# Learning Lessons from Incidents at Other facilities

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A key area to improving safety at any potentially hazardous facility such as a research reactor is through learning lessons from operational experience, including incidents and near-misses that occur at comparable facilities.

This paper summarises the approach taken by ANSTO Reactor Operations to gain insight and learnings from the National Bureau of Standard Reactor (NBSR) fuel failure incident of February 2021. It must be emphasised that this paper is not intended to be a review of the NBSR fuel failure or its subsequent investigation but rather, an example of how the sharing of operational experience by one research reactor facility can be highly beneficial to other facilities.

Although the design of ANSTO's OPAL Reactor is significantly different to that of the NBSR, an initial review of the publicly available investigation reports indicated that a number of the identified contributory and root causes could be relevant to any research reactor. The approach taken was to review and investigate the design, operational, training and human factors aspects of fuel management and handling within the OPAL Reactor, taking into consideration the root and contributory causes identified by the NBSR fuel failure investigation report. This review and investigation was performed through a series of toolbox sessions involving staff from across all areas of Reactor Operations.

A number of potential lessons to be learned were identified, including some that may be applicable to a wider range of facilities. The benefits gained from the approach adopted, such as the involvement of multiple staff from across Reactor Operations, are also discussed.

## 1. Introduction

A key area to improving safety at any potentially hazardous facility is through learning lessons from operational experience at other facilities, including incidents and near-misses that occur at comparable facilities. This can even extend to learning lessons from incidents and near misses in what appear to be totally unrelated industries and situations.

This paper summarizes the approach taken by ANSTO Reactor Operations to gain insight and learnings from the National Bureau of Standards Reactor (NBSR) fuel failure incident of February 2021. In particular, it describes a systematic and formalized methodology by which the fuel failure incident was assessed in relation to the OPAL Reactor and may be used by other facilities. It also identifies the lessons learned from the NBSR fuel incident that were subsequently identified as applicable to the OPAL Reactor as well as some of these lessons that may be applicable generically to all research reactors.

## 2. The NBSR Fuel Incident

On the 3rd of February 2021, the National Bureau of Standards Reactor (NBSR) was conducting a start-up one month after refueling on the 4th of January 2021. As the reactor

was approaching full power, a release of fission products was detected, which is indicative of a fuel failure, and a reactor trip occurred.

A post-incident in-core video inspection revealed that one fuel element had lifted out of its secured position in the lower core grid plate and was skewed in an apparent unlatched condition. This resulted in a lack of adequate cooling to the element and eventual fuel failure.

Following the incident, a detailed and comprehensive investigation was conducted by a NIST Centre for Neutron Research (NCNR) Technical Working Group and reported in [1]. This report was made publicly available and identified five root causes of the incident as follows, based on 15 causal or contributing factors:

1. The training and qualification program for operators was not on par with programmatic needs.
2. Procedures as written do not capture necessary steps in assuring elements are latched.
3. Procedural compliance was not enforced.
4. Inadequacies existed in the fidelity of latch determination equipment and tools.
5. There was inadequate management oversight of refueling staffing.

A review of both the event response and the root cause investigation report was performed by a Safety Evaluation Committee (SEC) Subcommittee and reported in [2]. This report was also made publicly available and identified two further root causes as follows:

6. Change management program needs improvement
7. There was a culture of complacency, with a lack of staff ownership of continuous improvement.

A total of 23 corrective actions were identified by NCNR as reported in [1] and [2] to address these seven root causes.

A request to restart the NBSR was submitted by letter to the US Nuclear Regulatory Commission (NRC) in October 2021 as supplemented by letters in December 2021 and June, August and November 2022. Following a comprehensive review of the submissions made by NCNR, the US NRC authorized the restart of the NBSR in March 2023.

## 3. ANSTO Response

Like most other research reactor operating organizations, ANSTO monitors incidents and events that occur or are reported at other facilities worldwide through both formal and informal means. The formal means include notifications from the IAEA's Incident Reporting Systems for Research Reactors (IRSRR) monitoring performed by ANSTO's international liaison and corporate communications groups. Informal means include news media and personal contacts among senior staff with their counterparts in other facilities. Incidents and events that OPAL staff become aware or are notified of are subject to simplified screening review and assessment to determine their relevance to OPAL and whether further detailed review and assessment would be appropriate.

