

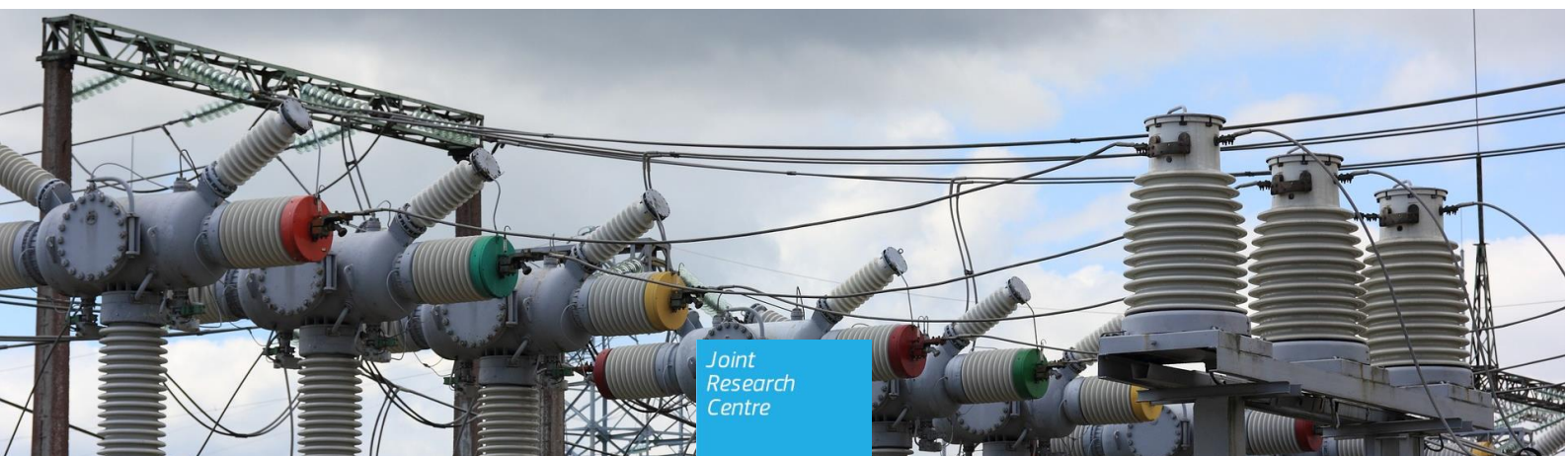
JRC TECHNICAL REPORTS

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 April - June 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

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

1. 10/05/2019: Auxiliary feedwater system actuation and manual reactor trip due to careless withdrawal of control rods (REP. OF KOREA / HANBIT 1).
2. 21/01/2020: Containment vacuum relief lines found isolated (US / SEQUOYAH 1).
3. 28/05/2020: Failure to comply with regulations on external explosions risk (FRANCE / GRAVELINES).

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.

As COVID-19 pandemic continues to spread worldwide, some operators have reported delays in the analyses of the causes of some events. In these cases, reports will be updated later with further information.

3.1 Auxiliary feedwater system actuation and manual reactor trip due to careless withdrawal of control rods

HANBIT 1 – 10/05/2019

A report for this event is already available at the IRS database, where authorised users may obtain additional information. It has been included in this newsletter as the event has been reported publicly through the IAEA's NEWS¹ channel only recently.

During low power physics test to measure the worth of the control rods, reactor power rapidly increased up to 18.06%. Due to the heat transfer from the reactor coolant system, the level of steam generators increased beyond the high-high level set-point, triggering the isolation of main feedwater and the trip of all feedwater pumps. As a result, motor-driven pumps from the Auxiliary Feedwater System were actuated to provide feedwater to the steam generators, restoring the normal water level.

