

JRC TECHNICAL REPORTS

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 in January - March 2020.

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 worldwide 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. 01/10/2019: Automatic reactor scram during start-up due to Intermediate Range Monitor noise (US / BROWNS FERRY 2).
2. 06/12/2019: Division 2 Service Water discharge blockage resulting in unplanned Service Water inoperability (US / COOPER).
3. 01/01/2020: Manual reactor trip due to trip of both main feedwater pumps (US / COMANCHE PEAK 2).
4. 31/01/2020: Emergency diesel generators - earthquake resistance risk (FRANCE / 1300 MW MULTISITE).
5. 24/03/2020: Automatic and manual shut down because of acetes (krill-like shrimps) (CHINA/ YANGJIANG 1-6)

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.

During this quarter, the COVID-19 pandemic has spread all over the world, and nuclear power plants and regulatory bodies have taken measures to mitigate its consequences. The JRC has prepared a report¹ on continued safe operation of NPPs in this context. Furthermore, the IAEA, within the framework of the IRS activities, has collected information on measures adopted by NPPs to manage risks imposed by the virus outbreak².

3.1 Automatic reactor scram during start-up due to Intermediate Range Monitor noise

BROWNS FERRY 2 – 01/10/2019

Unit 2 received a reactor scram signal from less than 1% power that originated from the Neutron Monitoring System. There were no complications associated with this scram. All required safety systems functioned as designed. The initiating condition was discovered to be a scram signal due to electrical noise induced when the pushbutton was depressed for driving Source Range Monitors (SRMs) C and D out concurrently.

The event occurred because the IRM system design was not robust enough to mitigate the effects of noise intrusion. This issue was a long-standing one, but plant crew failed to take action on it. Previous scrams due to IRM noise spiking in 2010, 2012, and 2017 were missed opportunities to evaluate the aggregate impact of the IRM noise susceptibility. Furthermore, available operating experience from Hatch NPP and Industry Event Report L3-12-17, "Manual Reactor Scram Because of Erratic Intermediate Range Monitor Indications During Start-up" discussed the time constant modification that, if implemented, could have prevented this event.

Corrective actions which will reduce or mitigate the probability of recurrence are to implement a process to manage the risk of identified equipment vulnerabilities; to implement time constant modifications to BFN Units 1, 2, and 3 which will make the system more robust against noise spiking; and to revise the Bridging and Mitigation Strategy Development procedure to explicitly require review of OE during bridging or mitigation strategy development.

¹ *Continued safe operation of NPPs during the Corona virus pandemic*, B. Farrar et al, JRC Technical Report JRC120361 (available for registered users at <https://clearinghouse-oef.jrc.ec.europa.eu/>)

² Regular updates are available for registered users at <https://www.iaea.org/resources/databases/irsni>

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

Long-standing, unresolved technical issues may gradually become tolerated by plant staff and leadership. As recognised by INPO's Significant Operating Experience Report SOER 10-2, an engaged, thinking organisation should avoid this type of shortcomings. Operating experience from industry, as in this case, may often offer the solution.

3.2 Division 2 Service Water discharge blockage resulting in unplanned Service Water inoperability

COOPER – 06/12/2019

While attempting to place Reactor Equipment Cooling Heat Exchanger B in service, plant staff was unable to establish the Service Water flow to the heat exchanger, which was then declared inoperable.

At this plant, cooling water is pumped from the Missouri River by the Service Water pumps to the essential components through the two main headers. After removing heat from the components, the water is collected into two discharge headers and routed to the discharge canal where the water is returned to the river.

A few days later, troubleshooting located a flow blockage on the common buried Division 2 service water piping downstream of diesel generator 2, Reactor Equipment Cooling Heat Exchanger B, and Residual Heat Removal Heat Exchanger B. Manual sounding of the discharge canal was performed, and it determined that the sediment level above the pipe outfall was approximately 15 feet. Channel dredging with the aid of a barge and a pump was required to remove the sediment, and the service water was fully restored approximately one week after the beginning of the event. A temporary configuration change was in place during this time to mitigate the risk.

A modification to separate the divisional Service Water discharge piping carried out in 2014 had inadvertently introduced a new failure mode: sediment blockage in the discharge canal under historically high and prolonged river level conditions. This new failure mode was not recognised at the time the design change was prepared and implemented.

