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April 4, 2021

U.S. Nuclear Regulatory Commission  
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Washington, DC 20555

Subject: Docket #50-184

Gentlemen and Ladies:

Transmitted herewith is Operations Report No. 74 for the NBSR. The report covers the period January 1, 2021 to December 31, 2021.

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

-- #74--

January 1, 2021 - December 31, 2021

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, 2021 to December 31, 2021.

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

April 4, 2021,

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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, 2021, through December 31, 2021, the reactor was critical for .65 hours with a thermal energy output of 2.24 MWH (0.03 equivalent full power days). Major activities during this period included:

- Performed efforts directly involved to recover the reactor.
  - Established 19 Corrective Action and Reactor Recovery Item (CARRI) teams
    - Revise Training Program
    - Procedures and Compliance
    - Metrology
    - Index Plate
    - Visual Checks
    - Fuel Head Design Considerations
    - 1175 Removal
    - Primary Cleanup
    - Fuel Reuse Evaluation
    - Remote Sensors
    - Evaluation of all LCO's
    - Operational Surety of Balance of Plant
    - Develop ARM Program
    - Organizational Changes
    - Mechanical Anomaly Detection
    - Modernize Document Control Systems
    - Emergency Control Station (ECS) upgrade(s)
    - Carbon Dioxide System
    - Sump Reconfiguration
- Recovered and removed element 1175 to the spent pool storage. This includes an IX system designed for temporary storage of element 1175 in the spent storage pool.
- Utilized one element to measure 27 of the vessel grid positions. These measurements looked for variations from position to position. The measurements showed no significant variations.

- Performed measurements of the index plate. These measurements showed that the index plate is suitable for its purpose.
- Performed tests on a sleeve for verification of the rotational latch check. The sleeve provides the fiduciary markings to verify the position of the latch check tool to the index plate.
- Performed visual inspections of 27 of 30 upper grid plate notches. These inspections showed the notches did not have excessive wear. The remaining 3 positions will be inspected after the remaining 6 assemblies are removed.
- Updated AR 5.0 for procedure use and adherence. All procedures are now being routed utilizing the guidance of AR 5.0. This included training for all ROE staff.

### **6.7.1(2) Unscheduled shutdowns, including reasons therefore**

There was one unplanned shutdown as of December 31, 2021:

1. During startup the reactor major scrambled on 02/03/2021 due to the release of fission products from element 1175. A cladding failure occurred due to exceeding the fuel Safety Limit. The reactor remained secured for the remainder of the year.

### **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:

14 regularly scheduled calibrations

- Adjusted clutch gap on #3 clutch and performed in/out times and rod drop times. Loctite was placed on set screw.
- Replaced electronics for RM 3-5, Normal Air Monitor. Ratemeter, preamplifier and detector.
- Removed digital controller for RM 3-5 Normal air monitor to return to manufacturer.
- Completed ECN 1201 Remove Test Point on RM 4-1 (Stack Monitor) Signal Loop.

The following maintenance occurred during the unscheduled shutdown.

- Completed P9 electrical panel replacement.
- Completed work on panels P3 and P8 electrical panels.
- Replaced FTV-1 packing.
- Completed work on electrical panel P1.
- Completed electrical panel A replacement.
- Completed electrical panel P2 replacement.
- Completed new T.C. pumping system from the T.S. collection tank system for ECN 1184.
- Completed removal of #2 Air compressor per ECN 1147.
- Repaired loose wire on load side of SF-11 process room supply fan breaker.
- Completed work on P4 and P5 electrical panels.
- Completed replacement of panels P6 and P6A electrical panels.
- Completed work on electrical panel RA.
- Completed work on electrical panels PG and PH.
- Replaced faulty pulley on EF-3, Normal air exhaust fan.
- Completed replacement of #4 Cooling Tower Fan motor gearbox.
- Replaced broken DC motor brush for EF-6, emergency exhaust fan.
- Contractors replaced SCV-675 #1 HCSC Discharge Isolation.
- Replaced mounting bolts on EF-3, Normal air exhaust fan.
- Replaced SCV-7 Cooling Tower Cell Bypass Valve operator.
- Linkage and ball and socket joint were replaced in EF-3, Normal air exhaust fan.
- Replaced SCV-20 Bypass System Automatic Valve operator diaphragm.

**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 Zero Level II Engineering Change Notifications (ECN) for which further evaluation was performed using 10 CFR 50.59.

