

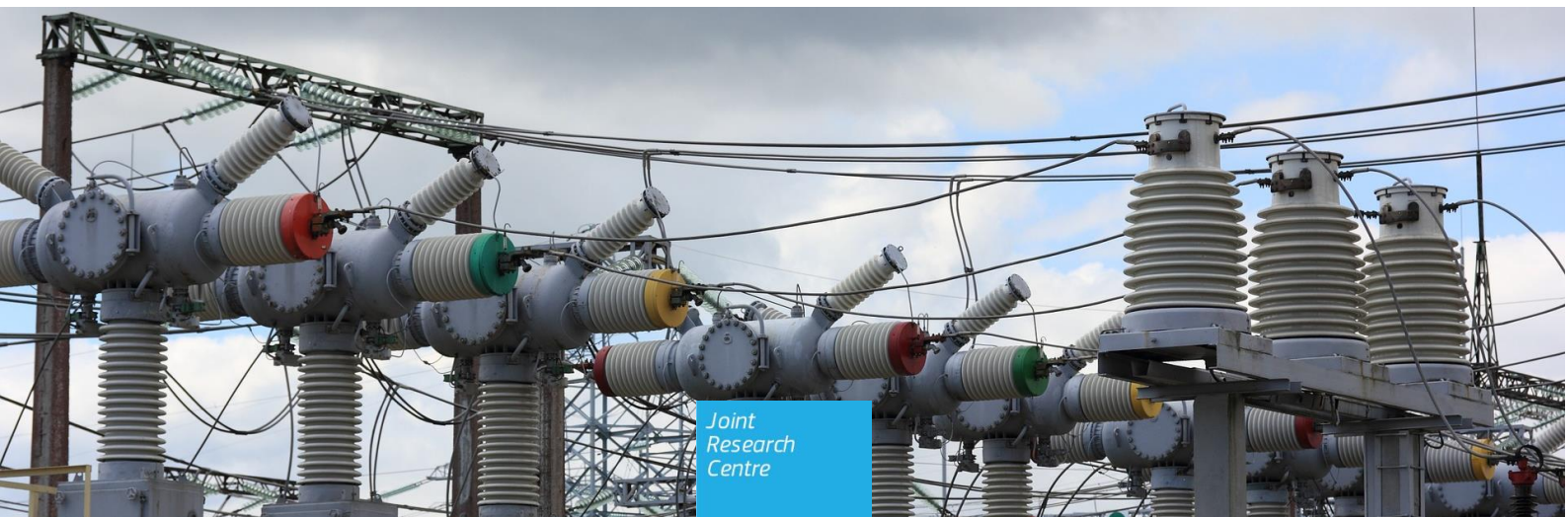
JRC TECHNICAL REPORTS

Quarterly report on NPP events

October – December 2019

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2020



Contents

Foreword	2
Abstract	3
1 Introduction	4
2 Events short-listed	5
3 Events selected	6
3.1 Multiple trains of RHRSW inoperable for greater than time allowed by Technical Specifications due to pipe corrosion	6
3.2 Unanalyzed condition due to inoperable security doors following a lightning strike	7
3.3 Loss of diesel starting air during maintenance leads to loss of High Pressure Core Spray system	7
3.4 Primary circuit draining operations	8
3.5 Defective electrical components	9

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 in October - December 2019.

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 them. 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 at least one of the following criteria are short-listed for further consideration:

- Unplanned or unexpected automatic or manual reactor trips;
- Events rated at INES Level 2 or above;
- Significant radiological events;
- Real or potential challenges to nuclear safety or defence in depth; including recurrent events and actuation of systems;
- Events with common cause failure aspects;
- Events with lessons learned worth being disseminated;
- Events requiring the entry into emergency operating procedures

Furthermore staff may occasionally short-list other events based on other criteria.

The final selection of the events is made by the JRC 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 judgment 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, most significantly, the information made available to the public, varies widely among countries.