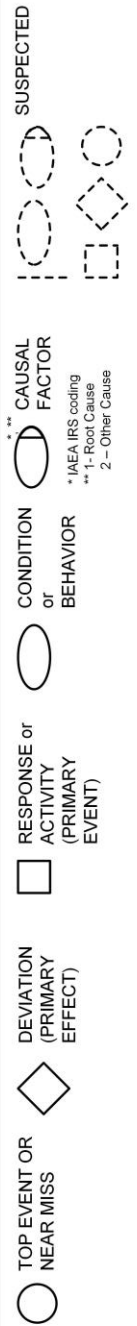
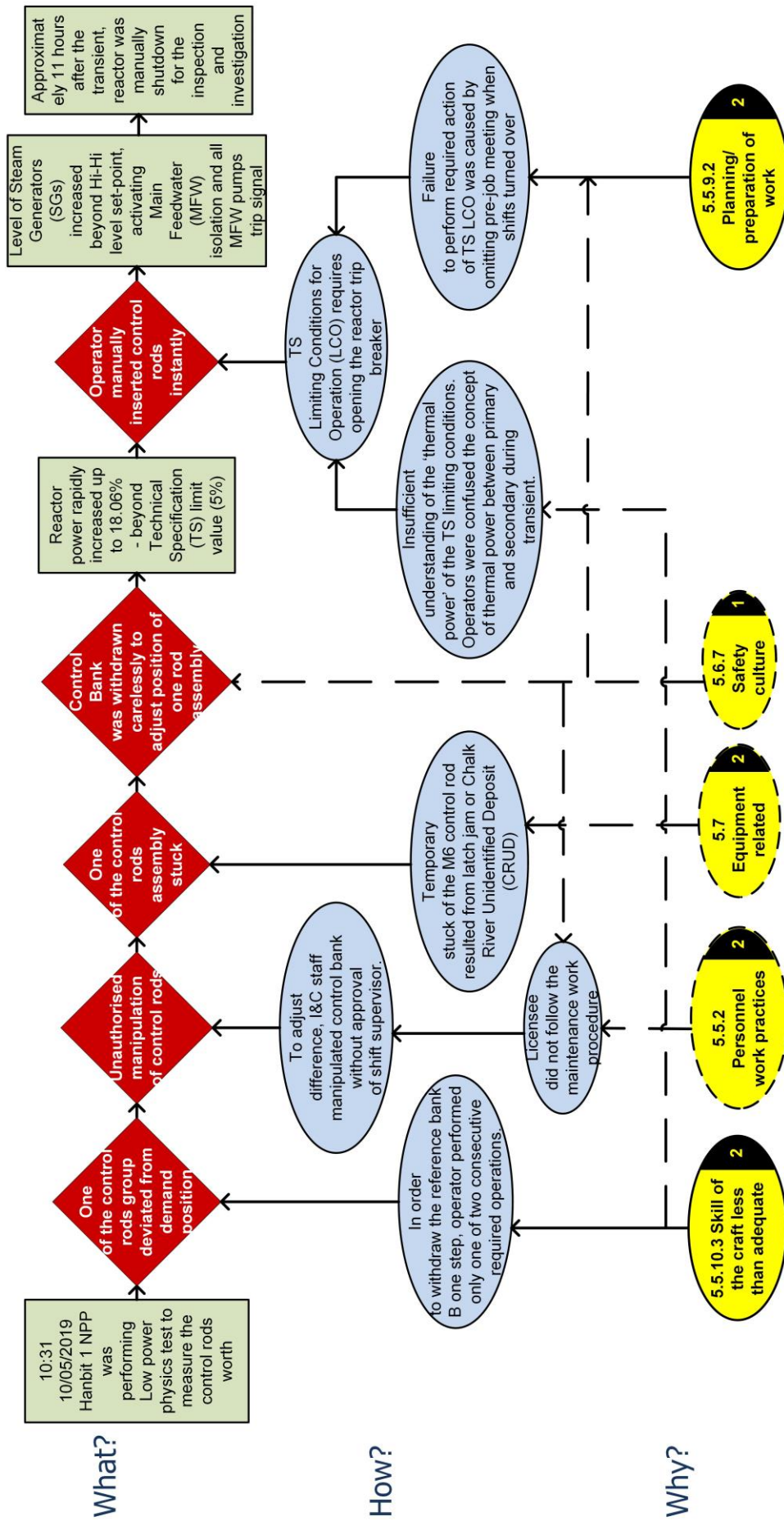
During the conduct of the test, reactor operators noticed that the position of some control rods did not correspond to their expected value due to the mis-operation of reactor operator. During trouble shooting, one of the control rod assemblies become stuck. In an attempt to resume the test, a control bank was withdrawn carelessly, causing the reactor power surge, beyond limiting value (5%) of the plant's technical specifications. At this point, the reactor should have been immediately shutdown but, recognising the abnormal condition, the operator manually inserted the control rods immediately, instead of opening the reactor trip breaker as required by technical specifications. The reactor power thus decreased to the zero power state. Approximately 11 hours after the transient, the reactor was manually shutdown for inspection and investigation.

