Discussion of Treatment of an Undetected SPND Failure in Chapter 15 Event Analysis

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Purpose

- **Provide an overview of the proposed approach to incorporate the undetected failure of an SPND in the U.S. EPR™ safety analysis bases.**
  - **Highlight where the failure is implemented**
  - **Discuss how the ANP-10287P methods will be used and how they will respond to the SPND failure**
  - **Describe the manner in which the proposed method of trip threshold generation provides the same level of protection for the safety limits**

Background

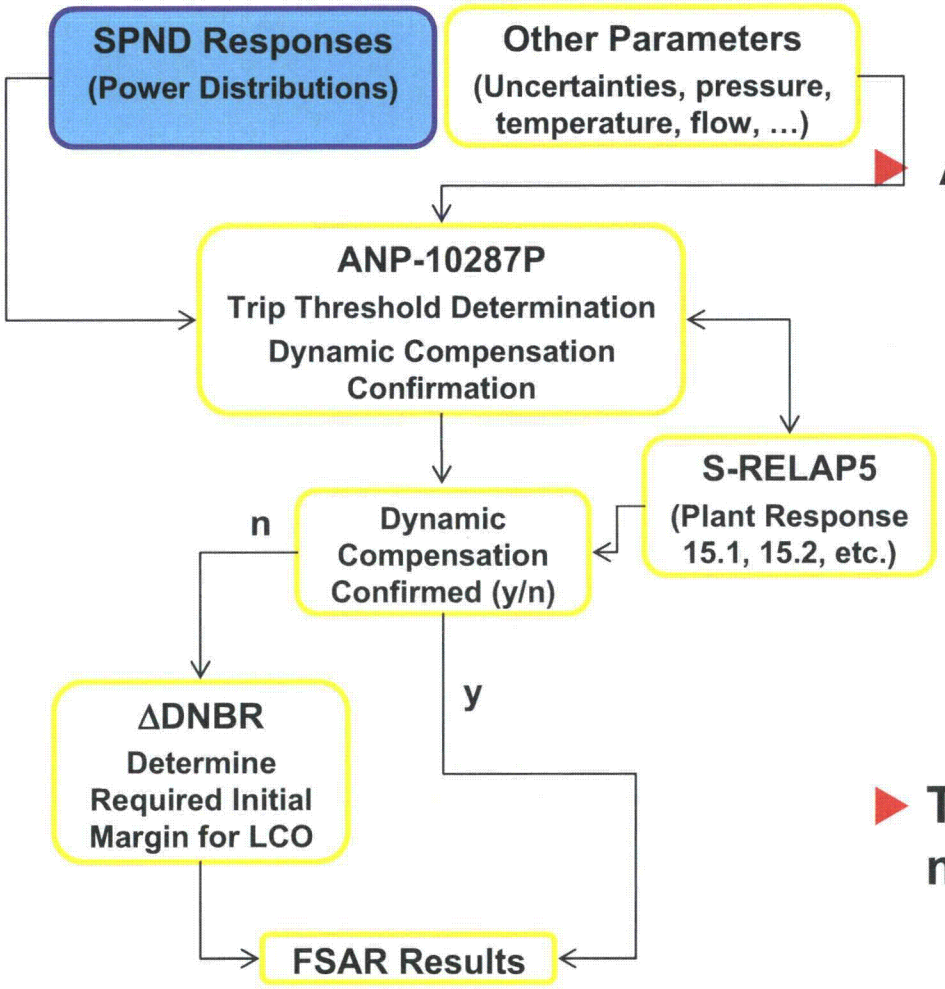
▶ Redundancy, single failure and the SPNDs

- ◇ **All 72 SPND signals are distributed to each of the four redundant protection system divisions**
- ◇ **The SPNDs themselves are not redundant to each other**
- ◇ **The alternative request, acceptable level of protection, and conservative setpoint selection**
  - Detected failure
    - Trip threshold shift to more restrictive value
    - Threshold is calculated through application of the statistical methods to a series of random failed sensor calculations
  - Undetected failure
    - Low probability, non-self announcing failures may be postulated in the SPND amplification and signal multiplication equipment
    - Include failure of the most limiting SPND response as an initial condition in the trip threshold determination and transient compensation confirmation

Background (Continued)

- U.S. EPR™ FSAR Chapter 15
  - Original submission did not include a undetected SPND failure as a credible single failure
  - Non self-announcing failure within signal conditioning modules can be incorporated as proposed in the alternative request
- Alternative request proposed method
  - Utilize the existing ANP-10287P methodology
  - Modify inputs to the methods to explicitly account for the undetected failure of the most limiting SPND response

