
116. Repaired NC-3 Indication.
117. The following instrument calibration surveillance tests were performed:

**Channel Title**

BTUR-1	Reactor Thermal Power Recorder
FR-1	Reactor Vessel Outlet Flow Recorder
FRC-3	Outer Plenum Flow Recorder
FRC-4	Inner Plenum Flow Recorder
FIA-6	D2O IX Flow Indicator
FCA-7	Thermal Column Flow Indicator Control
FIA-12	Secondary Cooling Water Flow Indicator
FIA-15	Thermal Shield Coolant Flow Indicator
FIA-16	Thermal Shield IX Flow Indicator
FIA-17	Secondary Auxiliary Cooling Flow Indicator
FI-18	D2O Injection Flow
FI-30	Helium Compressor Secondary Flow
FIA-40	Reactor Outlet Flow Indicator Alarm
SS-K103	Relay Scram Safety System
LRC-1	Reactor Vessel Level Recorder

LIA-3	D2O Storage Tank Level
LIA-4	Thermal Column Tank Indicator Alarm
LIA-7	Experimental Demineralized H2O Level
LIA-8	Thermal Shield Storage Tank Level
LIC-9	Cooling Tower Level Indicator & Control
LIA-18	Storage Pool Level Indication & Alarm
LCA-19	Storage Pool Pump Pit Level Control
LIA-40	Reactor Vessel Level Indicator
NC-1	Source Range Channel NC-1
NC-2	Source Range Channel NC-2
NC-3	Intermediate Channel NC-3
NC-4	Intermediate Channel NC-4
NC-5	Nuclear Power Channel NC-5
NC-6	Nuclear Power Channel NC-6
NC-7	Nuclear Power Channel NC-7
NC-8	Nuclear Power Channel NC-8
NC-9	Nuclear Safety System
PIC-1	Experimental Demineralized Water Pressure Indicator & Control
PIC-2	D2O Experimental Cooling Water Pressure Indicator & Control
PC-3	Normal Exhaust System Pressure Controller
PIA-3	Recombiner Outlet Pressure Indicator & Alarm
PIA-4	Recombiner Inlet Pressure Indicator & Alarm
PC-27	Process room Pressure Controller
PIA-30	HE-1A Pressure Differential Pri./Sec. Delta P. Indicator & Alarm
PIA-32	HE-2 Pressure Differential Pri./Sec. Delta P. Indicator & Alarm
PIA-40	HE-1B Pressure Differential Pri./Sec. Delta P. Indicator & Alarm
PIC-102	Thermal Column Pressure Indicator & Controller
SPC-150	Emergency Fan Controller
SPS-150	Emergency Standby Fan Controller
SPS-151	Vacuum Breaker Controller
RM 1-1	Area Monitor - First Floor North Wall
RM 1-2	Area Monitor - First Floor East Wall
RM 1-3	Area Monitor - First Floor South Wall
RM 1-4	Area Monitor - First Floor West Wall

LIA-3	D2O Storage Tank Level
LIA-4	Thermal Column Tank Indicator Alarm
LIA-7	Experimental Demineralized H2O Level
LIA-8	Thermal Shield Storage Tank Level
LIC-9	Cooling Tower Level Indicator & Control
LIA-18	Storage Pool Level Indication & Alarm
LCA-19	Storage Pool Pump Pit Level Control
LIA-40	Reactor Vessel Level Indicator
NC-1	Source Range Channel NC-1
NC-2	Source Range Channel NC-2
NC-3	Intermediate Channel NC-3
NC-4	Intermediate Channel NC-4
NC-5	Nuclear Power Channel NC-5
NC-6	Nuclear Power Channel NC-6
NC-7	Nuclear Power Channel NC-7
NC-8	Nuclear Power Channel NC-8
NC-9	Nuclear Safety System
PIC-1	Experimental Demineralized Water Pressure Indicator & Control
PIC-2	D2O Experimental Cooling Water Pressure Indicator & Control
PC-3	Normal Exhaust System Pressure Controller
PIA-3	Recombiner Outlet Pressure Indicator & Alarm
PIA-4	Recombiner Inlet Pressure Indicator & Alarm
PC-27	Process room Pressure Controller
PIA-30	HE-1A Pressure Differential Pri./Sec. Delta P. Indicator & Alarm
PIA-32	HE-2 Pressure Differential Pri./Sec. Delta P. Indicator & Alarm
PIA-40	HE-1B Pressure Differential Pri./Sec. Delta P. Indicator & Alarm
PIC-102	Thermal Column Pressure Indicator & Controller
SPC-150	Emergency Fan Controller
SPS-150	Emergency Standby Fan Controller
SPS-151	Vacuum Breaker Controller
RM 1-1	Area Monitor - First Floor North Wall
RM 1-2	Area Monitor - First Floor East Wall
RM 1-3	Area Monitor - First Floor South Wall
RM 1-4	Area Monitor - First Floor West Wall

