

## Analysis of events related to cracks and leaks in the reactor coolant pressure boundary



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### HIGHLIGHTS

- The important role of Operating Experience Feedback is emphasised.
- Events relating to cracks and leaks in the reactor coolant pressure boundary are analysed.
- A methodology for event investigation is described.
- Some illustrative results of the analysis of events for specific components are presented.

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### ABSTRACT

The presence of cracks and leaks in the reactor coolant pressure boundary may jeopardise the safe operation of nuclear power plants. Analysis of cracks and leaks related events is an important task for the prevention of their recurrence, which should be performed in the context of activities on Operating Experience Feedback. In response to this concern, the EU Clearinghouse operated by the JRC-IET supports and develops technical and scientific work to disseminate the lessons learned from past operating experience. In particular, concerning cracks and leaks, the studies carried out in collaboration with IRSN and GRS have allowed to identify the most sensitive areas to degradation in the plant primary system and to elaborate recommendations for upgrading the maintenance, ageing management and inspection programmes. An overview of the methodology used in the analysis of cracks and leaks related events is presented in this paper, together with the relevant results obtained in the study.

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### 1. Introduction

The integrity of the reactor coolant pressure boundary (RCPB) is important to safety because it forms one of the three defence-in-depth barriers. For that reason the RCPB is designed and manufactured so as to have an extremely low probability of abnormal leakage, which can be caused by different degradation mechanisms as shown in Fig. 1. Components of the RCPB are designed to permit periodic inspection and testing of important areas and features to assess their structural integrity. Leak

detection contributes to the prevention of reactor coolant system (RCS) loop breaks by detecting any through-wall cracks that may appear in service before they reach a critical size.

Evaluation of operating experience is a powerful tool for the safety assessment of nuclear power plants (NPP) (Schulz, 1991; Weil and Apostolakis, 2001; Michel, 2012). When applied to cracks and leaks related events, the analysis aims to find response to critical questions, such as:

- How relevant are the events, treated together, to their categorization (design, plant status, component, event cause, etc.)?
- What conclusions can be drawn on the safety impact and the corrective measures taken?
- What are the lessons learned for each category of event?
- What are the recommendations to prevent the repetition of such events?

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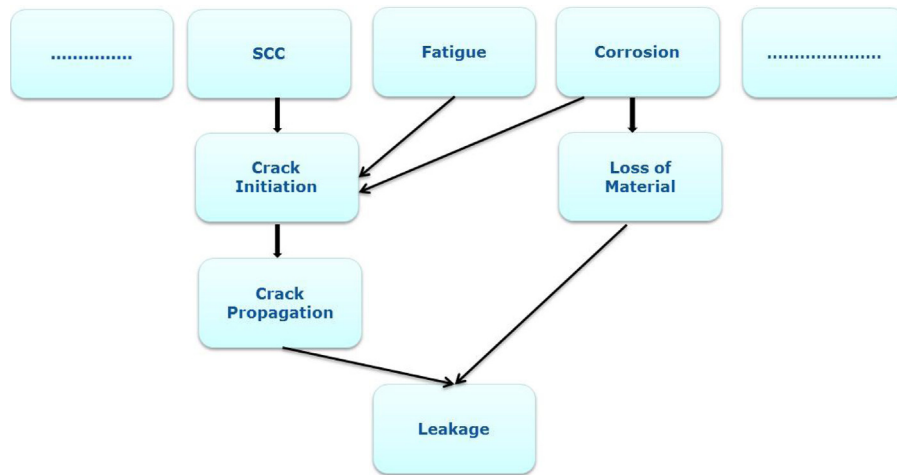


Fig. 1. Process leading to leakage.

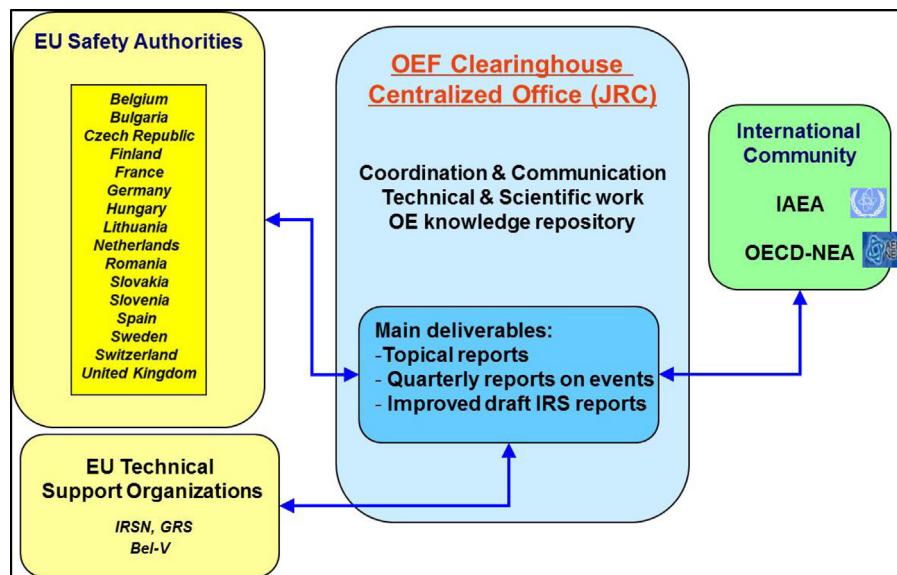


Fig. 2. Main actors and deliverables in the EU Clearinghouse.

## 2. European clearinghouse

The EU Clearinghouse on NPP Operational Experience Feedback (OEF) (Noël, 2010; Mühleisen, 2011), <https://clearinghouse-oef.jrc.ec.europa.eu/>, carries out on a regular basis technical work to disseminate the lessons learned from past operating experience as well as background scientific research in OEF. Additionally, the EU Clearinghouse is conducting work on exchange of OEF, as well as collaborating with international organisations. The EU Clearinghouse is managed by the JRC of the European Commission and fosters the collection of operating experience from European nuclear regulators and/or operators, assessing the potential value of lessons learned, and providing support for events relevant for the global OEF to be reported systematically and in consistent manner to the IRS system (IAEA, 2010) operated by NEA/IAEA.<sup>1</sup>

One of the EU Clearinghouse tasks is to provide topical reports of events with similar features or causes, conducting precursor studies of events at selected European NPPs facilitating the trend

analyses and enabling better understanding of the main patterns in operational experience events. Fig. 2 shows the organisations involved in the EU Clearinghouse and their main deliverables.

This publication is based on the results of the topical study on cracks and leaks related events performed by the JRC in collaboration with IRSN and GRS for the EU Clearinghouse. Other two independent analyses conducted recently are on events involving emergency diesel generators, see (Kancev and Duchac, 2013) and NPP modifications, (Zerger, 2011; Zerger et al., 2013).

## 3. Methodology

Four different databases were used in this study. Namely, the IAEA International Reporting System database IRS, the US Licensee Events Reports database LER, the French (IRSN) database SAPIDE and German (GRS) database KomPass. The screening period runs for 20 years, from 1991 to 2011 for IRS and LER, and from 1990 to 2010 for French and German databases. After screening, 145 IRS reports and 75 LERs were found to be applicable, to which 129 French event reports and 61 German event reports were added. The total number of events considered is 409.

<sup>1</sup> NEA: Nuclear Energy agency of the Organisation for Economic Co-operation and Development (OECD); IAEA: International Atomic Energy Agency.

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