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Quarterly report on NPP events

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Foreword

In the European Union, a regional network, the European Clearinghouse on Operating Experience Feedback for Nuclear Power Plants, has been established to enhance nuclear safety through improvement of the use of lessons learned from operating experience.

The European Clearinghouse is composed mainly of European nuclear safety regulatory authorities and their technical support organisations. It is operated by dedicated staff from the European Commission´s Joint Research Centre.

Abstract

This newsletter provides Feedback on Operating Experience (OEF) from significant safety related events at nuclear power plants (NPPs) worldwide, compiling the NPP events that were reported publicly during the period from 1st January 2017 to 31st March 2017.

1 Introduction

This newsletter provides Feedback on Operating Experience (OEF) from significant safety related events at nuclear power plants (NPPs) worldwide, every three months. It is intended to provide timely information to the Clearinghouse members about recent significant events, with a real or potential impact on nuclear or radiation safety. The report is intended to be complementary to other international reporting systems such as the International Atomic Energy Agency (IAEA) IRS, rather than duplicate the information provided by it. Usually the information used to prepare the report is publicly available and the information is notified promptly, in advance of other reporting systems. Only events that are considered to be likely to have lessons applicable to EU NPPs are selected.

Event selection for reporting in this newsletter is a two stage process. All the information found on relevant web sites is initially screened and the events that match the following criteria are short-listed for further consideration:

- Unplanned or unexpected automatic or manual reactor trips;
- Violations of Operational Limits & Conditions (Technical Specifications);
- Events rated at INES Level 1 or above;
- Events leading to a significant radiological release;
- Real or potential challenges to nuclear safety or defence in depth; including recurrent events and actuation of systems.
- Events with common cause failure aspects; and
- Lessons learned worth being disseminated.

Final selection of the events is made by the JRC-IET Clearinghouse Selection Committee. The following criterion is adopted to guide the Committee's final selection:

- Level of actual or potential effect on safety;
- Events rated at INES Level 2 or above; and
- Significance of lessons learned for EU NPPs.

Clearly the criteria above are open to a degree of interpretation and judgment and the selection committee is comprised of suitably qualified and experienced personnel who by applying engineering judgement and through consensus, arrive at the final selection.

Finally, no comparison should be made among countries with regards to the number and significance of events, as the number of nuclear power plants, the reporting criteria and the information media are not homogeneous.

This Quarterly Report compiles the NPP events that were reported publicly from 1st January 2017 to 31st March 2017.

2 Events short-listed

Gathering event information for short-listing involves searching potential sources of operating experience information including relevant world-wide websites. When NPP related event reports are identified as potential candidates for the shortlist the information is translated into English for the purpose of screening and possible inclusion in this newsletter. The sources of the event information are referred to in an event list compiled for the purposes of screening which then results in the initial short-list.

The short-list of events considered for inclusion in this quarterly report are drawn from NPPs world-wide and can be found in the Annex to this newsletter on our website. The information is organized by country for each event shortlisted and the following information is collected: title of the event; date of event or date of reporting if date of incident not available; event description; INES level (if available) and name of the NPP.

3 Events selected

Three events were selected from the short-list for this Newsletter:

1. 26/08/2015: Both Diesel generators declared inoperable (US NRC)
2. 30/06/2016: Application of technical specification for the safety features actuation system instrumentation (US NRC)
3. 15/10/2016: Reactor vessel closure head penetration nozzle indications attributed to primary water stress corrosion cracking and a weld fabrication void (US NRC)

The information provided is extracted from publicly available sources. More detailed information on these events may become available in due course, either from the original source or through international operating experience sharing systems.

3.1 Both Diesel generators declared inoperable

WATERFORD 3 – 26/08/2015

Waterford 3 was in Mode 1 at approximately 100% power. The emergency diesel generator train A (EDG A) was being run in accordance to a testing procedure, when it was declared inoperable following a trip on «generator differential». The plant staff tried to start the EDG B, as the technical specifications require in this case to demonstrate the operability of the remaining EDG. However the EDG was declared inoperable too, following the failure to start of the EDG B room exhaust fan. The fan failed to start because a solenoid operated valve in the damper compressed air circuit failed closed.

An offsite vendor performed an analysis of the solenoid and determined that rapid cycling of the solenoid valve caused excessive wear and damage.

It is believed that the cycling of the valve was caused by a relay with intermittent or high resistance connections. If the solenoid valve cycles quickly from an intermittent contact, the damper actuator may not have time to react to the fast cycle. From the damper closed position, with the actuator spring compressed and the air volume full of air, a quick cycle of the valve may not allow the actuator to exhaust its air volume. Thus, the inlet damper may not move and the control room may have no indication of the solenoid cycling.

The root cause of the EDG B failure to start was the lack of adequate preventive maintenance of the damper components. In past years, several work orders had been issued to correct spurious openings of the damper, but the root cause was never identified and no adequate action taken.

