NIST Response to NCNR Event

James Olthoff, Associate Director for Laboratory Programs

National Institute of Standards and Technology
U.S. Department of Commerce

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NIST Immediate Actions

- ✓ **Convened a NIST-Level Incident Response Team to provide institutional support for NCNR**
  - **Public Affairs, Safety, Acquisitions, Chief Counsel, Director's Office Chief of Staff**
- ✓ **Ensured communications with stakeholders**
- ✓ **Provided resources necessary to recover from the event and resume safe operations**
- ✓ **Obtained review and recommendations from external subject matter experts**

External Review

Subject Matter Experts individually evaluated: conditions that allowed the Feb 3 2021 event to occur; NCNR's response to the immediate event; NIST's management of the event; efficacy and completeness of the proposed corrective actions. Each SME provided an independent review and recommendations to NIST Leadership.

Dr. Julia Phillips
Vice President & CTO, Sandia National Laboratory (retired), Executive Emeritus National Science Board

Dr. Eric Kaler
President, Case Western Reserve University

Dr. Thom Mason
Director, Los Alamos National Laboratory, President and CEO of Triad National Security, LLC (Triad)

Alexander Adams, Jr.
Chief, U.S. Nuclear Regulatory Commission Research & Test Reactors Licensing Branch (retired)

Key Findings and Recommendations

1. **The NCNR is an important national resource, it is imperative to restart safely.**
2. **The root cause analysis was thorough and comprehensive.**
3. **NIST Leadership should provide resources needed for corrective actions, in full.**
    1. Ensure adequate staffing, by recruiting and retaining qualified staff
    2. Improve reactor operator training, including emergency response training
    3. Support long-term efforts to improve safety culture and continuous improvement, including external benchmarking to ensure best practices
4. **NIST Leadership should be engaged, provide ongoing support for NCNR operations.**
    1. Elevate risk management of NCNR to the NIST-level and recognize regulatory risk
    2. Ensure adequate resources to support nuclear safety at the NCNR
    3. Ensure adequate internal and external oversight by the SEC and SAC
    4. Align and integrate NCNR into NIST safety management programs
5. **NIST should institutionalize lessons learned from this event, incorporate into NIST story.**

NIST concurs with findings and recommendations of Subject Matter Experts and is working to implement both short-term corrective actions and long-term operational changes to address these.

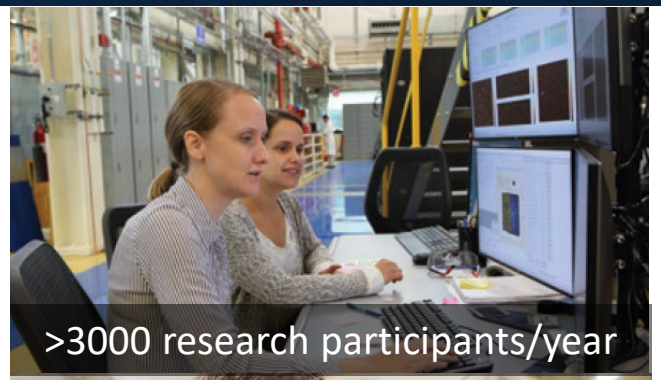
NCNR Status Update

06.14.2022

Photo credit: Brian Renegar

NCNR – A National User Facility

30 beam instruments/experiments | ~40% of U.S. scientific productivity in neutrons



