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U.S. Nuclear Regulatory Commission
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Gentlemen:

Transmitted herewith is Operations Report No. 72 for the NBSR. The report covers the period January 1, 2019 to December 31, 2019.

Sincerely,



Robert Dimeo
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Enclosure

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

Docket #50-184

Facility License No. TR-5

Operations Report

-- #72--

January 1, 2019 - December 31, 2019

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, 2019 to December 31, 2019.

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

April 2, 2020,



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 of January 1, 2019 through December 31, 2019 the reactor was critical for 5186.5 hours with a thermal energy output of 102421.1 MWH (213.4 equivalent full power days). Major activities during this period included:

1. Implemented a Corrective Action Program (CAP)
2. 1 SRO trainee received their operator license
3. 2 SROs resigned
4. 3 SROs retired
5. Replaced linear level recorder
6. Replaced nuclear channel-3 drawer
7. Replaced North and South inner vestibule doors for the confinement building
8. Upgraded C200 crane
9. Contractor installed #1 secondary pump after balancing the impeller and rewinding the motor
10. Replaced burnt through "B" phase wire on load side of breaker terminal for SF-3
11. Replaced reg rod drive motor with "B" spare after reg rod failed
12. Upgrade of the reactor safety system that replaced the reactor control and safety system mercury wetted relays with new electromechanical relays rated for safety related circuits
13. Replaced union and PAV-16 to prevent loss of compressed air to confinement building
14. Replaced DORA ARM in control room with new detector
15. Repaired burned connector on #2 cooling tower fan fast speed in controller
16. Replaced SF-11 VFD and Motor
17. Replaced helium tank relief valves
18. Replaced leak detector computer
19. Replaced reg rod drive motor "B" with reg rod drive motor "A"
20. Replaced the cooling tower fan vibration switches
21. Repaired loose connection for Evacuation alarm
22. Fabricated new FME cover for the drop out chute
23. Rewired solenoid wire connections for DWV-95A, 95B, 100A, and 100B
24. Replaced #5 cooling tower fan and gear box
25. Replaced reg rod drive motor "A" with reg rod drive motor "B"
26. HCC pipe repaired after discovering leak underground

6.7.1(2) Unscheduled shutdowns, including reasons therefore

There were five unplanned shutdowns as of December 31, 2019:

1. The reactor was started at 1024, May 21, 2019 for the cold source team to perform load testing on the new cold source. Reactor reached 20 MW at 1155. At 1158 there was a major scram on RM 3-4 (irradiated air) that was caused when the Helium Gas Holder level exceeded the high level setpoint during the return to normal operating temperatures and discharged to the irradiated air system. Reactor was restarted and returned to 20 Mw at 1235.
2. May 23, 2019 at 1507 there was a Reactor Scram due to the momentary loss of commercial electrical power that caused the shutdown of the Main Primary Pumps and Cold Source compressor. During restart there were problems with the cooling tower fans that delayed the return to full power. Reactor returned to 20MW at 1723.
3. At 1200 on 11/8/2019 a loss of commercial power resulted in an unplanned reactor shutdown due to the main primary pumps tripping. The reactor was returned to 19MW at 1233 on 11/8/2019.
4. At 0225 on 11/21/2019 a short interruption of commercial power resulted in an unplanned reactor shutdown due to the main primary pumps tripping. The reactor was returned to 19.5MW at 0244 on 11/21/2019.
5. At 1556 on 12/1/2019 DVW-100A closed unexpectedly which resulted in a loss of flow to HE-1A, thermal transient, and subsequent SCRAM. An investigation to the cause of DVW-100A closing proceeded and it was determined a loose connection in the valve operator was the cause of the valve closing unexpectedly. The connection was replaced with a wire nut and the valve returned to operating normally. The reactor was returned to 20MW at 0817 on 12/3/2019.

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

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

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

Feb 26– Replaced NC-3 drawer after failure of NON-OP circuit.

