A SCHEME FOR HARMONIZATION OF TERMINOLOGY ON SAFETY MARGINS AND CRITERIA

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Abstract

Many international documents contain variety of terms dedicated to criteria and margins problem. Different international documents were issued by different organizations and the documents were created by experts from different areas such as regulatory, scientific, safety analyses (nuclear and radiation), technical specification, operation and others. However Nuclear Power Plant staff deals with all the areas and often one can find one specific item called in different terminology and different items called identically. This situation called out for attempt to systemize the terminology among different areas.

Therefore, after thorough review of international documents from different areas of concern to NPP staff, the scheme of criteria terminology was created. Considering the design, manufacturing, assembly and operation processes, which contain conservatisms, only after that, corresponding margins were identified by its nature. Only then, to different, broadly used margins terms these identified by its nature margins were assigned. Proposed Criteria and Margins terminology could be used by different groups of experts. Definitions are provided along with practical examples. In order to make the scheme user friendly, scheme animation is provided.

1. INTRODUCTION

Margin management is recognized worldwide as one of very important area for safe and reliable NPP operation, but comparing terminology used in different guiding documents may be source of confusion for those who need to use more than one guide. Essentially in every activity connected with NPP, conservative approach is preserved, even when best estimate methods are used. All applicable criteria are demonstrated to be met with “satisfactory” margin at NPP design stage as well as operation stage, using different methods. These methods use conservative input data, conservative models etc. It can be understood, that there is a built in conservatism within the NPP design covering modes of operation, which is, in general, not quantified, but it is assumed that it exists.

In order to properly understand margins and conservatism built in the NPP design, it should be noted that the problem of margin management in principle should cover the entire NPP design – licensing - operation chain. The particular margin management is NPP specific, but the terminology should be clear and unambiguously defined trough out entire NPP design – licensing - operation chain and therefore guides issued by international organizations involved too. It should be understood, that for safe and reliable NPP operation the mutual understanding across entire NPP design – licensing - operation chain which means that harmonized terminology is important too. A question is, how and where to start with terminology harmonization. The entire NPP design – licensing - operation chain can be essentially seen from the top to bottom. The “Top” can be represented by customer requirements, regulatory requirements, and essential material properties. Then standards, acceptance criteria, design practices, SSC manufacturing and assembly can follow down to NPP startup, operation and modifications, including safety enhancement, power up rates and LTO.
For the purpose of criteria and margin management terminology harmonization, taking into account that different licensing practices may exist in a country of a designer and a country of a utility, two schemes were created. First scheme (Fig. 1) should help to understand where are the sources of margins, which may emerge from conservatism built in the NPP design documentation including operating procedures, SSC manufacturing and assembly stages. The second scheme (Fig. 2) then expands the approach to the NPP licensing and operation stage. Both schemes reflect the fact that in particular general design criteria may be satisfied via different limits of physical parameters expressed in different units at design and operation stage. Within the definition/abbreviation part of report, where appropriate, attempt is made to juxtapose terms used in different international guides, which potentially can have the same meaning within the criteria and margin scheme.

2. HARMONIZATION APPROACH

The proposed way for terminology harmonization is based on:
- Essential design and licensing process for new plant SSC design with built in different type of conservatisms (which may be seen as not quantified potential margin), plant startup and operational experience feedback, modifications and ageing, taking into account methods improvements, which may generate quantifiable margins (positive margin) or reveal deficiencies/non conservatism (negative margin) over plant operation.
- Criteria hierarchy and the way how they were established, covering entire NPP design – licensing – operation chain starting from GDC to operation criteria.
- Identification of types of possible margins, then grouping them by its nature and only after that assign them broadly used terms as Safety…, Design,… etc margin.
- The following definitions are used:

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**FIG. 1 Design phase Criteria-Margin scheme**
AC - Acceptance Criteria - criteria, expressed in terms of physical parameters in order to demonstrate that General Design Criteria (Requirements) are met. AC are Safety, Design, Manufacturing, Assembly and Operational. To each Safety AC parameter can be assigned Safety, Acceptance and Licensing limit.