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, wherever necessary, 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 database on our website, accessible to Clearinghouse members. 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

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

1. 27/08/2019: Multiple trains of RHRSW inoperable for greater than time allowed by Technical Specifications due to pipe corrosion (US / LIMERICK 1).
2. 10/09/2019: Unanalyzed condition due to inoperable security doors following a lightning strike (US / BROWNS FERRY 1/2/3).
3. 24/09/2019: Loss of diesel starting air during maintenance leads to loss of High Pressure Core Spray system (US / COLUMBIA).
4. 10/11/2019: Primary circuit draining operations (FRANCE / GOLFECH 2).
5. 18/12/2019: Defective electrical components (FRANCE / PENLY 2)

The information provided is extracted from publicly available and other authorised 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 Multiple trains of RHRSW inoperable for greater than time allowed by Technical Specifications due to pipe corrosion

LIMERICK 1 – 27/08/2019

On July 11 a pin hole leak was identified on the 18-inch distribution piping of one of the 4 spray networks while it was in operation for Spray Pond cooling. Subsequent inspections identified wall thinning over a large arc of the piping's circumference; approximately 34 feet of piping required replacement. Later, the extent of condition inspection identified additional pin holes in one of the networks and similar corrosion damage (but no pin holes) in the other two. Although the 18-inch spray network distribution piping was degraded, the spray networks and the ultimate heat sink were determined to be functional.

The affected piping was replaced and an NDE inspection and proactive pipe replacement strategy will be established to ensure long term reliability of the above ground spray pond spray network piping.

The Spray Pond serves both units at the site and is designed to supply and cool the safety-related cooling water for the Emergency Service Water and the Residual Heat Removal Service Water systems. The Spray Pond contains four spray networks. Each network contains 240 spray nozzles with all the piping and spray nozzles above the water level supported by concrete pillars. Only one spray network is required for the safe shutdown of one unit and any two networks provide sufficient cooling to safely shut down both units.

The apparent cause of the pipe corrosion damage observed was flow-induced film removal accompanied by high humidity electrochemical atmospheric corrosion. The required standby alignment for the spray pond spray networks results in the piping normally being drained and open to the atmosphere. When the system is placed in service, the air from the network piping and the subsequent flow oscillations, driven by the piping geometry, results in removal of any scale and corrosion products formed during the time the piping was out of service. When the system is not in service the newly cleaned pipe surface is exposed to the atmosphere in high humidity conditions. The corrosion footprint in the areas of excessive pipe corrosion and through-wall defects matches the corrosion footprint of excessive atmospheric corrosion.

This condition had not been identified earlier because there was a lack of understanding of this potential failure mechanism. Non-destructive inspection of the spray network piping had previously been performed on two of networks (the intent was that the inspection results would be representative of all spray network piping). The last non-

destructive inspection had been performed in June 2011, showing reasonably healthy piping with no evidence of excessive wall thinning. However, only localized scanning (spot readings) at the top, bottom and sides of piping was performed.

Editor's comment – *This event has been highlighted because of the potential for common cause failure and the significance of its lessons to be learned.*

The ability to select the appropriate preventive measures (type, extent and frequency of inspections) depends on the correct understanding of all applicable failure mechanisms. The identification of the failure mechanisms requires a full understanding of the environment conditions and detailed analysis of failure modes. Other licensees with safety-related piping subject to similar environment and operating conditions (open to atmosphere during standby and subject to strong flow during system operation) may want to review their inspection practices.

3.2 Unanalyzed condition due to inoperable security doors following a lightning strike

BROWNS FERRY 1/2/3 – 10/09/2019

On September 10 a lightning strike caused a power surge which affected the electrical circuits of some security doors. Three and a half hours later, it was discovered that some of the oncoming night shift personnel could not access particular areas which required keycard access. An extent of condition check determined that access to two electric board rooms, which contain remote shutdown panels and fire safe shutdown equipment, was prohibited for the night shift personnel. This condition impacted the ability of operators to perform their required actions within prescribed time limits if a fire had occurred.

