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

**Dr. Eric Kaler**  
President, Case Western Reserve University

**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 – 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
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

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**

**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
Status

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

Filter elements

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

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

*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.
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 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

<table>
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<tr>
<th>Individual Commitment</th>
<th>Management Commitment</th>
<th>Management Systems</th>
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<tbody>
<tr>
<td>Personal Accountability</td>
<td>Leadership Accountability</td>
<td>Continuous Learning</td>
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<tr>
<td>Questioning Attitude</td>
<td>Decision-Making</td>
<td>Problem Identification and</td>
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<tr>
<td>Safety Communication</td>
<td>Respectful Work Environment</td>
<td>Resolution</td>
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<td>Environment for Raising</td>
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<td>Concerns</td>
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<td>Work Processes</td>
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Leadership Values and Actions
Problem Identification and Resolution
Work Processes
Continuous Learning
Safety Communications
Questioning Attitude
Environment for Raising Concerns

Root causes directly related to broader safety culture issues
Our nuclear safety culture is a work-in-progress

We are committed to continuous improvement
### Benchmarking

**What does “good” safety culture look like?**

Safety culture and operations informed by best practices at other organizations

### Continuous Improvement

Safety culture and operations are continually improved and informed in multiple ways

### Education

Opportunities to learn about ways to ensure safety are sought out and implemented

### Communications

A healthy safety culture is directly supported by frequent communications focused on safety.

### Monitoring and Assessment

Effectiveness of the NSCIP is monitored regularly

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**Goal:** Build and maintain strong nuclear safety culture and system
### Nuclear Safety Culture Improvement Program

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

<table>
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<tr>
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<th>Continuous Improvement</th>
<th>Monitoring and Assessment</th>
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<td>What does “good” safety culture look like?</td>
<td>Safety culture and operations informed by best practices at other organizations</td>
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- ✓ 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

<table>
<thead>
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<th><strong>Issue</strong></th>
<th><strong>Action</strong></th>
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</table>
| **Staffing and Resources** | • Resources and creative actions (OHRM) to recruit, hire, and retain reactor operators, including 5<sup>th</sup> 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 |