Editor's comment – *This event has been highlighted because of the potential for common cause failure. Usually, the main common cause failure modes potentially leading to the loss of the Ultimate Heat Sink are linked to the intake structures on the water supply side of the system. This event shows that the discharge structures are also subject to such risks. In this case, a design modification intended to mitigate this risk turned out to create a new, unexpected failure mode.*

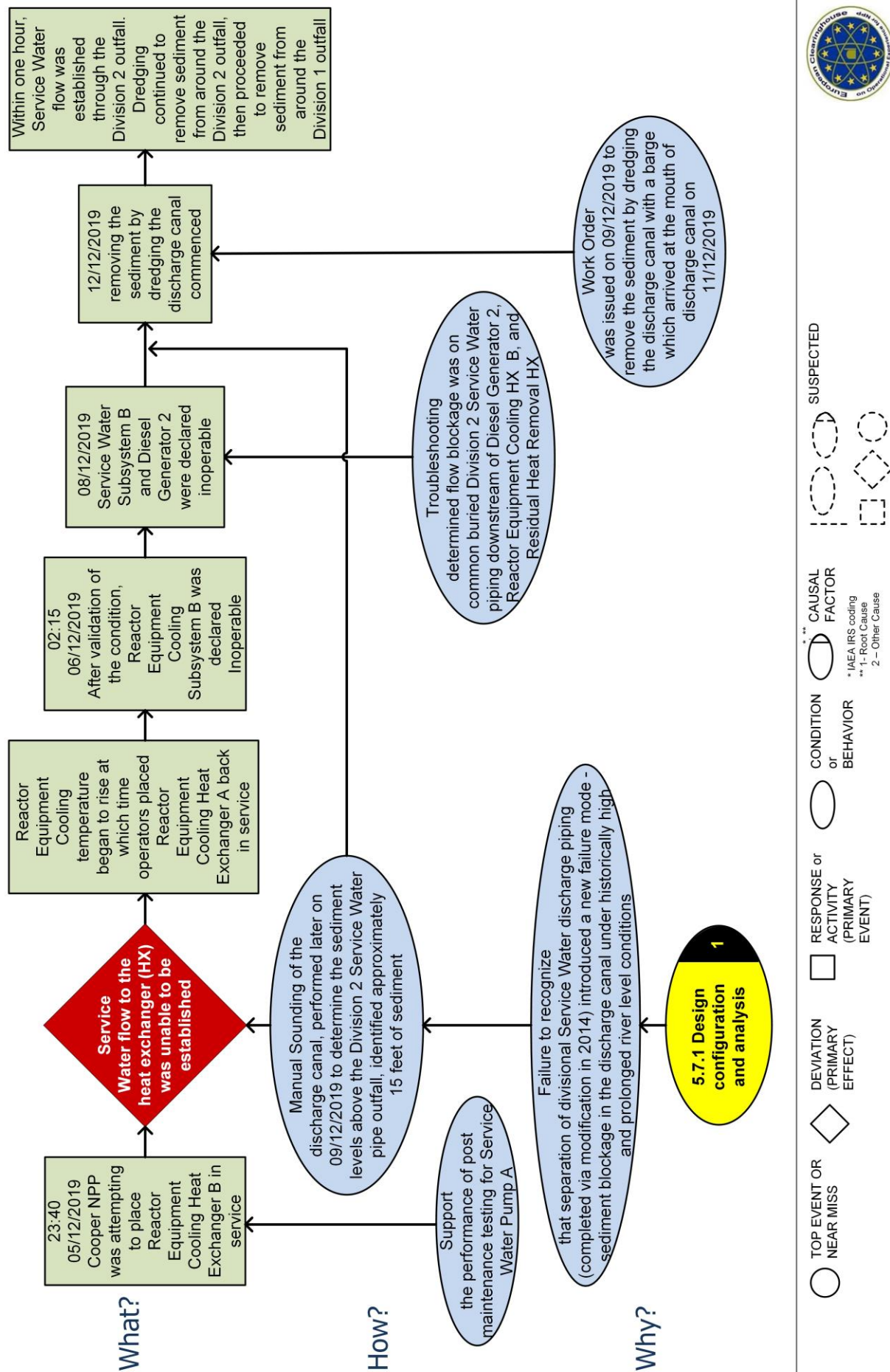
3.3 Manual reactor trip due to trip of both main feedwater pumps

COMANCHE PEAK 2 – 01/01/2020

The unit was manually tripped due to a loss of auxiliary condenser vacuum leading to the automatic trip of the two main feedwater pumps. The auxiliary feedwater pumps started as designed and all other plant systems behaved as expected.