In the case of the NBSR fuel incident, members the OPAL senior management team became aware of the incident through the US NRC website shortly after the incident occurred. At that time, it was agreed to wait until the formal incident investigation was completed and published before assessing the relevance, if any, to the OPAL Reactor. As such, when the

request to restart was submitted to the US NRC in October 2021 with the formal incident investigation reports simultaneously made publicly available [1] and [2], this assessment was undertaken. Although the design of ANSTO's OPAL Reactor is significantly different to that of the NBSR, this assessment indicated that a number of the identified contributory and root causes could be relevant to any research reactor. The approach taken was to review and investigate the design, operational, training and human factors aspects of fuel management and handling within the OPAL Reactor, taking into consideration the root and contributory causes identified by the NBSR fuel failure investigation reports.

This review and investigation was performed through a series of toolbox sessions involving staff from across all areas of Reactor Operations facilitated by the Chair of the OPAL Reactor Assessment Committee (RAC), the internal independent safety committee. The Chair RAC was considered most appropriate to facilitate these workshops as he is a senior manager with extensive research reactor knowledge and experience but is also independent of the OPAL line management, i.e. he does not report to the OPAL Reactor Manager.

A total of five toolboxes were carried out over a period of 10 weeks so as to ensure that all shift personnel could participate. Attendance included Shift Managers and Reactor Operators who form part of the Operations Group, Utilization Operators who form part of the Utilization Group and carry out the manual handling and movement of reactor fuel, and the relevant System Engineers. Staff from Reactor Operations Training Group and the Technical Support Group also participated

The toolboxes consisted of a presentation by the Chair RAC of the NBSR fuel incident followed by an open-ended roundtable discussion of the root causes and the contributary/causal factors in relation to the OPAL design or operations. As facilitator, the Chair RAC encouraged all participants to be involved on the understanding that only the Chair's notes would be made available to OPAL line management and that they would not identify participants. The draft notes from each individual toolbox were reviewed by the toolboxes' participants and modified as appropriate whilst continuing to main that anonymity.

After all the toolboxes were complete, the Chair RAC prepared a collated set of notes that were distributed to OPAL line management for consideration. Where appropriate, the lessons learned have been incorporated into existing initiatives as part of the ongoing Reactor Operations workforce plans.

## 4. Feedback from ANSTO Toolboxes

The feedback from the ANSTO toolboxes regarding the lessons learned applicable to the OPAL reactor were in many areas similar to the root causes identified in the investigation into the NBSR fuel incident. In particular, a number of opportunities for improvement were identified in relation to:

1. The training of OPAL operating staff (both Reactor Operations Staff and Utilization Staff);
2. The change management process;
3. The resourcing of refueling activities;
4. Knowledge management; and
5. Procedural compliance.

Whilst many of the opportunities for improvement were specific to the OPAL situation, some were mirror images of the causal or contributing factors identified by the NBSR fuel incident investigation. In addition, the OPAL toolboxes identified further lessons learned in relation to reporting of incidents (particularly near-misses), an accumulation of obsolescent and/or defective tools in the work area and operational pressures to complete work to schedule.

However, positive feedback was identified in relation to the roundtable nature of the toolbox sessions themselves involving both Reactor Operators, Utilization Operators and System Engineers. It was suggested that more toolbox sessions covering other processes and activities common across different groups within OPAL should be organized and this is being reflected in revisions to the training schedule. Many of the participants were also appreciative of the opportunity to provide input anonymously as this encouraged greater involvement and openness in the roundtable discussions.

Overall, it was felt that the toolbox approach was an appropriate method for communicating an incident from another facility to OPAL personnel and better than a simple lecture or presentation. The toolboxes were also very good for identifying lessons and that the subsequent roundtable discussions facilitated by an independent senior manager produced some good findings.

## 5. Cross-cutting Themes

Whilst reviewing the NBSR fuel incident investigation reports and facilitating the subsequent toolboxes among OPAL personnel on the same topic, it became apparent that there were some common cross-cutting themes applicable. These themes are discussed further below.

### 5.1. Communication between designers and users

It is evident from both the NBSR fuel incident investigation reports and from the OPAL toolboxes that communication between the design or engineering groups and the operating personnel is necessary to minimize the potential for such incidents to occur. In both cases, examples were identified of design shortcomings identified by operating groups that were either not communicated to the relevant engineering group or if they were, were not acted upon appropriately. Conversely, there were also examples identified in both cases where new or modified tools were designed and put into operation by the engineering group without appropriate consultation with the operating groups.