The immediate corrective action was to reset the malfunctioning equipment. Access was restored to all plant areas 6 hours after the lightning strike, and 2 ½ hours after the access of the night shift to the electric rooms was denied.

The power surge from the lightning strike had disabled signal repeaters between the local intelligence units of some security doors and the monitoring stations. This resulted in the two electrical rooms security doors failing to receive roster updates, rendering these rooms inaccessible to oncoming night shift personnel.

As a corrective action, the site created a constantly-activated, all-access emergency keycard, as a contingency against future door communication failures.

Editor's comment – *This event has been highlighted because of the potential significance of its lessons to be learned.*

Interfaces between safety and security are currently an object of interest for nuclear safety international and national organisations. This event is an example of issues resulting from the opposing requirements stemming from the security approach (restrict access to unauthorised personnel) and the safety approach (grant swift access to required staff in emergency situations). The corrective actions taken by the plant may be of interest for regulators and licensees worldwide.

3.3 Loss of diesel starting air during maintenance leads to loss of High Pressure Core Spray system

COLUMBIA – 24/09/2019

The plant was operating at 100% power, with all Emergency Core Cooling Systems operable. During maintenance on the High Pressure Core Spray (HPCS) system, one of the HPCS diesel starting air receivers vented from the in-service air header through a

pressure control valve causing the in-service air receiver's pressure to lower. As part of the maintenance evolution, the air receiver to be drained was isolated from the starting air header and the air start motor cross connect valve was opened per procedure. The isolation valve leaked and created a lower pressure upstream of the PCV, which caused the PCV to relieve the pressure, dropping the in-service air receiver pressure below the required value. Operations declared the HPCS diesel generator, the HPCS Service Water, and the HPCS system inoperable.

The root cause of the event was that the plant procedure was revised in 2009 to open the air start motor cross connect valve to retain all 4 air start motors available for diesel start which is not in accordance with current licensing/design bases. A contributing cause was that a Condition Report to assess the controlling procedure for the maintenance was not fully evaluated. Corrective actions include the revision of station procedures and the repair of the leaking isolation valve.

Editor's comment – *This event has been highlighted because of the potential significance of its lessons to be learned.*

Deficiencies in procedures should be remedied in a reasonable time. Failure to do so may reveal organisational weaknesses embedded in the plant management system.

3.4 Primary circuit draining operations

GOLFECH 2 – 10/11//2019

On 8 October the unit was in a refuelling outage. In order to prepare for the reactor defuelling, the plant crew started the procedure to drain the reactor coolant system. A field operator entered the containment in order to open the pressuriser vent, according to procedures. As the technician was interrupted before finishing, the vent was not opened. However, believing that the vent had been opened, the operators on the control room proceeded with the drainage of the primary circuit, causing its depressurisation. In spite of a first water level control, the erroneous position of the pressuriser vent remained unnoticed, and the drainage continued. With this configuration, the primary water level measurements are not representative of the actual values.

Eight hours later, an operator noted that the primary level was not behaving as expected, and stopped the primary drainage and sent a technician to the containment in order to verify the position of the pressuriser vent. When the technician confirmed that the vent was closed, he was instructed by control room to open it. However, the control room operators did not complete the actions required by the technical specifications before opening the vent.

The opening of the pressurizer vent resulted in uncontrolled displacements of primary water and a decrease of the primary level. The operators therefore supplied additional coolant to the primary circuit to restore its level. No low water level alarm was triggered during the event.

The decisions made and the actions taken by the operator as they learned that the vent was closed were precipitated, without prior assessment of their proven and potential impacts, while the reactor was in a configuration not in accordance with general operating rules. The analysis performed later by the licensee, at the request of ASN, showed that the cooling of the fuel assemblies located in the reactor vessel was maintained during the event.

This event occurred a few days before a review inspection was carried out by 13 ASN inspectors and 11 IRSN experts on the Golfech site. This inspection was an opportunity for ASN to monitor, in particular, the measures implemented by EDF to secure the continuation of reactor shutdown operations and to strengthen the monitoring of operating activities following this event.

