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PAPER 11

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ONTARIO HYDRO NUCLEAR

CANADA

Safe Operating Envelope

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The Safe Operating Envelope

SAFE OPERATING ENVELOPE:

"The outer bound of plant conditions within which day-to-day plant operation must be maintained in order to comply with regulatory requirements, associated safe design criteria and corporate nuclear safety goals"

- expressed mainly in plant operating documents (OPPs, etc)
  - special safety system setpoint limits
  - process parameter acceptable range or limit
  - minimum equipment availability
  - allowable equipment configurations and operating states
- the bounds for which acceptably safe operation has been demonstrated by the safety analysis of DBAs

Nuclear Safety Management Framework

- A framework of performance objectives to support management of public radiological risk
  - » Equip the Organization
  - » Define the Safe Operating Envelope
  - » Prevent Incidents and Accidents
  - » Mitigate Incidents and Accidents
  - » Manage Accidents

Public Nuclear Safety Performance Areas and Objectives- DEFINE SOE

- The safe limits of operation shall be comprehensively defined and understood
  - » SOE defined in a systematic and rigorous manner to ensure it is complete and comprehensive
  - » SOE shall be actively maintained to be current and correct
  - » SOE shall be effectively disseminated and understood

SOE Issues...

- SOE defined rigorously and systematically to ensure completeness
  - » scope of plant safety report updates
  - » methods to derive safety parameter limits
  - » quality of safety analysis tools and products
  - » clear identification of factors that impact SOE, consistency and linkage between limits and their source
    - – SR, reliability/risk assessment, licence req'ts and commitments, design req'ts/specs, regulator reqts

...SOE Issues...

- SOE maintained actively to be current/correct
  - » review / account for industry info. (failure data, inspection/surveillance results, changed system conditions, new operating phenomena)
  - » new regulations, acceptance criteria
  - » safety R&D and safety analysis to support and improve SOE definition and understanding (new understanding and insights)
  - » mods or changes in design, equipment, materials, testing, maintenance accounted for

...SOE Issues

- SOE shall be effectively disseminated and understood.
  - » develop and document clear specification of safety significance and rationale for each limit or credit
  - » clearly flag changes to defined SOE and their rationale
  - » defined SOE readily accessible, with limits specified explicitly
  - » clear compliance strategy and process for all relevant limits

SOE-Related Activities and Initiatives...

- Safety Parameter Limits
  - » develop uniform policy defining principles to be followed in deriving and applying safety parameter limits
  - » develop standards for deriving and applying safety parameter limits
  - » response to AECB Position 1992-93
  - » OHN team 1996-97
- Safety Report Updates
  - » Pickering/Bruce reference safety analysis includes derivation of key safety parameter limits
  - » Darlington SR pilot application of Operating Parameter Methodology (OPM)

OHN Safety Parameter Tolerances Policy

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...SOE Related Activities and Initiatives...

- Derivation of Safety Parameter Limits
  - Various methods to set plant operating conditions for reference safety analysis. They vary in rigour, comprehensiveness and consistency.
    - all sensitive parameters set simultaneously to limit of the operating envelope (LOE)
    - one parameter set at SOE limit, others set at less conservative values within their operating range.
    - assign probability distributions to each sensitive parameter and compute probability of an effective trip. (eg. ROP/NOP systems)
  - Darlington OPM pilot is a systematic framework to set operating parameter values for safety analysis based on expected range for sensitive parameters
  - key concern is tractability of analysis scope and associated data collection burden. Availability of suitable data a problem.

...SOE-Related Activities and Initiatives...

- Nuclear Safety Analysis QA
  - » comprehensive and consistent program
  - » analysis processes
    - – ensure that analysis is properly planned, executed, reviewed and verified
    - – ensure consistency between analysis assumptions and plant conditions(actual or expected)
    - – ensure proper linkage of analysis results to updates in operating documentation and procedures
  - » analysis tools
    - – qualified analysis software(validated and verified)
    - – qualified plant data sets (verified and linked to plant design)

...SOE-Related Activities and Initiatives...

- Safety Analysis Tool Qualification
  - » Industry Validation Team
    - – validation matrices
    - – coordinated code validation and code uncertainty methodology
  - » Industry Standard Toolsets
    - – consolidation of tools to permit thorough qualification of workhorse codes with limited resources
    - – impact on SOE must be assessed
- Improvements to Safety System Testing and Compliance
  - » instrument uncertainties, drifts and time response properly accounted for and supportable
  - » ensure adequate impairment margins through design or procedural changes or through reanalysis.
  - » consistent & rigorous definition of compliance model & analysis limits in operating documents.