The plant staff restored the damper to the safe open position, and the EDG was declared operable again after 2 hours and 20 min. Other than this short window of increased risk, there was no actual consequence to nuclear safety. There was a high probability that the damper could be opened manually or that the room could be cooled by other means if a loss of offsite power had occurred during this time window.

Editor´s comment *– This event has been highlighted because of the interest of its lesson learned.*

Solenoid valves used in critical services should be subject to preventive maintenance that takes into account a failure mode linked to excessive wear of the moving components inside the solenoid valve housing.

Defective relays with partial or intermittent contacts may cause a quick cycling of the solenoid valve, eventually leading to premature wear.

In this event, not considering this failure mode led to the solenoid valve to fail in the non-safe position, even if the valve was designed fail-safe. This may lead to a full safety system train failure.

3.2 Application of technical specification for the safety features actuation system instrumentation

DAVIS-BESSE 1 – 30/06/2016

Unit 1 operated at approximately 100 percent power when a level transmitter of Borated Water Storage Tank (BWST) used for Safety Features Actuation System (SFAS) Channel 1 was declared inoperable for scheduled maintenance. Technical Specification (TS) Limiting Condition of Operation (LCO) 3.3.5 Condition A was entered. At 23:42 hours, a power supply in SFAS Channel 2 failed and a separate TS LCO 3.3.5 Condition A was entered, but not Condition B as required. Condition B requires the unit to be in Mode 3 in 6 hours and Mode 5 within 36 hours.

Upon recognition that two channels of SFAS were inoperable, TS LCO 3.3.5 Condition B was entered next day at 02:45 and then exited at 03:30 with the use of compensatory actions to restore SFAS Channel 1 operability. After further review, it was determined the compensatory actions could not be credited and TS LCO 3.3.5, Condition B was re-entered at 13:25. SFAS Channel 1 was restored and declared operable at 13:51 hours.

The direct cause for the failure to properly apply TS 3.3.5 was determined to be that the Shift Manager failed to initially recognize that entry conditions for TS LCO 3.3.5 Condition B had been met following a loss of power to SFAS Channel 2. The TS was not reviewed in its entirety and provided peer checks were not performed independently.

A contributing cause of the improper application of TS 3.3.5 was determined to be that station personnel failed to use or rigorously implement required processes and procedures involving the conduct of operations, event reporting, operability determination, and regulatory communications and interface.

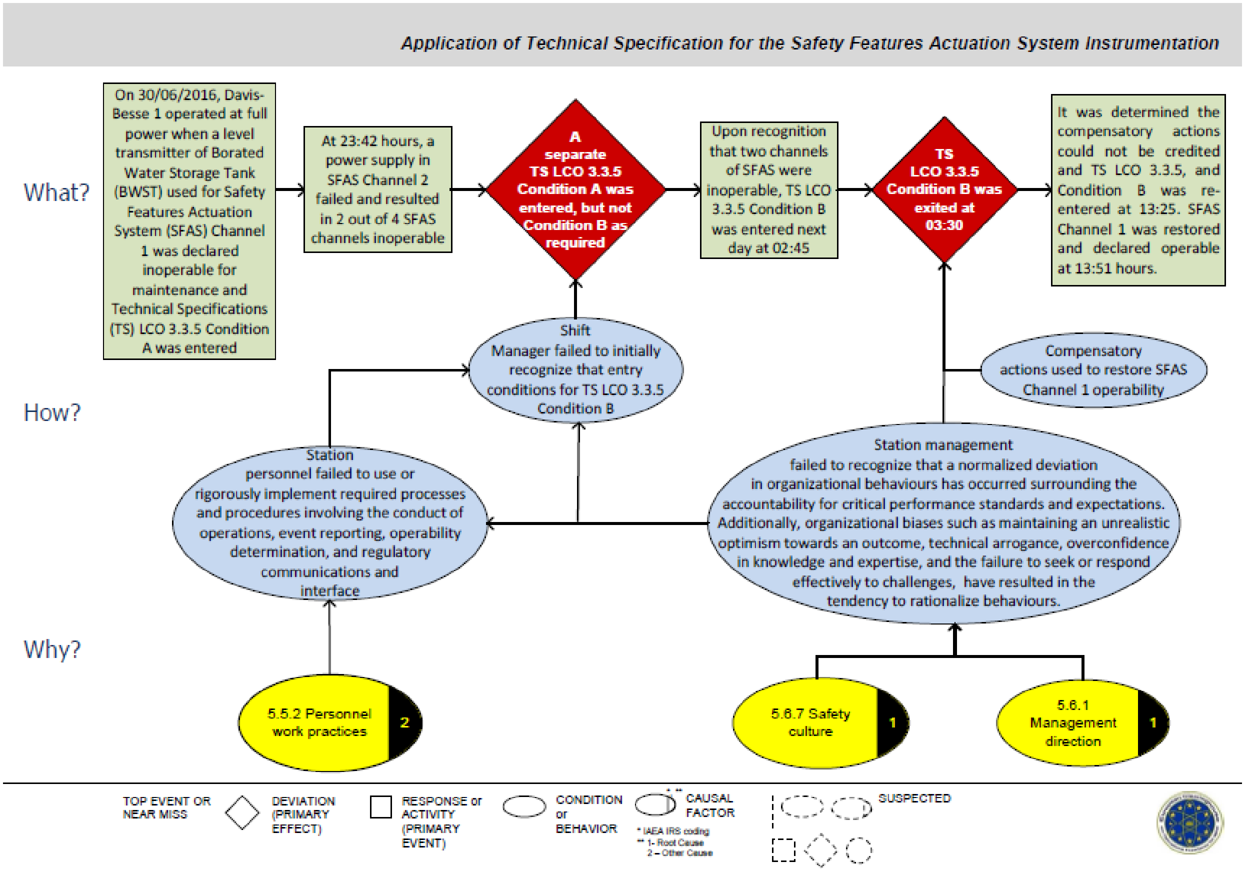
The root cause for the failure to properly apply TS 3.3.5 was determined to be that station management failed to recognize in a timely manner that a normalized deviation in organizational behaviours has occurred surrounding the accountability for critical performance standards and expectations. Additionally, organizational biases such as maintaining an unrealistic optimism towards an outcome, technical arrogance, overconfidence in knowledge and expertise, and the failure to seek or respond effectively to challenges, have resulted in the tendency to rationalize behaviours.