These are examples of where communication between the designers and the users has failed or is not effective and is common in many, if not all industries, not just the nuclear industry. All the standards and guides on the application of design processes and change management generally include a requirement to consult with stakeholders early in the process yet this is often missed or only done in a partial manner. Similarly, users also often fail to give adequate or appropriate feedback to designers about the shortcomings in their designs. This may be for a variety of reasons, ranging from simple apathy to a feeling that they will not be paid attention to anyway.

As such, organizations should try to maximize the opportunities for interaction and communication between the design or engineering groups and the operating groups.

### 5.2. Procedural adherence and compliance and knowledge management

Both the NBSR fuel incident investigation and the OPAL toolboxes identified issues with procedure adherence and compliance but from opposite directions. The NBSR fuel incident investigation identified procedural compliance not being enforced as one of the root causes of the incident whereas the OPAL toolboxes identified overly rigid compliance with all aspects of the instructions as potentially counter-productive and a safety risk. Staff felt that highly trained and competent technicians should have the capability to deviate from an instruction where necessary subject to an appropriately documented control and approval process.

This is an example of a perennial issue of finding an appropriate balance between reliance on the knowledge of the operating staff versus having all knowledge documented. There is a strong incentive among operating organizations for all information and knowledge to be documented so that the loss of staff does not result in the loss of institutional knowledge. However, there is also a strong case of having highly trained and competent operating personnel capable of using their own judgement and expertise rather than having them simply following instructions by rote. As commented by some OPAL Utilization Operators, there is a certain "feel" to the handling and movement of fuel correctly that is very difficult to document or even understand without practical experience.

It is also a basic principle of technical writing that a procedure or instruction should be written for the end user, not necessarily those who would review and approve it. This is on the basis that the procedure or instruction should be user friendly to the actual user. However, it is not uncommon for procedures and instructions to become "bloated" with details and explanations to facilitate understanding by those who do not actually use the procedures or instructions but are involved in the review and approval process. This in turn can lead to the documents being less useful to the end users.

As such, the preparation, review and approval of procedures and instructions important to safety should always involve those charged with the responsibility of actually implementing them and should be written with that group in mind.

### 5.3. Staffing, resourcing and training

Both the NBSR fuel incident investigation reports and the OPAL toolboxes identified issues with staffing and resourcing, including the impact of such issues on other aspects, such as knowledge management, training and competencies and ownership of the process. Whilst in both cases, the completion of formalized training was recognized as important and needed to be documented appropriately, simply giving practical hands-on experience to newer staff under appropriate supervision was also considered to be of significant benefit. A number of other staffing or resourcing practices were identified during the OPAL toolboxes, including the mentoring of newer staff by existing staff and the rostering of new staff to ensure that they gain experience in all aspects of the work area.

Both the NBSR and OPAL have mock-ups that can be used to facilitate training. However, in both cases, there are shortcomings with the mock-ups. In the NBSR case, the mock-up does not accurately reflect the latching process whilst in the OPAL case, the mock-up does not reflect both pool-top and fuel clamp activities. It is well recognized that the use of mock-ups can be of great benefit in the training of personnel. They can also be very useful and cost-effective in the optimization of major project activities. In OPAL's case, it has been estimated that the use of a partial mock-up of the lower reactor pool has already saved

millions of Australian dollars in relation to the forthcoming replacement of the Cold Neutron Source (CNS). However, to be most effective, mock-ups need to reflect all aspects of the task or activities being simulated accurately and realistically.

As such, research reactor operating organization are encouraged to consider the provision of appropriate mock-ups to facilitate the training of operating staff in tasks and activities that are difficult to perform on the real facility or are performed only rarely.

## 6. Summary and conclusions

Following a fuel incident in February 2021, NCNR performed a detailed investigation of the incident and identified a number of root causes as identified in [1]. The NCNR SEC reviewed this investigation report and identified a further two root causes as identified in [2]. Both these reports were made publicly available as part of the NCNR request to the US NCR to restart the NBSR.

ANSTO Reactor Operations reviewed these two reports and determined that there may be lessons to be learned for the OPAL Reactor design and operations as a result of the fuel incident. This review and investigation was performed through a series of toolbox sessions involving staff from across all areas of Reactor Operations and a number of opportunities for improvement were identified. Three generic cross-cutting themes were also identified that other research reactor operating organization may wish to take into consideration.

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## References

[1] NCNR Technical Working Group, “Root Cause Investigation of February 2021 Fuel Failure”, Revision 2, September 2021

[2] Safety Evaluation Committee (SEC) Event Response and Corrective Action Subcommittee (ERCAS), “Review of the NCNR Event Response and Technical Working Group Root Cause Analysis and Corrective Action Plan”, August 2021