ASN also asked EDF to assess the consequences of depressurization on the primary circuit equipment, which led to additional checks on the installations. The results were analyzed by ASN as part of its instruction on the request for agreement to restart reactor 2, which was issued on November 21.

Due to the deterioration of the safety functions and the potential consequences for nuclear safety, linked in particular to faults in the management of the event and the monitoring of operations, as well as insufficient consideration of the lessons learned from operating experience, the event was rated as INES 2.

Editor's comment – *This event has been highlighted because of its INES 2 rating.*

3.5 Defective electrical components

PENLY 2 – 18/12//2019

On 12 October, during a refuelling outage, and when the operators were testing a safety cooling system after maintenance, the licensee noted that a medium voltage pump in the system failed to start within the expected time. After investigation, the operators replaced the moving contacts within the pump contactor in the electrical cabinet, and the pump returned to nominal status.

On 3 December, another pump (this time from the CVCS system) also failed to start, and again the moving contacts in the pump contactor were replaced. On 6 and 10 December, similar failures were observed with other equipment.

The contactors concerned are located within the 6.6 kV electrical cabinets supplying power to different safety equipment across the plant. They are used to control the start/stop of equipment according to control signals received (including automatic signals, reactor protection system signals and manual signals from both control room and local panels).

A contactor includes a moving replaceable part, driven by two coils, to close the contacts and to ensure that contacts remain closed. On the faulty contactors, this moving part may remain blocked in open position.

The preliminary cause of the problem identified by the contactor's manufacturer, after analysis, is the absence of a functional clearance between the pin and the sliding guide, potentially causing the moving contacts to get stuck in an intermediate position.

On 14 December, as a precaution, all moving contacts installed during the outage were replaced.

The contactors of both safety trains had been serviced in 2019 during this refueling outage, contrary to the usual practice of servicing only one train in one outage, which generated the potential for a common cause failure mode. The reason for the departure from the usual practice was that spare parts were not available during a previous outage. The maintenance on both redundant trains during the same outage requires some specific compensatory provisions which were not put in place.

The affected contactors supply power to the following safety systems: Essential Service Water system, Component Cooling Water system, Residual Heat Removal system, Safety Injection system, Auxiliary Feedwater system, Chemical Volume Control system and Containment Spray system.

In case of accident, the concurrent failure of several contactors could have led to the safety systems failing to reach and maintain a safe reactor shutdown. For instance, in case of a loss of coolant accident, the safety systems could have failed to quickly reduce the containment pressure and temperature.

The licensee replaced all faulty contactors before restarting the reactor, and is investigating the potential impact on other nuclear plants.