The investigation of the event confirmed that the step deviation of the rod was caused by operator's mis-understanding of rod manipulation, and the careless withdrawal of the control bank was due to an inadequate troubleshooting work process. The failure to comply with the technical specifications was caused by omitting pre-job meeting when the shifts turned over and by insufficient understanding of the technical specifications during the test. Finally, it was assessed that the temporary stuck of the M6 control rod resulted from latch jam or CRUD (Chalk River Unidentified Deposit).

With regard to the impact of the event, there was no adverse effect on the plant safety, no radiation exposure to the workers, or no release of radioactive materials to the environment. However it has been rated as INES 2.

¹ <https://www-news.iaea.org/>

Auxiliary feedwater system actuation and manual reactor trip due to careless withdrawal of control rods



Editor's comment – This event has been highlighted because of its INES 2 rating and for the opportunity to deepen the human and organisational factors role, in completing the extraction of the lesson learned, and the tailoring the corrective actions.

In the narrative and in the cause analysis of the event several contributors to the events are identified: the step deviation of the rod, caused by a operator's mis-understanding of rod manipulation; the withdrawal of the control bank, caused by the improper maintenance work process for the troubleshooting; the failure to meet the required action of TS LCO, caused by omitting pre-job meeting when the shifts turned over; the insufficient understanding of the TS LCO during the test; the temporary stuck of the M6 control rod, resulting from latch jam or CRUD (Chalk River Unidentified Deposit). What is described indicates that there are human factors, and possibly even organisational factors, playing a role in the event dynamics.

The lessons learned from the event investigation emphasise, in case of testing involving control rods, the importance of having pre-job meetings.

It is an event for which the safety assessment has concluded the absence of adverse effects on the plant safety. However, the valorisation of this operating experience, in particular by deepening the human and organisational factors role, is going to complete the gained insights, and, as well, the extraction of the lesson learned, and the tailoring the corrective actions for avoidance or mitigation of the future recurrence of the identified issues.

3.2 Containment vacuum relief lines found isolated

SEQUOYAH 1 – 21/01/2020

The primary containment vessel is fitted with a vacuum relief system to protect the vessel from an excessive external force. It is a self-activated system that limits external pressure on the vessel in the event of maloperation or inadvertent operation of systems that result in additional external forces on the containment vessel. Those limiting external forces are created by design basis transients: inadvertent containment spray actuation, inadvertent containment air return system operation and simultaneous occurrence of both. The system consists of 3 containment relief pathways (i.e. vacuum relief lines) each containing a normally closed self-actuated vacuum relief valve and position indication. In series with the vacuum relief valve is a normally open, fail open, pneumatically operated containment isolation valve with necessary instrumentation and controls. The containment vessel VR system assures that the external pressure differential on the containment vessel does not exceed the design external pressure of 0.5 pounds per square inch delta (psid) assuming one vacuum relief valve fails to open in keeping with single failure criteria. When an external pressure exceeds a relief valve actuation force it opens allowing air flow from the annulus space into the containment vessel.