>3000 research participants/year

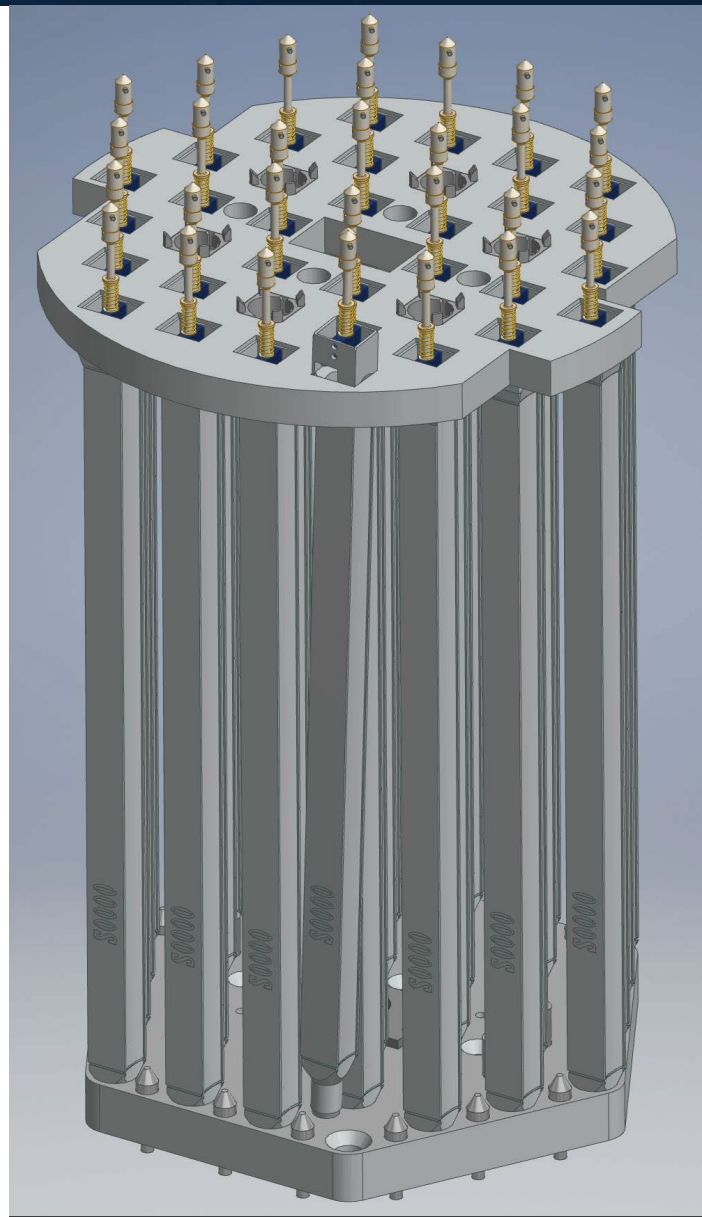
demand >> supply (2-3X)

~50 companies/year

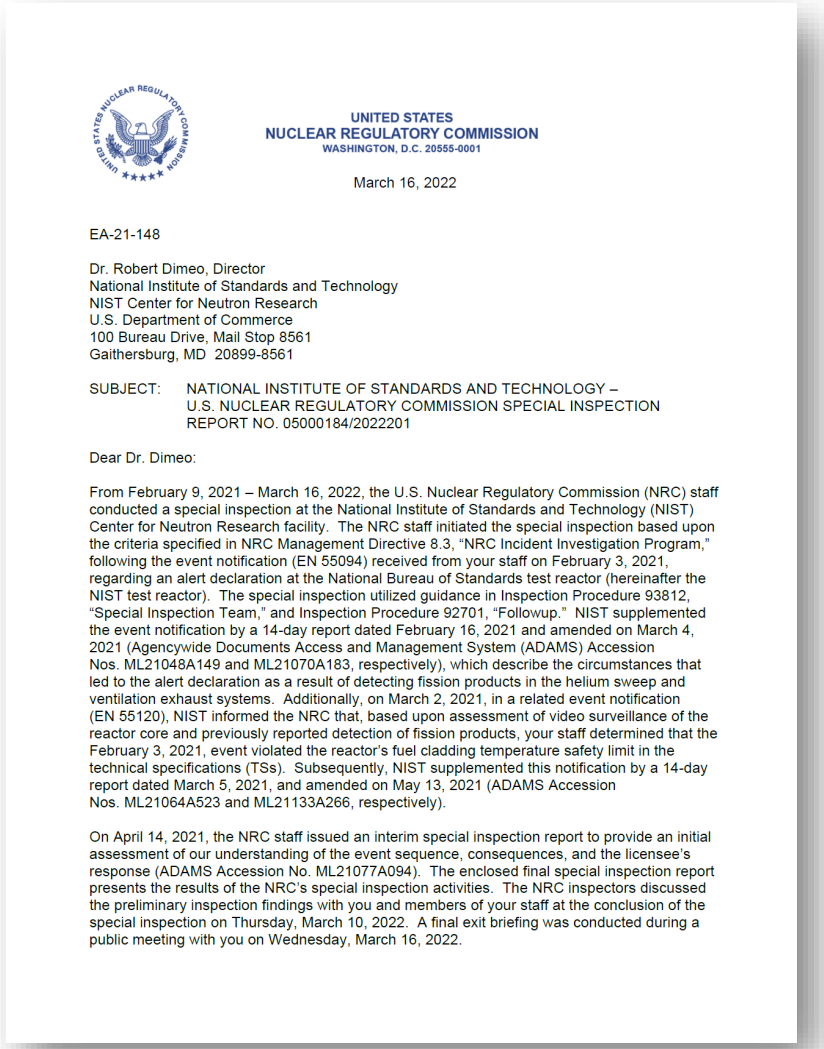
Unplanned Shutdown - February 3, 2021

- Fission products detected in confinement building upon normal reactor startup causing reactor to automatically shut down
- No health/safety impacts to staff, public, or environment
- The event posed no risk to personnel nor the community

Direct cause – a fuel element was unlatched at startup, did not receive sufficient cooling, and overheated.



