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Gentlemen:

Transmitted herewith is Operations Report No. 68 for the NBSR. The report covers the period January 1, 2016 to December 31, 2016.

Sincerely,

Robert Dimeo
Director, NIST Center for Neutron Research

Enclosure

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

Docket #50-184

Facility License No. TR-5

Operations Report

-- #68--

January 1, 2016 - December 31, 2016

This report contains a summary of activities connected with the operations of the NBSR. This report fulfills the requirements of section 6.7.1 of the NBSR Technical Specifications for the period from January 1, 2016 to December 31, 2016.

The section numbers in the report (such as 6.7.1(1)) correspond to the sections in the Technical Specifications.

April 25, 2017



Robert Dimeo
Director, NIST Center for Neutron Research

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6.7.1(1) Summary of plant operations including the energy produced by the reactor and the hours the reactor was critical

During the period January 1, 2016 through December 31, 2016 the reactor was critical for 5989.7 hours with a thermal energy output of 119,210.8 MWH (248.4 equivalent full power megawatt days). Major activities during this period included:

1. Page phone system replacement completed.;
2. Installed Thermal Shield 3rd Ring Header (C100)
3. Replaced thermo-wells and RTD's for TRCA-3, TIA-40A&B, TRA-2 Reactor Outlet and BTUR inlet.
4. Installed surge protector modules for the 24V power supply to the cooling tower level and cooling tower temperature instruments;
5. Replaced Thermal Shield eductor pumps 'A' and 'B' mechanical seals;
6. Replaced suction side gasket on #2 D2O pump
7. Replaced operator for SCV-7, Tower Basin Bypass Valve; and
8. Replaced Three Fuel Element Pickup Tools (E6, A4 and L3).

In addition, 1 operator trainee received a senior reactor operator license.

6.7.1(2) Unscheduled shutdowns, including reasons therefore

There were nine unplanned shutdowns as of September 27, 2016:

1. On January 12 at 0726 there was a reactor SCRAM, TIA-40A, Reactor Differential Temperature, failed high. After an inspection of the channel in the conductivity rack the instrument began to indicate normally (See February 3 SCRAM). The reactor was returned to 20 MW in about 61 minutes.
2. On January 25 at 2200 there was a reactor low flow SCRAM caused by a PEPCO commercial power dip. The reactor was returned to 20 MW in about 26 minutes.
3. On February 3, at 1555 a reactor SCRAM occurred when TIA-40A Reactor Differential Temperature failed high, which was determined to be a loose wire. The wire was tightened and the reactor was returned to 20 MW at 1615 (20 minutes). It was realized that the cause of the January 12 SCRAM (above) was also caused by this loose wire.
4. On March 30, at 1133 and 1438 there were two rundowns associated with the Thermal Column when power was lost to MCCs A5 and B6. At 1135 the reactor operator manually scammed the reactor in response to the loss of power to MCC A5 and B6 without a known cause. Power was restored to MCCs A5 and

B6 by closing the #1 feeder breaker on MCC A5. The reactor was restored to 20 MW as soon as power was restored to the MCCs A5 and B6. However, after the 1438 rundown, it was determined that the C-100 elevator was causing an over current condition and tripping the #1 breaker on MCC A5. The elevator was taken out of service until the cause of the failure could be determined and corrected.

5. On April 3 at 0148 there was commercial power dip that caused the SCRAM of the reactor from loss of Primary flow. The reactor was returned to 20 MW at 0208 (20 minutes).
6. On July 28 at 1604 a 28-volt power supply failed causing reactor level and flow to fail low. This caused a SCRAM. The 28-volt power supply was replaced but operation was precluded due to Xenon and the reactor was shut down until decay of Xenon allowed restart. The reactor was started and power was raised to 20 MW at 1010 on July 30 (42 hours).
7. On September 7 at 1814 there was a reactor SCRAM due to loss of commercial power. During the recovery, there was a Thermal shield 8-in-a-row rundown. After adjusting flow on 4 lines the thermal shield system was operable and power was restored to 20 MW at 1856 (42 minutes).
8. On September 13 at 1250 a loss commercial power from a blown PEPCO transformer caused a reactor low flow SCRAM. Reactor power was returned to 20 MW at 1308 (18 minutes).
9. On September 14 at 2300 power was reduced to 200 kW to reprogram a cold source PLC that caused a loss of the cold source instrumentation display. It was thought by the engineers that its functionality could be restored in time to allow restart and continue operation at 20 MW. It was discovered that the PLC failed and its replacement took longer than the 36 minutes available before Xenon preclusion. An attempted was made to return to power but the shims and the regulating rod were full out without reaching critical. The reactor was shut down until decay of Xenon allowed restart. The reactor was started and power was raised to 20 MW at 1119 on September 15 (36.3 hours). The cycle schedule was extended 1.3 days to make up some of the loss in time.