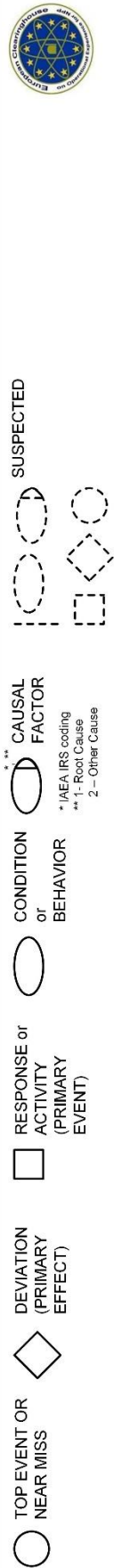
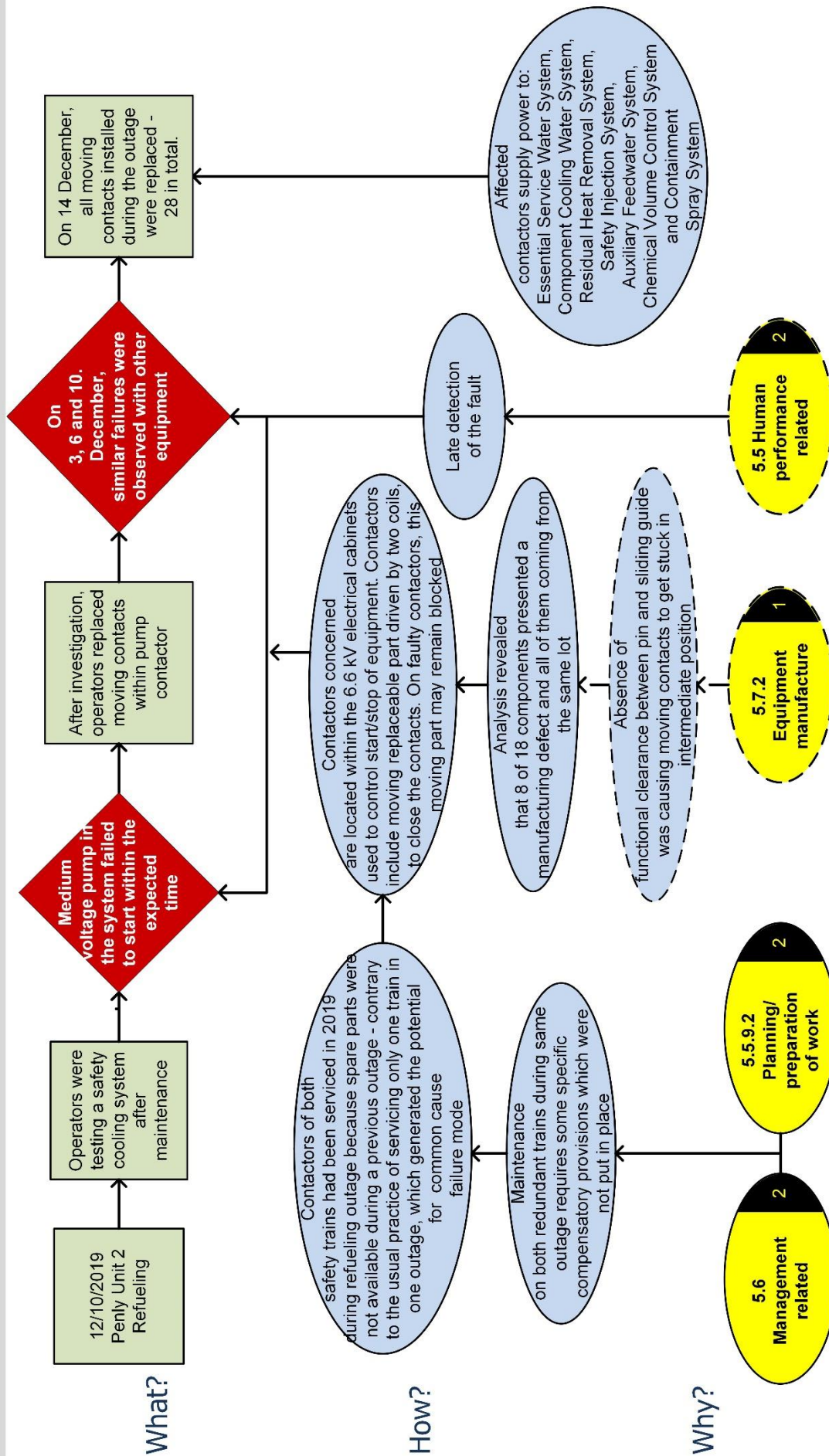
Because of the safety functions degradation caused by the assembly of faulty electrical components on safety-related switchboards, and because of the faulty organisation of the licensee, linked to both the maintenance preparation and the late detection of the failures, the event has been rated as INES 2.

The operator has replaced 28 moving contacts in total. The analysis of the first 18 among them has revealed that 8 components presented a manufacturing defect, all of them coming from the same lot. In parallel, the operator is verifying if these faulty components could have affected other reactors in France.

Editor's comment – *This event has been highlighted because of its INES 2 rating.*

Regulatory bodies and licensees in other countries may have an interest to verify the use of the concerned parts in their relevant installations. Furthermore, the event illustrates the effectiveness of alternating the servicing of redundant safety trains every other outage to prevent common cause failure modes.

Defective Electrical Components



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