NRC Special Inspection Report Issued



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 16, 2022

EA-21-148

Dr. Robert Dimeo, Director
National Institute of Standards and Technology
NIST Center for Neutron Research
U.S. Department of Commerce
100 Bureau Drive, Mail Stop 8561
Gaithersburg, MD 20899-8561

SUBJECT: NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY – U.S. NUCLEAR REGULATORY COMMISSION SPECIAL INSPECTION REPORT NO. 05000184/2022201

Dear Dr. Dimeo:

From February 9, 2021 – March 16, 2022, the U.S. Nuclear Regulatory Commission (NRC) staff conducted a special inspection at the National Institute of Standards and Technology (NIST) Center for Neutron Research facility. The NRC staff initiated the special inspection based upon the criteria specified in NRC Management Directive 8.3, "NRC Incident Investigation Program," following the event notification (EN 55094) received from your staff on February 3, 2021, regarding an alert declaration at the National Bureau of Standards test reactor (hereinafter the NIST test reactor). The special inspection utilized guidance in Inspection Procedure 93812, "Special Inspection Team," and Inspection Procedure 92701, "Followup." NIST supplemented the event notification by a 14-day report dated February 16, 2021 and amended on March 4, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML21048A149 and ML21070A183, respectively), which describe the circumstances that led to the alert declaration as a result of detecting fission products in the helium sweep and ventilation exhaust systems. Additionally, on March 2, 2021, in a related event notification (EN 55120), NIST informed the NRC that, based upon assessment of video surveillance of the reactor core and previously reported detection of fission products, your staff determined that the February 3, 2021, event violated the reactor's fuel cladding temperature safety limit in the technical specifications (TSs). Subsequently, NIST supplemented this notification by a 14-day report dated March 5, 2021, and amended on May 13, 2021 (ADAMS Accession Nos. ML21064A523 and ML21133A266, respectively).

On April 14, 2021, the NRC staff issued an interim special inspection report to provide an initial assessment of our understanding of the event sequence, consequences, and the licensee's response (ADAMS Accession No. ML21077A094). The enclosed final special inspection report presents the results of the NRC's special inspection activities. The NRC inspectors discussed the preliminary inspection findings with you and members of your staff at the conclusion of the special inspection on Thursday, March 10, 2022. A final exit briefing was conducted during a public meeting with you on Wednesday, March 16, 2022.

NRC public meeting and report released on March 16th

7 apparent violations

Enforcement: Alternative Dispute Resolution → AIP is the goal

Outcome: Final confirmatory order to be issued to NIST

Status


Filter elements

Progress

Root causes determined and corrective actions identified in several incident reviews

Funds for corrective actions secured in FY22

Significant progress made in corrective actions

Primary coolant system cleanup continues

Fuel inspection complete

Alternate startup core concept analysis underway

Two scientific community briefings since last VCAT meeting


March 11, 2022 - President signs FY2022 omnibus spending bill. Official White House Photo by Adam Schultz

Status


Filter elements

What's Next?

NIST – complete restoring the reactor to operational readiness

NIST – complete all corrective actions required for reactor restart

NRC – issue confirmatory order (CO) to NIST

NIST – begin implementation of enforcement actions from CO

NRC – issue decision on NIST's restart request

NIST – schedule user experiments


March 11, 2022 - President signs FY2022 omnibus spending bill. Official White House Photo by Adam Schultz

Restart

Restart = Technical Readiness **&** NRC Authorizes Restart

Technical Readiness

Assumptions:

- Primary coolant filtering goes perfectly
- Plan to use alternate startup core successful

Low power testing: August
Neutron production: September

NRC

Verify implementation of enforcement actions
Approve license amendment
Complete required regulatory inspections
Authorize restart

Technical and regulatory process timing uncertainties remain

Uncertainties potentially affecting 2022 restart

Risk item	Probability	Potential impact
Cleanup of primary does not go as planned	Medium	High
~~Fuel elements cannot be reused~~*	~~Medium~~	~~High~~
Concept for startup core concept cannot be implemented	Low	High
Protracted license amendment disposition for startup core	Medium	High
Procedure revisions required for startup delayed	Low	Low
~~Additional corrective actions from external review impacts restart~~	~~Medium~~	~~Medium~~
Protracted license amendment disposition for visual checks	Low	Medium
NRC does not authorize restart • ~~Not satisfied with corrective actions~~ • Not satisfied with progress towards corrective actions	Medium	High

*This risk item has been removed from the risk register now that we are pursuing an alternative to fuel reuse: the current plan is to use a startup core composed of fresh fuel elements and 7th-cycle elements that were *not* in the core on February 3, 2021.