RM 1-5	Area Monitor – Second Floor Ceiling
RM 1-6	Area Monitor – Second Floor West Wall
RM 1-7	Area Monitor – Fuel Storage Pool Area
RM 1-8	Area Monitor – Process Room East Wall
RM 1-9	Area Monitor – Process Room West Wall
RM 1-10	Area Monitor – Control Room
RM 1-15	C001 Rabbit Lab Radiation Area Monitor
RM 3-1	Secondary Cooling N-16 Radiation Monitor
RM 3-2	Helium Sweep Gas Radiation Monitor
RM 3-3	Secondary Cooling N-16 Radiation Monitor
RM 3-4	Irradiated Air High Activity Radiation Monitor
RM 3-5	Building Exhaust High Activity Radiation Monitor
RM 4-1	Stack Gas High Activity Radiation Monitor
RM 4-2	Emergency Ventilation Stack Radiation Monitor
RM 4-4	MAA Gamma Radiation Monitor
Guide Hall Guide Hall Area Monitors	
BT-4FACS BT-4 FACS Spectrometer Radiation Monitors	
TRC-1	Reactor Delta-T Recorder
TRA-2	Reactor Outlet Temperature Recorder
TRCA-3	Reactor Inlet Temperature Recorder Controller
TR-4	D2O HE-1A Outlet Temperature Recorder
TR-5	D2O HE-1B Outlet Temperature Recorder
TIA-6	D2O HE-2 Outlet Temperature Indicator & Alarm
TI-7	D2O HE-2 Inlet Temperature Indicator
TIA-8	Thermal Column Tank Outlet Temperature Indicator & Alarm
TRA-10	Recombiner Outlet Temperature Recorder
TRA-11	Recombiner Internal Temperature Recorder
TI-13	Secondary Outlet HE-1A Temperature Indicator
TI-14	Secondary Inlet HE-1A & -1B Temperature Indicator
TIA-15	Storage Pool Water Temperature Indicator & Alarm
TCA-16	Thermal Shield HE-6 Outlet Temperature Controller & Alarm
TIA-17	Thermal Shield HE-6 Secondary Outlet Temperature Indicator & Alarm
TI-21	Experimental Demineralized Water HE- Inlet Temperature Indicator
TI-22	Thermal Shield Storage Tank Inlet Temperature Indicator

TIA-23	Thermal Shield Floor Header Outlet Temperature Indicator & Alarm
TIA-24	Thermal Shield Ring Header Outlet Temperature Indicator & Alarm
TIA-31	Experimental Demineralized Water HE-7 Outlet Temperature Indicator
TI-33	Secondary Outlet HE-1B Temperature Indicator
TI-36	Secondary Outlet HE-2 Temperature Indicator
TIA-40A	Reactor Outlet-Inlet Temperature Differential Indicator & Alarm - Channel A
TIA-40B	Reactor Outlet-Inlet Temperature Differential Indicator & Alarm - Channel B

**7.8(3)(d) Tabulation of Major Changes in the Facility and Procedures, and the Test and Experiments, Carried Out Without Prior Approval by the NRC pursuant to 10 CFR 50.59.**

Significant Changes to Procedures (Affect on Reactor Operation) were;

1. Fuel Element Latch Verifications
  - a. O.I. 1.1 Reactor Startup
  - b. O.I. 1.1A Reactor Startup Checklist (Shutdown >24 hours)
  - c. O.I. 6.1 Fueling and Defueling Procedures
2. Cold Source Related Protective Actions
  - a. A.P. 4.25 Cold Source Hydrogen Pressure High (30 psia)
  - b. A.P. 4.26 Cold Source D2O Cooling Flow Low (5 gpm)
  - c. A.P. 6.2 Rundown
  - d. All procedures associated with the previous Cold Source facility were deleted.
3. Rabbit Tube Operation
  - a. A.P. 1.42 Rabbit Tip D2O Cooling Low Flow--heavy water to RT-1,2,4
  - b. A.P. 2.13 C001 High Radiation--receiver alarms
4. New Heat Exchangers
  - a. O.I. 3.2A Filling of Secondary Side of HE-1A and HE-1B
  - b. O.I. 3.2C Backflush of Secondary Side of Heat Exchangers
  - c. A.P. 2.17 Secondary Coolant Activity High--action levels changed
5. All scram setpoints for 20 MW operation.