March 12– Replaced TIA-40B transmitter

May 10– Replaced Reactor Safety System

May 10– Replaced relay and power supply in 3-1 drawer

May 24– Replaced LIA-2 power supply

June 18 – Replaced sub-pile room Radiation Detector

Aug 28– Replaced BTUR recorder

Sept 29- Replaced TR 4&5 Sensors and transmitters

Dec 18- Replaced DWV-95A&B, 100A&B connectors after finding flaw in connections

The Reactor Instrumentation Group performed 57 calibrations during 2019. The calibrations were completed using procedures that ensure the sensors, indications, and controls of the NBSR safety systems are accurate and fully operational. In addition, the Reactor Instrument Group, with support from the reactor engineering group, completed 9 corrective maintenance actions to some of the instrumentation and control systems at the NBSR in 2019. One such project was the upgrade of the reactor safety system that replaced the reactor control and safety system mercury wetted relays with new electromechanical relays rated for safety related circuits.

The following is a list of the maintenance items completed in the respective scheduled reactor maintenance shutdown:

March:

Replaced C100 North Wall Electrical Panel LS

Received and install new spent fuel storage pool underwater saw

Modification to Experiment Cooling Water System (C100)

Replaced Fuel Element Pickup Tools (E6, I6, K6, D7 and J7)

April-May:

Installed Cooling Tower Maintenance Platforms

Installed Data Acquisition on Thermal Column Level Indication (LIA-4) Behind Control Room Console

Installed New Control Room Console Relay System

Replaced Cooling Tower Wet Doors

Replaced Leak Detection System (Process Room)

Replaced Panelboard LB (Located on B-2)

Replaced Panelboard PD (Located on C200)
Replaced Panelboard PC (C100 South Wall - Powers South Service Doors and Truck Door Operator)
Modifications to Experimental Demin. Water System

July:

Replaced Cooling Tower Dry Doors
Replaced Panelboard LP (Located in B-3 Hallway, Near Elevator)
Replaced Panelboard DC (Located on B-2, Near Reactor UPS Units)
Replaced Panelboard DCP2 (C200, Main Control Room)
Replaced HCSC/HCCP Heat Exchanger
Installed ODH Monitors in C100 & C200
Replaced Fuel Element Pickup Tools (F7 and H7)

August-September:

Updated Firmware for Storage Pool and Tritium Recorders
Upgraded BTUR Recorder
Replaced PS-108 with a Pressure Relief Valve
Replaced Back Pressure Regulator on ECW System
Replaced Panelboard DC (Located on B-2, Near Reactor UPS Units)
Replaced Panelboard DCP2 (C200, Main Control Room)
Replaced Helium Manifold in Room A133
Install two Leak Detector Trays and one Spark Plug in the Subpile Room

October-November:

Replaced Panelboard CP1 and CP2
Added New Heat Exchanger Plates to Cold Source Compressor Heat Exchanger
Installed New Building Leak Rate Test System
Installed Redundant NC-6 and NC-7 Reactor Power Signal to Cold Source

December:

Replaced Cooling Tower #5 Fan and Gearbox
Replaced Panelboard LU (C200 Lighting)
Replace Panelboard LT (C200 Lighting)
Modifications to Refueling Panel
Modify Thermal Shield PLC settings for the New Data Diode
Tied-in New Compressed Air Lines in K, E and A Wings

The following is a list of other preventative and corrective maintenance items completed throughout 2019:

Note: Some of these items may be listed during under the shutdown maintenance list
Jan 28 - Replaced Linear Level recorder after it failed.