...SOE-Related Activities and Initiatives

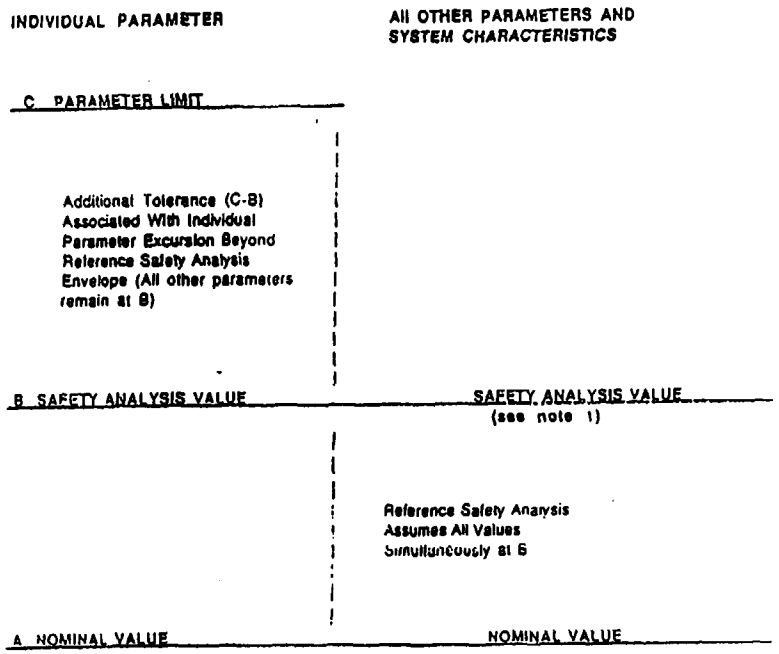
- Safety R&D
  - » validation of safety analysis codes and models
  - » providing data for model development to better characterize underlying phenomena, improve calculated margins...
  - » support for analysis acceptance criteria and metrics (eg., post-dryout operation prior to trip)

SOE-Future Steps

- Areas for possible followup and/or collaboration
  - » standardization of methods for SOE definition and compliance
    - – computer codes
    - – methods for calculating safety parameter limits
    - – operational compliance models
    - – plant surveillance techniques
    - – policy, standards and processes developed in keeping with best international practices.
  - » development of statistical-based (or other) techniques to improve margins between normal operating range and SOE. (Derivation & compliance aspects of SOE)
  - » joint work on validating industry standard tools
  - » uniform QA policies and standards for SOE-linked activities

Figure 3.5-11

Assumptions Applied in Establishing
Parameter Limits for Special Safety System Setpoints



Note 1: For safety system setpoints, the effective setpoint is used.
For all other system characteristics, the conservative safety analysis limit is assumed.

Safety Analysis Parameter Selection

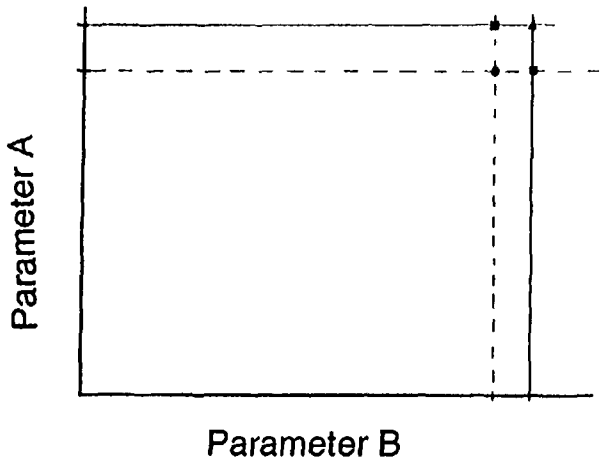
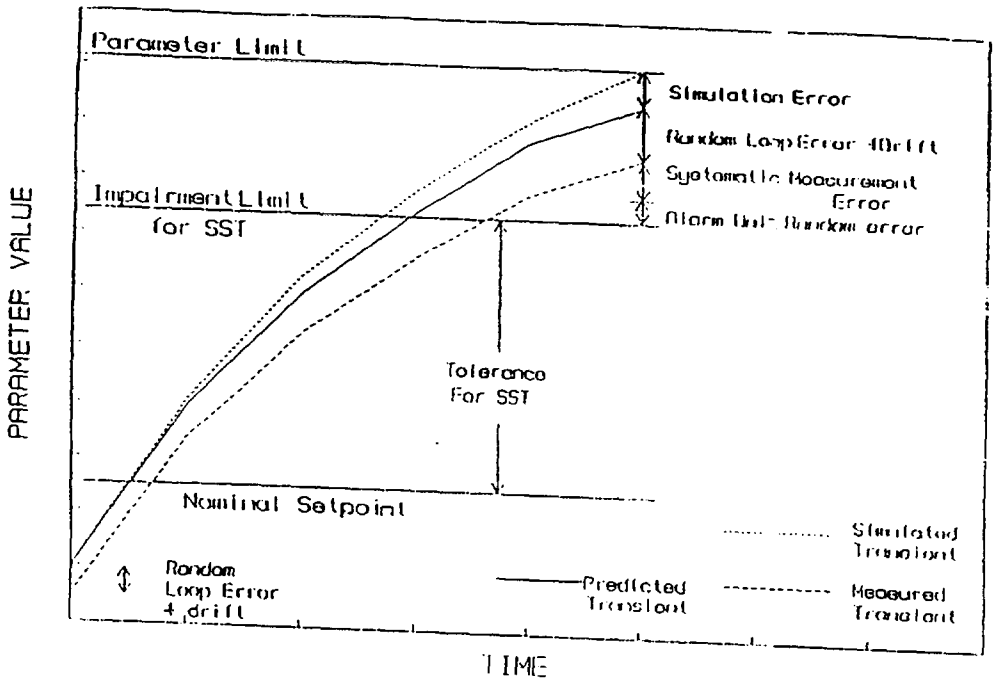