The operators were shutting down one of the circulating water pumps, a normal plant activity to improve efficiency during the winter months. Seasonal variation in the temperature of the heat sink necessitates periodic shifting in the lineup of the circulating water pumps and throttling cooling water flow to ensure maximum efficiency in plant operation.

Division 2 Service Water Discharge Blockage Resulting in Unplanned Service Water Inoperability



During adjustment of the auxiliary condenser outlet valves, operators inadvertently closed both of the outlet valves simultaneously, which caused the loss of vacuum on both main feedwater pumps. The cause of this event was that neither the on-shift crew nor the leadership supporting them recognised, understood or addressed the risk prior to closing the valves.

The corrective actions included the removal of the involved operations personnel pending performance improvement plans, additional around the clock field and control room oversight for two weeks with daily roll-ups, oral boards for all operations personnel, re-performance of leadership and team effectiveness assessments for crew composition, developing behavioural learning activities, and conducting a site wide observation blitz.

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

The lack of adequate supervision and leadership of operations personnel should be a permanent concern at all nuclear (and non nuclear) installations. This plant has taken strong corrective actions to redress the situation.

3.4 Emergency diesel generators - earthquake resistance risk

1300 MW FRENCH REACTORS – 31/01//2020

EdF reported a safety significant event concerning the earthquake resistance of some auxiliary systems required for the operation of the emergency diesel generators in French 1300 MWe reactors.

There are three types of issues:

- (1) unsuitable connection of flexible hoses to piping
- (2) corrosion of piping and piping supports
- (3) unsuitable electrical connections on electrical cabinets

In the case of some reactors (Flamanville 1/2, Paluel 1/3/4, Belleville 1, Nogent 1 and Penly 1), the operation of two redundant diesel generators could have been compromised in case of an earthquake, and the event was rated as INES 2. In other cases only one diesel generator was concerned, and the event was rated INES 1.

The deficiencies have already been repaired, or are currently being repaired. In some cases special monitoring provisions have been in place to mitigate the risk before the repairs are complete.

These deficiencies in the seismic resistance have been noticed in the framework of inspections ordered by the regulatory authority through ASN decision n° 2019-DC-0662 from 19 February 2019. Indeed, other cases of seismic-related weaknesses of different emergency diesel generators auxiliary systems in France have been reported in the past, and highlighted in this newsletter (see for example newsletters 2017Q2 or 2019Q2). Additional inspections related to the ASN decision 2019-DC-0662 are still in progress.

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

The seismic resistance of the emergency power generation systems is of utmost importance, notably because frequently a weakness in the design or in the manufacturing / installation affects both redundant trains at the same time.

3.5 Automatic and manual shut down because of acetes (krill-like shrimps)

YANGJIANG 1-6 – 24/03//2020

A large amount of *acetes* (a small type of shrimp resembling krill, translucent and measuring 1-4 cm long) flooded into the seawater diversion channel and circulating water pumping stations of the site, continuously blocking the cooling circulating water inlet filters of the station. At 6.30pm, the unit 4 went into automatic safe shutdown, and other units operated at 80 per cent of their full power.

After clearance of the *acetes* and cleaning of the filters, unit 4 was reconnected to the power grid on March 25 at 1.14pm. However, shortly afterwards, from 4.09pm to 4.35pm, large shoals of *acetes* again found their way into the channel, crippling the pumping stations. This time units 2, 3, 4 and 6 went into automatic safe shutdown, and plant staff proactively brought units 1 and 5 to safe shutdown conditions. This second event was classified as Level 1 in accordance with the International Nuclear and Radiological Event Scale and the relevant nuclear safety regulations. It had no effect on the safe operation of the nuclear power station, or on the health of the workers, nearby public or the environment.

China's nuclear safety regulator said it had asked all nuclear power station operators to use marine life detection systems in light of this type of incidents. But the warning systems must be adapted to different types of marine or river life, including small species such as *acetes*.

At present, all six units at YNPS are in safe and controllable conditions. Station staff at the scene is taking measures such as fishing out the *acetes* and cleaning the filters, before reactivating the units and bringing them back to normal operation in accordance with relevant procedures.

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

Biofouling of cooling water intake structures has been a matter of concern for many nuclear power plants around the world, including sites with seawater cooling systems as well as sites using rivers or lakes as heat sinks. The suitable measures to prevent these events depend heavily on local environmental conditions, but the use of operating experience may help to anticipate problems and improve both the performance and the safety of the nuclear power plants.

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