Jan 30 - Rebuilt ACV-7 internals and replaced its solenoid.
Feb 04 - Replaced #3 Main D2O pump soft start after it failed.
Feb 26 - FIA-8A Action Pak changed from dual mode to single mode to cause all functions to operate at same time.
Mar 07 - Replaced North and South inner vestibule doors for the confinement building.
Mar 08 - The +10Vdc -10Vdc was replaced with a dual 24Vdc and redundancy system. new clutch cards also installed.
Apr 12 - Replaced K-103D relay after it was chattering during a scram from a reactor shutdown.
Apr 26 - Completed C200 crane upgrade except for load test and final tune up.
Apr 30 - Contractor installed #1 secondary pump after balancing the impeller and rewinding the motor.
May 02 - Completed C200 crane load test and tune up.
May 02 - Replaced burnt through "B" phase wire on load side of breaker terminal for SF-3.
May 08 - Replaced reg rod drive motor with "B" spare after reg rod failed.
May 11 - Replaced union and PAV-16 to prevent loss of compressed air to confinement building.
May 16 - Replaced DORA ARM in control room with new detector.
May 17 - resolved issue with "A" Thermal Shield circulating pump PLC.
May 20 - Found loose wire connection on #1 5k hot waste tank LED indication.
Jun 03 - Repaired burned connector on #2 cooling tower fan fast speed in controller.
Jun 06 - Completed work on ECN 1119 for new bag filter safety lid latch and fold-up steps.
Jun 19 - Took the LED indication out of the circuit for #1 and #2 5k hot waste tanks. Connected the Simplex alarm circuit from the Yokogawa recorder.
Jun 27 - Thermal imaging of the control console was performed.
Jul 01 - The nuclear relays for the voting logic of the NC's were replaced.
Jul 05 - Torque checks were performed on the suction and discharge flanges for the Main D2O pumps.
Jul 07 - Replaced DWV-32 diaphragm.
Jul 07 - Replaced SF-11 VFD.
Jul 11 - Replaced SF-11 motor.
Jul 07 - Tightened resistor for FIA-40 indication to fix high readings when flow secured.
Jul 09 - Replaced #1 and #2 Helium tank relief valves.
Jul 10 - Replaced #4 Helium tank relief valve.
Jul 11 - Repaired #4 shim arm drive clutch gap after inconsistent drop times.
Jul 16 - Replaced leak detector computer after it failed.
Jul 22 - Replaced NG-1A shutter solenoid for NG-1.
Jul 30 - Replaced safety edge for south automatic confinement door.
Aug 07 - Replaced signal surge suppressors and voltage regulators for cooling tower level, secondary header flow and cooling tower temperature after power surge.
Aug 27 - Torqued cooling tower fast and slow speed contactors.
Aug 29 - Replaced Polaris connections for fast and slow speed motor windings in the motor terminal box.

Aug 09 - Secondary #4 pump was reinstalled after contractors replaced the outboard side bearing shaft journal and the outboard shaft seal.

Aug 22 - Replaced RWV-125.

Sep 01 - T-connection for DWV-10 air supply upstream of CAV-22- and 222 broke while changing diaphragm. The connection was fixed with a new T-connection a small length of copper tubing and a splice were soldered.

Sep 01 - Changed DWV-10 diaphragm.

Sep 01 - Changed DWV-37 diaphragm.

Sep 01 - Performed T.S.P 4.4(3) on three confinement building penetrations that were reopened for the new camera system and then resealed.

Sep 04 - Replaced #1 blower for RM3-5 Normal Air.

Sep 06 - Removed muffler for DWV-95A after it failed to operate.

Sep 06 - Replaced #3, #5, and #6 Helium tank relief valves. In addition, replaced isolation valves for #3, #5, and #6 Helium tanks.

Sep 09 - Contractors began work project for station battery and UPS rooms.

Sep 18 - Installed new weather station.

Oct 20 - Replaced BT-7 shutter solenoid.

Oct 23 - Removed mufflers from DWV-95B, 110A, and 110B.

Oct 30 - Replaced reg rod drive motor "B" with reg rod drive motor "A" after failure of K1001 relay.

Oct 31 - Added spare breakers to panels LB and PC.

Oct 31 - Replaced the cooling tower fan vibration switches.

Nov 01 - Evacuation alarm failed testing. Problem found to be loose connection that was repaired.

Nov 04 - Fabricated new FME cover for the drop out chute.

Nov 04 - Up graded the FTP code for testing of the cannon.

Nov 01 - Raised EF-4 overload setting on EF-4 to next highest trip point per NEC 430.32(c).

Dec 12 - Found loose wire connection on DWV-100A after it was found going off its open seat numerous times at power.

Dec 16 - Found restriction in needle valve TMV-10 for the tritium monitor.

Dec 19 - Replaced #5 cooling tower fan gear box.

Dec 19 - Performed surge suppressor upgrade for cooling tower instrumentation.

Dec 31 - Replaced reg rod drive motor "A" with reg rod drive motor "B" after failure during O.I. 1.1 CL-A.

Dec 31 - HCC pipe repair after discovering leak underground.

