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Modifications to nuclear power plants: A benefit which is at risk. An extensive analysis of the operating experience

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HIGHLIGHTS

- Four different event databases were screened.
- 769 events were found to be relevant for this study.
- Most of the events are initiated at the design stage of the modifications.
- Average detection time of the deficiencies is 4 years.

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ABSTRACT

This paper presents a study performed by the European Clearinghouse on Operational Experience for nuclear power plants, in cooperation with IRSN and GRS and covering events related to modifications of nuclear power plants.

This study summarizes the analysis of more than 700 modifications related events reported to different databases. To help identify generic lessons learned and recommendations, the events were classified into categories reflecting the stages of the modification process such as design, manufacturing and supply of components, implementation of the modifications, post-modification testing and secondly, into sub-categories related to components: civil engineering, electrical components and instrumentation & control, etc.

This paper presents the main findings and recommendations raised by this study.

1. Introduction

Modifications are implemented in nuclear power plants (NPP) for many different reasons: for safety reasons (for instance, following a periodic safety review), for economic motivations (power uprate or optimization of maintenance activities), to correct existing failures or deficiencies or to cope with the plant ageing (IAEA, 2001).

It can be expected that the number of modifications will increase over the coming years, for the operating NPPs but also for the NPPs under construction, considering the life time of the NPPs and the continuous upgrading of safety, security and environmental requirements.

It must be ensured that all modifications are designed, implemented and tested in such a manner that the safety of the plant as well as the safety of workers and environment is not degraded.

This article presents the results of a study (European clearinghouse, 2011) performed by the European clearinghouse on operating experience feedback of NPP (Noël, 2010) in cooperation with IRSN (Institut de Radioprotection et de Sûreté Nucléaire) and GRS (Gesellschaft für Anlagen und Reaktorsicherheit mbH). This study covers NPP events related to modifications to structures, systems and components, to process software, to operational limits and conditions, to operating procedures and to management systems, considering both permanent and temporary modifications.

The objective of this study was to identify the lessons learned from events related to modifications and to raise recommendations for regulatory bodies and utilities in order to avoid recurrence of similar events.

This article does not address the issues related to the supply chain and to modifications introduced at the construction stage, which were analyzed in other studies (Ziedelis and Noel, October 2011; Zerger and Noel, 2011).

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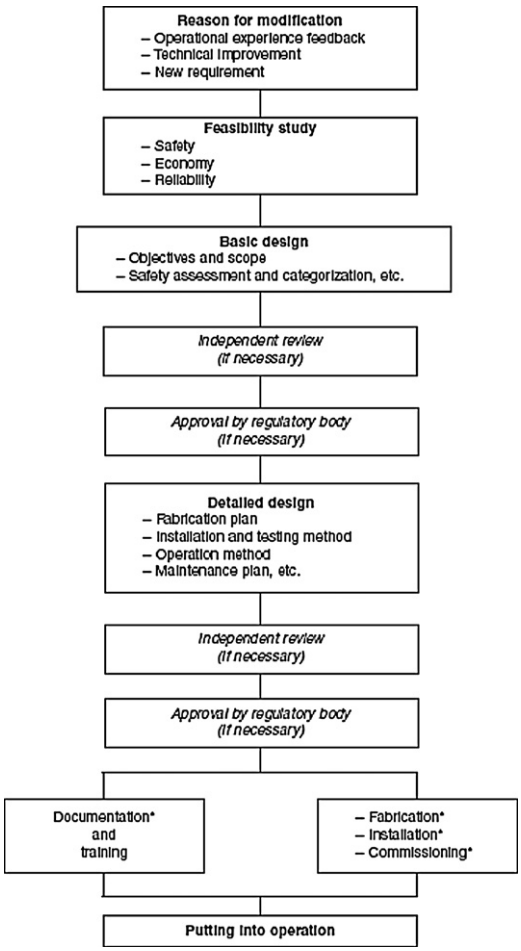

Fig. 1. Modification process (IAEA, 2001).

2. Methodology

This report summarizes the analysis of modification-related events reported to the IAEA International Reporting System (IRS) database, the US Licensee Events Reports (LER) database (https://lersearch.inl.gov/Entry.aspx), the French IRSN database and the German GRS database.