ECN	System or Component	Description

**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**

Gaseous release to the environs consisted of 0.252 Curies of Ar-41, 613 Curies of H-3, and 41.040 Curies of other beta-gamma emitters. The computer code EPA COMPLY version 1.7.1 was used to assess dose from routine airborne releases and the activity released after 2/6/2021 from event number 55120 which was reported to the NRC. HOTSPOT version 3.1.7 was used to assess dose from the short-term activity released from event number 55120 which started on or about 2/3/2021 0912 EST and was considered completed on or about 2/6/2021 2400 EST. The combined (added) results from the COMPLY and HOTSPOT codes showed that releases complied with 10CFR 20.1101(d).

The table below summarizes the building 235 disposal of licensed material by release into the sanitary sewer for calendar year 2021. Releases involved ~114,357 gallons of (40) routine/reviewed releases, (2) emergency-type shower releases, and “blowdown” and draining from the secondary basin.

H-3 <sup>(1)</sup> (STDEV[2s%]) <sup>(4)</sup>	C-14 <sup>(1)</sup> (STDEV[2s%]) <sup>(4)</sup>	Beta <sup>(2)</sup> (STDEV[2s]) <sup>(4)</sup>	Gamma <sup>(2, 3)</sup> (STDEV[2s]) <sup>(4)</sup>	Alpha <sup>(2, 5)</sup> (STDEV[2s]) <sup>(4)</sup>
1.017 Ci (0.002 Ci)	1600 μCi (40 μCi)	121 μCi (8 μCi)	2100 μCi (200 μCi)	5 μCi (2 μCi)

1. Via Liquid Scintillation Spectroscopy (TRI-CARB). Includes routine/supervisory reviewed releases. H-3 also includes estimated secondary blowdown and draining to the sanitary sewer.
2. Gamma column is from HPGe gamma spectrometer. Beta and Alpha columns are from a Series 5 Tennelec instrument

- (Beta activity includes contributions from gamma radionuclides).
3. Gamma isotope samples had sample volumes of ~738 to ~1001 ml, in Marinelli beakers. The 2021 total activities of detected gamma emitters are, in approximate decreasing order of reported values: Te-129, Te-127, Ce-144, Te-129m, Te-127m, Co-60, Ce-141, Nb-95, Xe-133, Zr-95, Cs-137, Xe-135, Zn-65, Ag-110m, Te-99m, and Mo-99.
  4. STDEV refers to the average propagated standard deviation using an Excel® function. For Alpha and Beta activity, 2s is two times 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  $2s\% = (100 \times 2 \times s) / (\text{Total Counts})$ .
  5. This has historically been attributed to natural background.

This was an atypical year for three reasons. 1.) the Feb-21 fuel damage event resulted in an increase in the number and quantity of nuclides being released. 2.) the event resulted in two post-entry decontamination showers of the “first responders,” whose water went directly into the sanitary sewers, bypassing the Hot Waste Tanks. The identities and activities of these isotopes were assessed using an HPGe spectra of the PPE (which covered the bodies), a day after next day. The amount and type of gamma isotopes on PPE was expected to be greater than the isotopes on the “first responders” bodies, resulting in an overestimate of the gamma products of the showers, not including some short-term beta isotopes. The gamma spectra indicates the PPE had both activation products and fission products. Though this abridged/delayed analysis did not permit as accurate an assessment as a normal release, the nature of the incident and the general fission product distribution of Uranium along with the gamma spectra generally bounds the release. 3.) standard “blowdown” releases of the secondary water are sent to the sanitary sewers to maintain water quality and replenish water loss to evaporation, and complete draining of the basin for maintenance also occurred. Heavy water reactors typically check for Tritium in the secondary water because they wish to detect leaks of primary (heavy) water into the secondary. Some reactors have seals that can leak though the main heat exchanger; the main heat exchanger in use at NCNR does not have such a seal. In the recent past, such releases to the sanitary sewer have been typically free of Tritium, but this year small amounts of Tritium were occasionally observed in the secondary during shutdown. This situation was studied by an interdisciplinary team of staff members, who concluded the best explanation of Tritium in the secondary water was of diffusion of TD through the metal of the primary/secondary heat exchanger, into the secondary.

Tritium in the secondary is possibly in the form of TD or TOH. The fact that Tritium is not typically seen in the secondary during reactor operation was believed to be due to T-D escape to the atmosphere during secondary flow, and TOD reduction below “detectable limits” through ongoing “blowdown” turnover of the secondary water.

#### **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:

For the 2021 Calendar year there were no doses above regulatory limits as stated in 10 CFR 20.1201 and 20.1301 to members of the public or to occupational workers. This is based on dosimetry monitoring of personnel and surveys conducted inside and outside the facility. It should be noted that dosimetry results for occupational workers for the 4<sup>th</sup> quarter of 2021 are still pending at the time of this report as a result of the COVID-19 epidemic. However, all occupational workers at the NCNR are also monitored with electronic dosimeters or personal ion chambers and based on these measurements all 4<sup>th</sup> quarter results are below occupational limits.