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 three Level II Engineering Change Notifications (ECNs) for which further evaluation was performed using 10CFR50.59.

ECN 1067: Shim Arm and Shim Arm Mechanism Clutch Card and Power Supply Refurbishment

Description: This ECR is to find a replacement clutch card that is commercially available off the shelf. The new clutch cards could be powered using 120VAC, negating the need for the $\pm 10V$ Power Supplies and reducing the number of power supplies that exist within the console. The OTS cards are available with an adjustable output, therefore the existing rheostats would not be needed. Overall, the new clutch cards would perform the same function as the currently installed clutch card, would reduce the number of devices in the system improving reliability, and would be easier to troubleshoot and replace as they are not custom components.

ECN 1117: Relocate Shim Arm Control Wiring

Description: The shim arm controls are wired to a terminal strip mounted on the mercury-wetted relay safety system. In the upcoming engineer change to the safety system (new safety relay cabinet), the mercury-wetted relay drawers, associated wiring and terminal strips will be removed or modified. Since the shim arm control switches and associated indicated light are difficult to access due to their location on then console, this ECN relocates their interface with the safety relay cabinet to terminal blocks ITB2 and ITB3. These changes do not modify the design or function of the shim arm controls and indications, only where they are wired.

ECN 1012: Reactor Safety System Upgrade

Description: The reactor control and safety system mercury wetted relays are part of a hardwired relay logic ladder, designed to perform multiple reactor control and safety functions (e.g., SCRAM, Rundown, Withdraw Prohibit, Reg Rod Control, Shim Arm Control). Each rung in the logic ladder has a unique function and consists of multiple contacts wired in series with either a single mercury wetted relay or multiple mercury wetted relays wired in parallel (Ref Drawings 70-009-01-ED through 70-009-04-ED). Control power at 48VDC is directly applied to the relay logic ladder by parallel redundant relay power supplies, EBA and EBB, from Critical Power Panel #1. Critical Power Panel #1 has backup if offsite power is unavailable.

The original reactor control and safety system mercury wetted relays have experienced failures at an increasing rate and have become obsolete making it nearly impossible to find replacement relays. In addition to being obsolete, working on these relays has proven to be difficult due to their delicate state. Therefore, the purpose of this ECN is to replace the reactor control and safety system mercury wetted relays with new GM

International Model D5290S-078/SA electromechanical relays rated for safety related circuits. This ECN does not modify any reactor safety system or reactor control system logic, as it is a mere replacement of the relays.

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 2019 the gaseous releases to the environs consisted of 1120 Curies of Argon-41, 1273 Curies of H-3, and 0.00325 Curies of other beta-gamma emitters. All NCNR gaseous radioactive releases complied with 10CFR20.1101(d).

The table below summarizes the Building 235 disposal of licensed material by release into sanitary sewerage of 135,891 gallons of water, for calendar year 2019.

H-3 ¹ (STDEV [2s%])	C-14 ¹ (STDEV [2s%])	Beta ² (STDEV [2σ])	Gamma ³ (STDEV [2σ])
0.665 Ci (0.002 Ci)	2150 μCi (60 μCi)	57 μCi (7 μCi)	12.9 μCi (0.7 μCi)

Table footnotes:

1. Via Liquid Scintillation Spectroscopy (TRI-CARB). STDEV refers to average propagated standard deviation using an Excel[®] 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 $2s\% = (100 \times 2 \times s) / (\text{Total Counts})$.
2. Via low background (P-10 gas) Alpha/Beta counter (Tennelec, Series 5). The “Beta” column also includes the (smaller) response of the instrument to gamma radionuclides. In 2019 the total a-activity in the releases was 6 mCi, with STDEV[2s]= 2 mCi; this has historically been ascribed to natural background. For both b and g activities, s refers to the standard sigma function. All “negative” counts provided by the counter were replaced with “0” counts.
3. Via gamma spectrometer (Canberra). Gamma isotopes were identified using (typically) 0.7 to 1 liter samples in Marinelli beakers, and this year Co-60 was the principal gamma emitting isotope. s refers to the standard sigma function.

All NCNR liquid radioactive effluent releases complied with 10CFR20.2003

6.7.1(6) Summary 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) Summary 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.