The following facility changes were completed this year;

ECN-407 Installed Period recorder system on NC-3 & NC-4 channels. This is not connected to the safety system and provides information only. It meets all the requirements of



10CFR50.59 and therefore, does not involve an unreviewed safety question.

ECN-408 Installed D2O cooling to the new Hydrogen Cold Source with system isolation valves and instrumentation in the Process Room. This change meets all requirement of the previous system and therefore, does not involve an unreviewed safety question.

ECN-409 Tube-and-shell heat exchangers HE-1A, HE-1B, HE-2 and HE-7 were replaced with plate-type heat exchangers. This involved major changes in the plant Primary and Secondary cooling system piping and instrumentation. This major modification meets or exceeds all the specifications and requirements of the previous system and therefore, does not involve an unreviewed safety question.

ECN-411 Shutters for the Cryogenic Facility were replaced with a much more elaborate system of shutters. This was necessitated by the installation of the Hydrogen Cold Source in place of the previous D2O Cold Source. These shutters serve the same purpose as the original shutters and therefore, does not involve an unreviewed safety question.

ECN-413 A liquid hydrogen cold source was installed in the Cryogenic Facility in place of the D2O cold source. This modification has received detailed safety analysis (NBSR-14) and a summary was submitted to the NRC for approval. This analysis has shown that it will not reduce the margin of safety as defined in the basis of any technical specifications nor does any accident or malfunction have any effect on the reactor and therefore, does not involve an unreviewed safety question.

ECN-418 Seven of the ten fuel transfer arms on the refueling plug were modified to prevent the possibility of lifting a fuel element improperly which could result in the element dropping from a pickup tool. While the refueling plug was out of the reactor for repair this possibility was discovered by a hands-on analysis and the solution was worked out. The modification does not involve an unreviewed safety question and is highly beneficial.

ECN-420 The day-tank for fuel for the emergency power diesel generators was located at ceiling level above the generators. It has been replaced with a UL-approved tank mounted at floor level between the two diesel engines. It replaces a tank that served the same function and therefore, does not involve an unreviewed safety question.



ECN-423 RT-4 rabbit tube was cooled with the H<sub>2</sub>O Experimental Cooling System. RT-1 and RT-2 were cooled by the D<sub>2</sub>O Experimental Cooling System. This modification put all three rabbit tips on the D<sub>2</sub>O system. It has no effect on safety systems or engineered safety features and therefore, does not involve an unreviewed safety question.

ECN-425 All components of the refueling plug were disassemble decontaminated to the extent possible, refurbished or replaced with identical (or pre-approved) replacement parts, reassembled with new seals and replaced. The intent was to take this opportunity to extend the operational life of the refueling plug for 30 years. Extensive post-replacement testing indicated the entire system functions as designed. All fuel element positions have been successfully loaded and the helium leak rates are of acceptable levels. Detailed procedures, video tapes, and photographs are available for review.

Modifications made during this repair has been reviewed by the SEC members on inspection of the Reactor Top area and a demonstration of the refueling plug. This ECN involves no unreviewed safety items.

#### **7.8(3)(e) Summary of Radioactive Material Released and Results of Environmental Surveys Performed.**

The gaseous waste released was 209 curies of tritium, 267 curies of Argon-41 0.14 curies of Cl-38, and 0.017 curies of Br-82. There were 1.3 curies of tritium and 0.13 millicuries of other beta-gamma emitters released into the sanitary sewer.

Environmental samples of the streams, vegetation, and/or soil, and air showed no significant changes.

#### **7.8(3)(f) Summary of Significant Exposures Received by Facility Personnel and Visitors.**

1. None to visitors.
2. Dosimetry results for this reporting period indicated that no facility personnel received significant exposures.