Title: Probabilistic Safety Goals for Nuclear Power Plants; Phases 2-4 / Final Report

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Abstract

Safety goals are defined in different ways in different countries and also used differently. Many countries are presently developing them in connection to the transfer to risk-informed regulation of both operating nuclear power plants (NPP) and new designs. However, it is far from self-evident how probabilistic safety criteria should be defined and used. On one hand, experience indicates that safety goals are valuable tools for the interpretation of results from a probabilistic safety assessment (PSA), and they tend to enhance the realism of a risk assessment. On the other hand, strict use of probabilistic criteria is usually avoided. A major problem is the large number of different uncertainties in a PSA model, which makes it difficult to demonstrate the compliance with a probabilistic criterion. Further, it has been seen that PSA results can change a lot over time due to scope extensions, revised operating experience data, method development, changes in system requirements, or increases of level of detail, mostly leading to an increase of the frequency of the calculated risk. This can cause a problem of consistency in the judgments.

This report presents the results from the second, third and fourth phases of the project (2007–2009), which have dealt with providing guidance related to the resolution of some specific problems, such as the problem of consistency in judgement, comparability of safety goals used in different industries, the relationship between criteria on different levels, and relations between criteria for level 2 and 3 PSA. In parallel, additional context information has been provided. This was achieved by extending the international overview by contributing to and benefiting from a survey on PSA safety criteria which was initiated in 2006 within the OECD/NEA Working Group Risk.

The results from the project can be used as a platform for discussions at the utilities on how to define and use quantitative safety goals. The results can also be used by safety authorities as a reference for risk-informed regulation. The outcome can have an impact on the requirements on PSA, e.g.,

regarding quality, scope, level of detail, and documen¬tation. Finally, the results can be expected to support on-going activities concerning risk-informed applications.

The project provides a comprehensive state-of-the-art description and has contributed to clarifying the history of safety goals both nationally and internationally, the concepts involved in defining and applying probabilistic safety criteria, and the international status and trends in general. It has identified critical issues and the main problem areas. Finally, the project provides useful recommendations and guidance on the definition and application of criteria.

Furthermore, the project makes it possible to define criteria stringently, improving the possibilities of argumentation on safety. Generally, this supports efficient use of criteria, yielding more useful PSA results. In this connection, the introduction of ALARP type criteria is judged to provide a very useful way of balancing stringency with the necessary flexibility. There is a possibility of making more active use of lower level criteria. This makes the connection to defence in depth more evident, and opens the perspective of increased control of defence in depth by use of probabilistic methods, including the use as design tools. There is an opportunity for comparison of risk of different NPPs, as well as of comparison of NPP risk with other risks in society. This is judged to provide an opportunity for improved communication on risks with non-PSA experts and with the public in general. However, a necessary condition for meaningful comparisons is to agree on the scope of PSA and methods applied.

Obviously, there will also be challenges in the future definition and application of probabilistic safety criteria. These include very general aspects, such as the interpretation of the probability, quality aspects of PSA, and the definition of meaningful and consistent risk criteria for different usages. The need and usefulness of subsidiary criteria has been stressed in the project, but there is obviously also a challenge in defining a relevant set of criteria on different levels. Defining criteria for L(E)RF is complex, especially if release criteria are defined as subsidiary for societal and individual risk. Finally, it will be a challenge to develop coherent application procedures relative to the criteria defined.

Key words Safety Goals, PSA, Safety Targets, ALARP, Decision criteria, Risk informed decision making

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