6.7.1(3) Tabulation of major preventative and corrective maintenance operations having safety significance

Note: Some of these items may be also listed as Engineering Change Notices (ECN) in section 6.7.1(4).

The following list is significant I &C maintenance and repair tasks:

Jan 9 Replaced BTUR inlet RTD.

Feb 18	Replaced contactor for air dryer on B2.
Feb 19	Replaced open/supply solenoid valve for BT-2.
Feb 20	Repaired fuse holder/wiring for BT-2 control panel.
Feb 21	Replaced ACV-4 air hoses.
Feb 23	Replaced HEV-41 operator.
Feb 26	Replaced TRCA-3.
Mar 2	Replaced NC-3 HV disconnect NI relay.
Apr 13	Replaced elevator breaker on MCC A5.
Apr 15	Replaced elevator breaker on MCC A5 with 100A breaker.
Apr 22	Installed thermal well for TRC-3.
Apr 25	Replaced contactor for EF-4.
May 5	C100 and C200 O2 deficiency alarms placed in service.
May 17	Page phone system replacement completed.
Jun 9	Replaced starting batteries for both diesels.
Jul 28	Replaced 28V power supply. Replaced TIA-8 action pack.
Aug 3	Replaced FIA-9 helium flow transmitter. Replaced coil on RWV-13.
Aug 6	Replaced SCV-722 and SCV-724.
Aug 8	Replaced thermal wells and RTD's for TRCA-3 and BTUR inlet.
Aug 10	Installed surge protector modules for the 24V power supply, cooling tower level, and cooling tower temperature instruments.
Aug 11	Installed drain trap on 'A' diesel intercooler.
Aug 15	Installed secondary bag filter d/p switch and inline snubbers. Replaced motor operator on breaker A-1.
Oct 2	Replaced repaired operator for SCV-7.
Oct 17	Repaired reactor console annunciator test switch.

The follow may contain duplications in other sections of this report but this listing is work during the designated scheduled reactor maintenance shutdown.

February-March:

Changed O-Ring on M-4 refueling pickup tool
 Replaced TRCA-3 and TIA-40A&B
 Repaired DWV-65 (Leak Detector Alarming)
 Repaired Unit 2 Vacuum Pump
 Installed 6K Nitrogen Tank in South Yard
 Replaced Air Operator on HEV-41
 Installed Thermal Couples for SEC DAC System (CT, SCPB & D-Wing)
 Replaced Camera Monitors in Control Room Console
 Replaced Six Thermal Shield Flow Meters

Installed Thermal Shield 3rd Ring Header (C100)
Repaired BT-2 Shutter Control Box
Removed resin from old water machine
Removed PVC Holding Tank and PVC piping from old water machine
Completed Tag Out Audit of Danger/Caution Tags
Cleaned VFD Filters for Main Secondary Pumps
Replaced E6 Refueling Plug Pickup Tool
Replaced Startup Control Relay

April:

Fixed Main Heat Exchanger Primary and Secondary Flow Meters (FR-20 and FR-21)
Fixed Purification Heat Exchanger Flow Meter (FIA-5)
Secondary DAQ Testing (Acceptance Testing with Contractor)
Replaced BTUR Inlet and Outlet Temperature Sensors
Tightened PV-1004 packing
Replaced TIA-40A&B
Installed LN2 Relief Valve Header (above C200 refrigerator)
Replaced Thermal Shield Ring Header Flow Meter (#1324)
Raised Helium Discharge Pressure on Helium Bulk Tanks to 150psi (Clear tag and open HEV-49)
Replaced BT-9 Vacuum Roughing Pump
Modified N16 Monitor RM3-1 Shielding Rack
Page Phone Installation
Finished Thermal Shield 3rd Ring Header Installation
Temporarily repaired leaking storage pool IX booster pump casing drain valve (SPV-19)
Repaired ACV-5
Replaced EF-4 contactor
Adjusted DWV-3 closed position indicator

June:

Replaced leaking storage pool IX booster pump casing drain valve (SPV-19)
Repaired SCPB Fire Main Valve
Replaced suction side gasket on #2 D₂O pump
Repaired leak detector points 28 and 67
Performed radiation measurements on spent fuel elements
Updated TRCA-3 Reactor Inlet Temperature Configuration Settings
Updated BTUR Digital Transmitter Configuration Settings
Replaced TRA-2 Reactor Outlet Temperature Sensor (Process Room) includes thermal bath test
Autotuned SCV-20 PID During Startup
Replaced Refrigerator Load Line to BT-9 (North Side of Reactor, C100)

Repair Cooling Tower #2 Dry West Door
Changed Exhaust Fan T-Stat in North Compressor Bldg.

August:

Diagnosis and Repair NC-4
Repair Helium Flow Meter FIA-9
Diagnosed and Repaired Discharge Valve RWV-13 at Process Room Sump
Diagnosed and Repaired Cooling Tower Bypass Valve SCV-7
Replaced TRCA-3 Reactor Inlet Thermo-well and TRA-2 Reactor Outlet Thermo-well (Process Room)
Replaced Bushing Seal on Thermal Shield Eductor Pump "A"
Replaced Blowdown Valves SCV-722 and SCV-724
Replaced 3 thermal shield flow meters
Replaced secondary bag filter D/P switch and added pressure snubbers

September-October:

Repaired Thermal Column Surge Tank Level Indication
Changed Storage Pool Conductivity Meter Range
Diagnosed Helium Blow off Alarm Failure
Adjusted Secondary Strainer System Pump Ramp and Coast down Timing
Painted D-Wing Stairwell Ceiling and Room D01
Replaced Vacuum Pump on Unit 2
Calibrated Oxygen Sensors on C100 and C200
Re-installed Cooling Tower Bypass Valve (SCV-7) Operator
Cleaned Deicing Nozzles on Cooling Tower Rolling Doors
Installed New Float on Sump #1 in Process Room
Replaced Console Counter Top
Remounted Control Room Console Door Switches
Resolved trouble ticket #7693 for leak detector panel point 29
Tightened diaphragms on valves DWV-3, 4, 5 & 6
Replaced #3 secondary strainer drain valve, SCV-698
Worked on thermal shield cooling lines 1323 and 1326

November-December:

Diagnosed and Repaired BT-5 Shutter
Replaced Two Fuel Element Pickup Tools (A4 and L3)
Changed Thermal Shield Flowmeter (#1326)
Painted D-Wing Room D001
Replaced Bushing Seal on Thermal Shield Eductor Pump "B"
Worked on C-Wing Elevator (Adjust Trip Settings and Install New Breaker)
Installed permanent corner bracket for console counter top

Installed Modified Bracket for Control Room Console Door Switches
Autotuned SCV-20 while reactor was at 15 MW
Building 235 Ventilation Control Study
Re-installed refueling PA microphone in Control Room
Repaired FRC-4 Alarm
Replaced FTV-3 push button.
FIA-12 Loop Modification

In addition to the mechanical and electrical The Reactor Instrumentation Group performed 63 instrument calibrations and 35 corrective maintenance operations during 2015. The calibrations were done using procedures that ensure that the sensors, indication, and controls of the NBSR safety systems are accurate and fully operational. In addition, the Reactor Instrument Group with the support of the reactor operations and engineering personnel have made corrective actions to some of the instrumentation and control systems at NBSR during 2016. One such project was upgrading the thermal power instrumentation and associated temperature channels.