AL - Acceptance Limit - value set up by regulator taking into account probabilistic nature of processes, events and the way, how the safety limit was obtained based on the experimental data and conditions.

Calc.Value – Calculated value within given methodology.

CDR - Component Design Requirements - Requirements to the components, which need to be met in order to comply with System DR and AC resp. their AL values.

DL - Dose Limit - Postulated value at which damage to human/nature occurs.

LCO – Limiting Condition for Operation in Condition assured in ultimate case by reactor shut down or trip initiated by operator or systems at reaching specific set points

LL - Licensing Limit - Regulatory approved value, which shall not be exceeded during licensing process, using specific approved methodology within specific project - LL ≤ AL ≤ SL=PDV

PDV - Postulated Damage Value – value at which damage is postulated

RIRV - Radiation Impact Real Value – value at which radiation harm/damage occurs

RSAC - Reload Safety analysis Checklist - parameters with limits which shall be satisfied for core design

RV - Real Value - As a matter of the fact, such value can be known indirectly (measurement at different then evaluated conditions e.g., Real Damage Value - RDV, calculation, measurement with subsequent calculation)

SL – Safety Limit - value, at which SSC, function fails/is damaged = PDV

ST ref. lim. – Source Term reference limit

σkrit – stress at which SSC fails/is damaged

SSC – Structure, System, Components

Margin - difference expressed in terms of physical parameters as a result of demonstration that current necessary conservatism can be less that conservatism originally implemented in the NPP SSC design

Criteria structure relaying on the above definition can be created for licensing and operation stage, (Fig.2) with identified types of margin as follows:

R1 Criteria Margin - Difference between limiting value corresponding to GDC (damage value) and value at which it is postulated that CCS will fail – Postulated Damage Value. It consists in:

R1.1: Transition from GDC to actual AC expressed in terms of set of physical parameters

R1.2: Method of SL=DV set up for each AC such as:

- Selection of acceptable measure of no failure (e.g. 95/95),
- Conditions and experimental data treatment
- Selection of DV as e.g.: average, RMS, Min, Max,

R1.3: The way of AC values setup such as e.g.: DV minus uncertainty, AC = DV

R2 Methodology Margin-- Difference between AC value and actual calculated value (Plant, System, Component, Equipment qualification design requirement). It consists in:

R2.1: Difference between AL - the conditions at which AC Limit was setup and LL corresponding to the analytical method used to demonstrate AL limit is met (in the Basic Design Analyses scheme covers also conservatism implemented due to parallel activities in design process)

R2.2: Difference between required properties and calculation result at specified design input

R2.3: Design / SA Methodology consist in:

R2.3.1- Selection and justification of initiating events taking into account frequency, initial and boundary conditions and single failure principles

R2.3.2 – actual modelling of processes, including user effects.

R 2.4: Selection of input values used in safety analyses) connected with:

R 2.4.1- methodology (e.g. to cover possible non-conservatism of scenarios R2.3.1)

R 2.4.2- the way of accounting for SSC reliability

R2.4.3 - extra conservatism (Design /licensing schedule, Processes knowledge, Capabilities of manufacturing and assembly

R 2.4.4 - Surveillance considerations e.g. Calibration accuracy, conditions, frequency

R 2.4.5 - Additional supplier's conditions

R3 As Built Margin consists in:
R3.1: Manufacturing due to better, then in design assumed limiting, values
R3.2: Assembly due to better, then in design assumed limiting, values
R3.3: SSC Servicing

R4 Operational Margin: - Difference between actual value of monitored parameter and its limiting value in operational procedure

At the end, the general terms for Margin can be assigned (Fig.3) as:
Safety margin - R1.1 - R1.3, Licensing margin R2.1, Output design margin R2.2, R2.3, Input design margin R2.4.1 – R2.4.4, R3.1 - R3.3, Operational margin at the design (including modifications) stage R2.4.5, , resp. Operational margin at the operation stage R4.
Applicability to Low water level in accumulator with references to documents and examples of limits as practical example of presented approach is demonstrated on Fig.4:

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