For this study, we screened 1160 IRS reports, 817 LERs, 3149 French events and 1053 German events. The screening period runs from the start-up of the database for IRS, from 1995 for the LERs and from 1990 for French and German databases and for all databases, it ends on 31 December 2009. After screening, 133 IRS reports and 250 LERs were found to be applicable, to which 267 French event reports and 119 German event reports were added, leading to a total amount of 769 events.

To help identify generic recommendations, the events were classified into several categories according to the main steps of the modification process (IAEA, 2001): design, fabrication and supply, implementation, post-modification tests, documentation (see Fig. 1) and secondly, into sub-categories related to components: civil engineering, electrical components, Instrumentation & Control, mechanical components, ventilation, fire protection and core.

The categories and sub-categories were screened to identify both lessons learned about specific components and generic recommendations for the different components and/or modification stages. This paper presents the generic recommendations raised by this study.

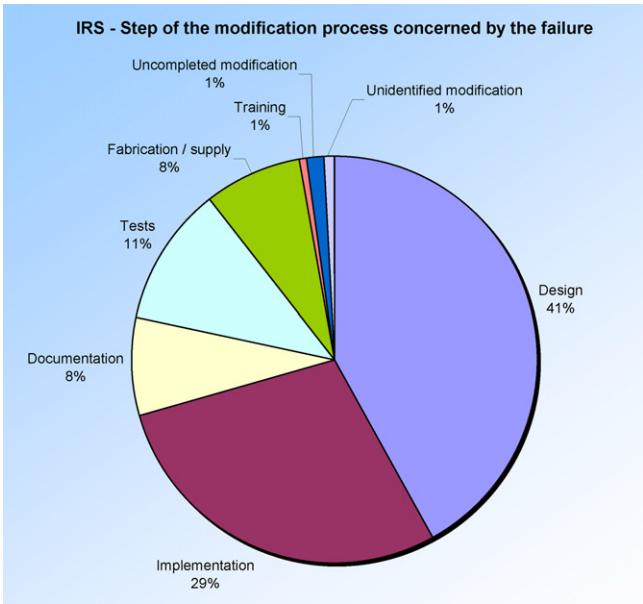

Fig. 2. Steps of the modification process when the reported events occurred.

3. Main findings

This section gives the main findings from the analysis of the IRS reports. Other results concerning the analysis of selected LERs as well as French and German events are available in the study (European clearinghouse, 2011).

Fig. 2 shows the distribution of the IRS modification events into categories corresponding to modification process steps: the two steps where the failures occurred mainly are design (about 40% of IRS reports) and implementation (about 30%).

Fig. 3 shows the distribution of IRS events according to groups of components: the most reported events concern mechanical components (about 40%), then I&C and electrical components (respectively 28% and 22%). It should be stressed that it does not mean that mechanical components are more affected than other components by modification failures. For such a conclusion, it

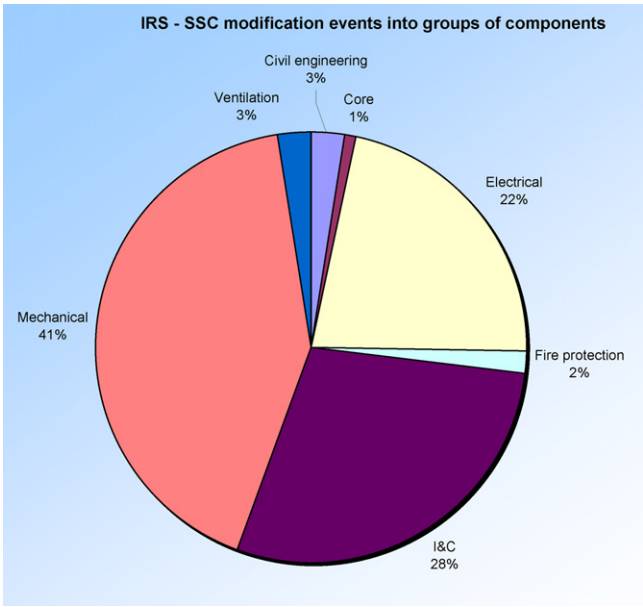

Fig. 3. Groups of components involved in the events.