Note: COVID continues to be a risk that could lead to delays in several of the items above

Strengthening Operations Safety at the NCNR

The fuel damage event on February 3, 2021, was unprecedented in research reactor history.

NIST is committed to ensuring that a fuel damage incident like that of February 3, 2021, **never happens again**.

NIST's corrective actions and program improvements are broad and comprehensive and minimize the probability that an event with the potential to impact **public health and safety** occurs.

Root Cause Analysis

ROOT CAUSES

Instruments, Equipment, & Tools
Deficiencies in the fidelity of latch determination equipment and tools

Procedures
Inadequacies in latch checking procedures
Procedural compliance not enforced

Qualifications & Training
Inadequacy of training and qualification program

Management Systems
Insufficient change management system
Inadequate oversight of refueling operations
Culture of complacency in reactor operations group

Traits of a Healthy Nuclear Safety Culture

INPO 12-012: Traits of a Healthy Nuclear Safety Culture

Individual Commitment

Personal Accountability

Questioning Attitude

Safety Communication

Management Commitment

Leadership Accountability

Decision-Making

Respectful Work Environment

Management Systems

Continuous Learning

Problem Identification and Resolution

Environment for Raising Concerns

Work Processes

Root Cause Analysis & Safety Culture

ROOT CAUSES

Instruments, Equipment, & Tools
Deficiencies in the fidelity of latch determination equipment and tools

Procedures
Inadequacies in latch checking procedures
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Root causes directly related to broader safety culture issues

- **Leadership Values and Actions**
- **Problem Identification and Resolution**
- **Work Processes**
- **Continuous Learning**
- **Safety Communications**
- **Questioning Attitude**
- **Environment for Raising Concerns**

Safety Culture

Our nuclear safety culture is a work-in-progress

We are committed to continuous improvement

Nuclear Safety Culture Improvement Program

Goal: Build and maintain strong nuclear safety culture and system

Benchmarking	Continuous Improvement	Education	Communications	Monitoring and Assessment
What does "good" safety culture look like? Safety culture and operations informed by best practices at other organizations	*Safety culture and operations are continually improved and informed in multiple ways*	*Opportunities to learn about ways to ensure safety are sought out and implemented*	*A healthy safety culture is directly supported by frequent communications focused on safety.*	*Effectiveness of the NSCIP is monitored regularly*

Nuclear Safety Culture Improvement Program

A few of the developments relevant to safety culture improvement include:

- ✓ Initial NSCIP program plan draft complete
- ✓ Baseline nuclear safety culture assessment completed by OSHE. Implementation of response underway.
- ✓ Benchmarking underway (DOW, ANSTO, INL, HFIR, AFRRI to date)
- ✓ Implemented new NCNR safety recognition program
- ✓ Strengthened safety communications (e.g. culture, incidents, lessons-learned)
- ✓ Leadership safety training: *Building Employee Engagement for a Strong Safety Culture*

External Review – NCNR Actions

Issue	Action
Staffing and Resources	• Resources and creative actions (OHRM) to recruit, hire, and retain reactor operators, including 5th shift. • Ensure resources for reactor operations and maintenance commensurate with needs of an organization with a continuously improving culture of safe operations
Safety Culture	• NSCIP: establish a culture of continuous improvement, change management • Shift from experiential knowledge to detailed written procedures: procedure revisions and adoption of industry standard procedure use and adherence principles
Emergency Response Training	• Wider range of potential scenarios for drills, including scenarios that extend beyond radiation issues
Alignment and integration between NCNR and NIST/OSHE	• Strengthen and clarify roles, responsibilities, authorities, and resource availability via scenario planning between NCNR and NIST/OSHE to ensure corporate-level support from NIST along with flexibility for specific needs of the NCNR: OSHE safety support embedded in NCNR
Enhance reactor safety oversight bodies, SEC and SAC, and engage with external organizations with expertise	• Outreach to (and benchmark programs at) other organizations with expertise managing process risk such as chemical processing industry, power plants, Institute of Nuclear Power Operations (INPO) • Enhance role of SEC, including scope of reviews and audits, broaden membership for more external perspectives and expertise • Enhance role of SAC