Corrective Actions include specific refresher training to all applicable personnel, revising relevant documents, and developing an event case study for training purposes.

Editor´s comment *– This event was selected because of the significance of its lesson learned for EU NPPs.*

Conditions prohibited by Technical Specifications (TS) must be avoided. Actions taken by Davis-Besse NPP could help other plants to define their own plan for preventing possible violations of TS and improve the Human and Organisational Factors (HOF) performance. Top level management has a leading role in promoting and setting high HOF performance standards.

Davis-Besse station management sought support of independent observers to monitor activities in the control room during plant start-up from the most recent forced outage. Site management reinforced expectations from station personnel regarding performance standards and commitment to compliance with TS. Furthermore, a standing order was issued to reinforce the expectations for review of TS and Operability Determinations, and Duty Team and Licensed Operator standards and expectations. Fleet Operations Business Practice, "First Energy Nuclear Operating Company (FENOC), Duty Teams", has been revised and improved. Also, the Davis-Besse Leadership Performance Improvement Commitment Plan has been implemented for achieving Leadership and Team



3.3 Reactor vessel closure head penetration nozzle indications attributed to primary water stress corrosion cracking and a weld fabrication void

The reactor was shut down for a scheduled refuelling outage for cycle 20. Non-destructive examinations identified four rejectable indications impacting four penetration nozzles.

Three of them were indicative of primary water stress corrosion cracking (PWSCC), with the largest indication having an axial extent of 0.372 in. with a through-wall extent of 0.247 in. (39 percent). The CRDM nozzles in the vessel head were originally constructed from Alloy 600 tubing and Alloy 82/182 weld metal. There is widespread industry operating experience that documents PWSCC of Alloy 600 dissimilar metal weld configurations.

The fourth indication was identified by dye penetrant testing. This indication had a rounded profile indicative of a weld fabrication void, and was 0.307 in. on the major dimension. The weld was fabricated during the previous outage, when the void was originally identified and was acceptable (0.135 in in the major dimension against an acceptance threshold of 0.1875 in). However, the void has since opened to unacceptable dimensions due to normal operating conditions. A leak path assessment and a bare metal visual examination of the reactor vessel head top was completed, with no leakage identified.

The three PWSCC indications were repaired using the inside diameter temper bead weld method. The fabrication void was removed via localized grinding, with no additional welding necessary. All repairs were completed prior to exiting the refuelling outage.

After PWSCC was identified in cycle 17, inspections of the vessel head were required every refuelling outage. These inspections include non-destructive examinations for all vessel head penetrations to identify indications, and are supplemented by bare metal visual examinations. If rejectable indications are found, repairs are completed. This ensures indications are identified and repaired before any significant impact on the integrity of the weld occurs. The bare metal visual examination and UT examination did not reveal any through-wall leakage. There was not a breach in the fission product barrier, and the structural integrity of the reactor vessel was not significantly compromised. Therefore, there was no significant impact to the health and safety of the public.

Editor´s comment – *This event was selected because of its potential safety significance (degradation of a fission product barrier) and because of the significance of its lessons learned for EU NPPs.*

— *The compatibility of materials should be checked also with respect to the operating conditions and environment.*

— *It is desirable that the components made of corrosion-susceptible materials be replaced by similar components made of more corrosion-resistant materials. Whenever possible and when compatibility can be assured, at least the repairs should be made using materials more resistant to corrosion.*

— *In-service inspection programmes should also focus on discovering manufacturing and other relevant defects that can cause further cracks and flaws, and not only on (post-event) identification of repairs needed in the plant.*

— *Stress corrosion cracks are not well visible by naked eye. Thus, when it comes to safety related components, such components should be included into the scope of the periodic penetrant testing programme, to avoid latent faults that may develop in failures.*

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

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