6.7.1(4) A brief description, including a summary of the safety evaluations, of changes in the facility or in procedures and of test and experiments carried out pursuant to 10 CFR 50.59

There were two Level II ECNs for which further evaluation was performed using 10 CFR 50.59. None of these required a license amendment.

Level II
ECN #

TITLE

944 D₂O Primary Cooling Replacement of the Reactor Inlet (TRCA-3) RTD and Transmitter

The reactor inlet temperature sensor and its transmitter were replaced. The uncertainty of the RTD (1826795) is specified as 0.1 °C from 0 °C to 100 °C. The new transmitter is set to fail high, ensuring that the failure of the transmitter will bring the reactor to a safe state.

A 10 CFR 50.59 Evaluation was performed. It was found that a Technical Specification was not changed nor an amendment required for this ECN.

963 Replacement of the Reactor Inlet (TRCA-3) Thermo-well

The reactor inlet temperature sensor (TRCA-3) thermo-well was replaced with an original sized spare until a thermo-well was purchased. The new thermo-well was installed in August 2016

A 10 CFR 50.59 Evaluation was performed. It was found that a Technical Specification was not changed nor an amendment required for this ECN.

946 Replace TIA-40A and TIA 40B Thermocouples and Transmitters

New dual-junction thermocouples were installed in the two existing thermo-wells for TIA-40A and TIA-40B. In addition, A new HART enabled transmitter was installed to replace the TIA-40A transmitter. The transmitter for TIA-40B will be replaced later.

A 10 CFR 50.59 Evaluation was performed. It was found that a Technical Specification was not changed nor an amendment required for this ECN.

6.7.1(5) Summary of the nature and amount of radioactive effluents released or discharged to the environs and the sewer beyond the effective control of the licensee as measured at or prior to the point of such release or discharge

During 2016 the gaseous releases to the environs consisted of 1823 Curies of Argon-41, 1991 Curies of Tritium, and 0.053 Curies of other beta-gamma emitters. All NCNR gaseous radioactive effluent releases complied with 10 CFR 20.1101(d).

The table below summarizes the liquid radioactive effluent releases to the sanitary sewer from Building 235 for calendar year 2016.

H-3 ⁽¹⁾ (STDEV[2s%])	C-14 ⁽¹⁾ (STDEV[2s%])	Beta ⁽²⁾ (STDEV[2σ])	Gamma ⁽³⁾ (STDEV[2σ])
4.726 Ci (0.005 Ci)	4910 μCi (80 μCi)	126 μCi (9 μCi)	190 μCi (3 μCi)

- (1) Via Liquid Scintillation Spectroscopy (TRI-CARB).
- (2) Via Tennelec instrument (Series 5); includes contributions from gamma radionuclides.
- (3) Gamma isotopes were identified using ~750 ml samples in Marinelli beakers. The following isotopes were identified, in approximate decreasing order of importance: Zn-65, Co-60, Sb-125, Ag-108m, and Cs-137.
- (4) STDEV refers the average propagated standard deviation of the instrument concentrations using an Excel[®] function. For Alpha and Beta activity, 2σ is the standard sigma function. For H-3 and C-14, 2s% refers to an industry standard function defined by Packard/Perkin Elmer. 2s% is the percent uncertainty in a gross count value (with 95% confidence limits), or $2s\% = (100 \times 2 \times \sigma) / (\text{Total Counts})$
- (5) For 2016 the alpha activity detected via Tennelec was 7 μCi (with STDEV[2σ]=2 μCi, and is historically attributed to natural background.

All NCNR liquid radioactive effluent releases complied with 10-CFR-20.2003

6.7.1(6) Summaries of environmental surveys performed outside the facility

Environmental samples of the water, grass, and/or soil showed no licensed radioactive material. Results from thermo-luminescent dosimeters located at the NIST fence line showed no statistically significant dose above background levels.

6.7.1(7) Summaries of significant exposures received by facility personnel and visitors

Dosimetry results:

1. There were no significant exposures (exceeding regulatory limits) to visitors for this reporting period.
2. There were no significant exposures (exceeding regulatory limits) to facility personnel for this reporting period.