Operations personnel identified that the three containment vessel vacuum relief isolation valves were isolated, with the plant running at 100% full power. The staff restored the vacuum relief lines to operable status immediately by opening the vacuum relief isolation valves. Investigation of the condition determined that while in a refueling outage on November 13, 2019, a licensed operator incorrectly closed the vacuum relief isolation valves during the performance of a surveillance instruction.

The closure of all 3 isolation valves defeated the vacuum relief lines single failure capability during a period of nearly two months, challenging the integrity of a fission product barrier in the unlikely event of a design basis transients that results in limiting external pressure on the containment vessel.

The cause of the event was a failure to follow the surveillance instruction by the licensed operator. The operator assumed that a process was in place to restore the valves to open position. It was also determined that Operations Leadership did not establish a rigorous outage oversight plan, which precluded the ability to identify degraded or declining operator fundamental behavior. Actions being taken to address this event include a formal oversight plan to reinforce use of Operator Fundamentals, monitoring for shortfalls, and coaching to standards. Also, a revision to the common operating procedure for unit startup will ensure the vacuum relief system is aligned for Mode 4 entry.

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

One of the lessons learned from the topical study on shutdown² reads «Staff working in test and maintenance during refuelling tend to assume that safety-related equipment configuration will be checked at the latest moment prior to resuming power operation, thus relaxing the administrative procedures for system alignment control during the outage. Experience shows that in some cases this assumption is wrong». This lesson is based on operating experience reported through the period 1992-2012, but this event shows that this type of issues continue to occur.

3.3 Failure to comply with regulations on external explosions risk

GRAVELINES – 28/05/2020

The operator reported to the Nuclear Safety Authority a significant safety event relating to the risk of loss of long-term cooling of the reactors in the event of an external explosion.

A new LNG plant was built close to the Gravelines site between 2011 and 2016. The risks posed to the nuclear power plant from this new industrial plant were assessed by the operator and reviewed by the regulator in due time. Among the scenarios considered, an accident on a LNG ship when entering the port (the closest distance was estimated at 3000 meters) was deemed as the worst case.

On February 11, 2020, the operator had already reported a deviation affecting the motors of the filter drums of the cold source of the six reactors at the site. In the event of an explosion near the nuclear power plant, a pressure wave of up to 70 mbar could be generated, sufficient to damage the motors of the filters and potentially leading to the loss of long-term fuel cooling means for the six reactors at the site. Although the centralised nuclear emergency service ("Force d'Action Rapide Nucléaire") could restore the cooling functions, the feasibility of such an intervention could not be proved, and the operator engaged in corrective actions to protect the filter motors from explosions generating pressure waves up to 200 mbar.

Pending the complete modification of its facilities, EDF has implemented material and organizational compensatory measures to make the facilities of the Gravelines nuclear power plant more robust in the event of an explosion of external origin. EDF has already modified its facilities for reactor 5 in order to address this discrepancy, and has committed to do so before October 31, 2020 for the five other reactors at the Gravelines site. ASN nevertheless decided to regulate the deadline for closing this gap with a formal notice.

This event had no impact on the facility, people and the environment. Taking into account, on the one hand, the low probability of an explosion of external origin of high intensity but, on the other hand, the fact that the deficiency affects the safety function linked to the cooling of the six reactors, ASN classified this event at level 1 of the INES scale.

² Events related to low power and shutdown, Joint Research Centre, 2015

Editor's comment – *This event has been highlighted because of the potential significance of its lessons to be learned. It shows the dynamic nature of safety assessments, and illustrates the need to carry out very careful and comprehensive periodic reviews to account for the ever evolving reality of the plant, in this case the construction of a new LNG facility in the vicinity of the site.*

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