Figure 3.5-5

Relationship Between Nominal Trip Setpoint, Parameter Limit and Setpoint Tolerance for Safety System Tests



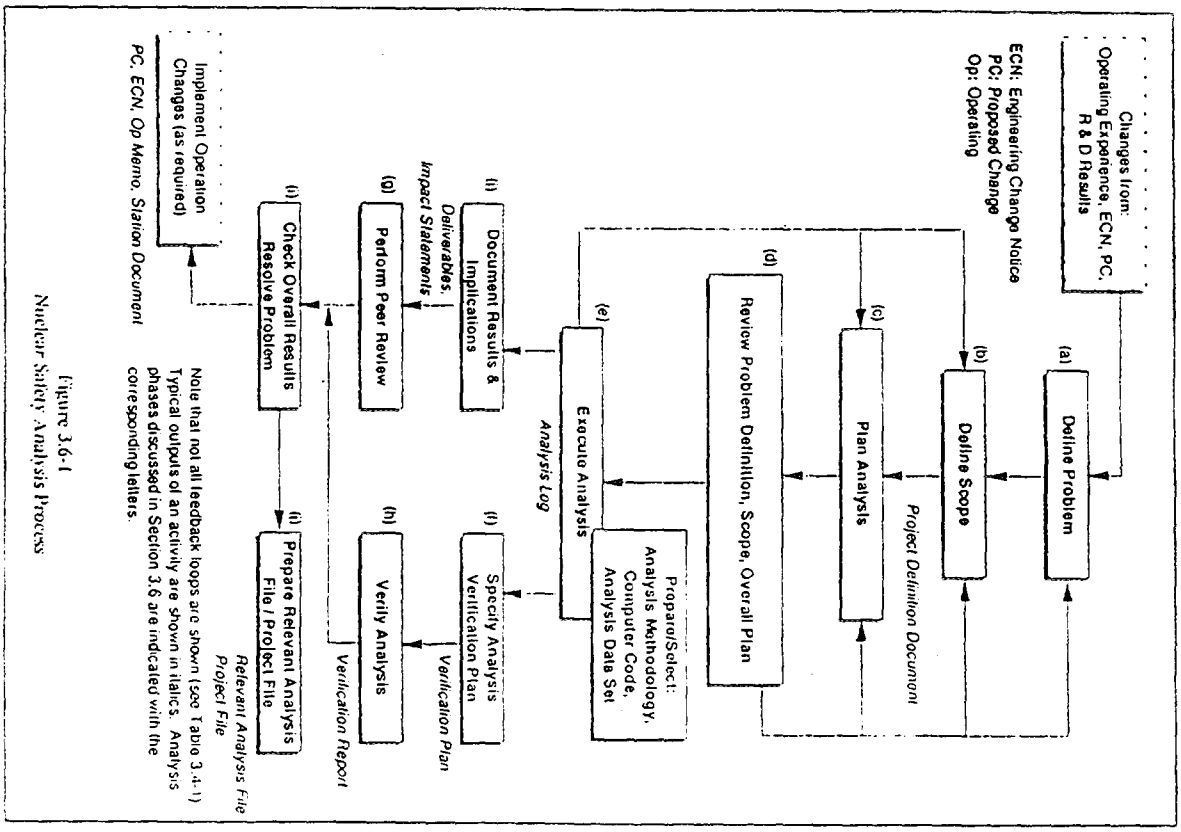


Figure 3.6-1
Nuclear Safety Analysis Process