Conceptual Path Overview



ANP-10287P

- **Sensed vs. Reference (LPD & DNBR)**
  - Fundamental concept of the methodology
  - Desire to quantify the difference between what the PS senses and the real core condition
- **Core power distribution is provided to the methodology as simulated SPND responses**
  - Facilitates simulation of the reference core condition and the sensed core condition with the requisite uncertainties

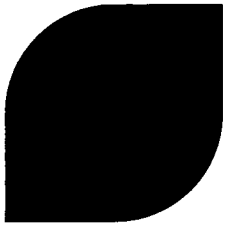
These simulated responses will be modified

- **Analyze each power distribution and remove the most limiting SPND response for DNBR and LPD**

Static Trip Threshold Determination

- **Inputs**
  - **State point combinations (pressure, temperature, flow)**
  - **Uncertainties (system, codes, etc)**
  - **Power Distribution**
    - Simulated SPND responses

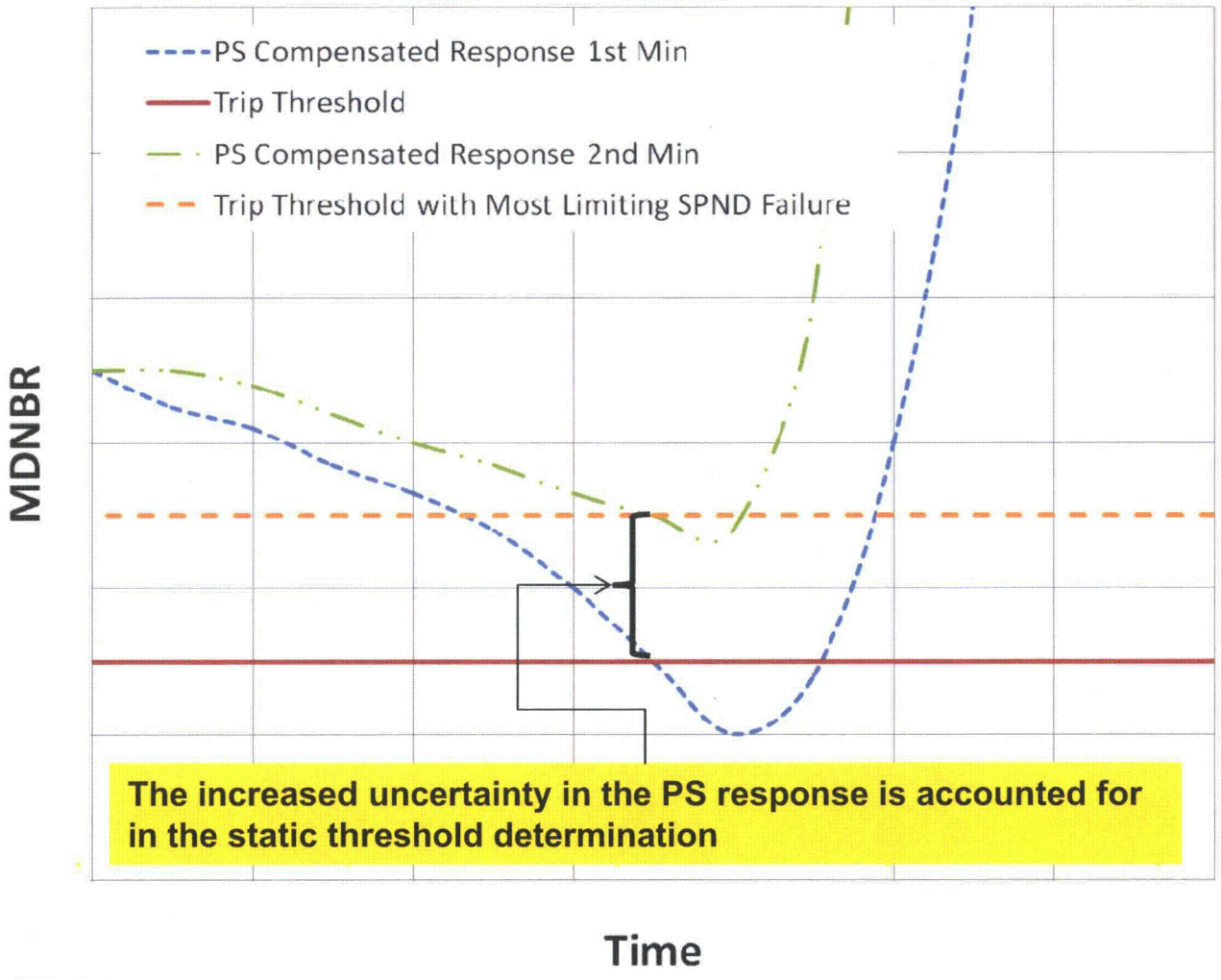
Conceptual Illustration of Monitored DNBR Distribution



▶ Removal of the most limiting SPND

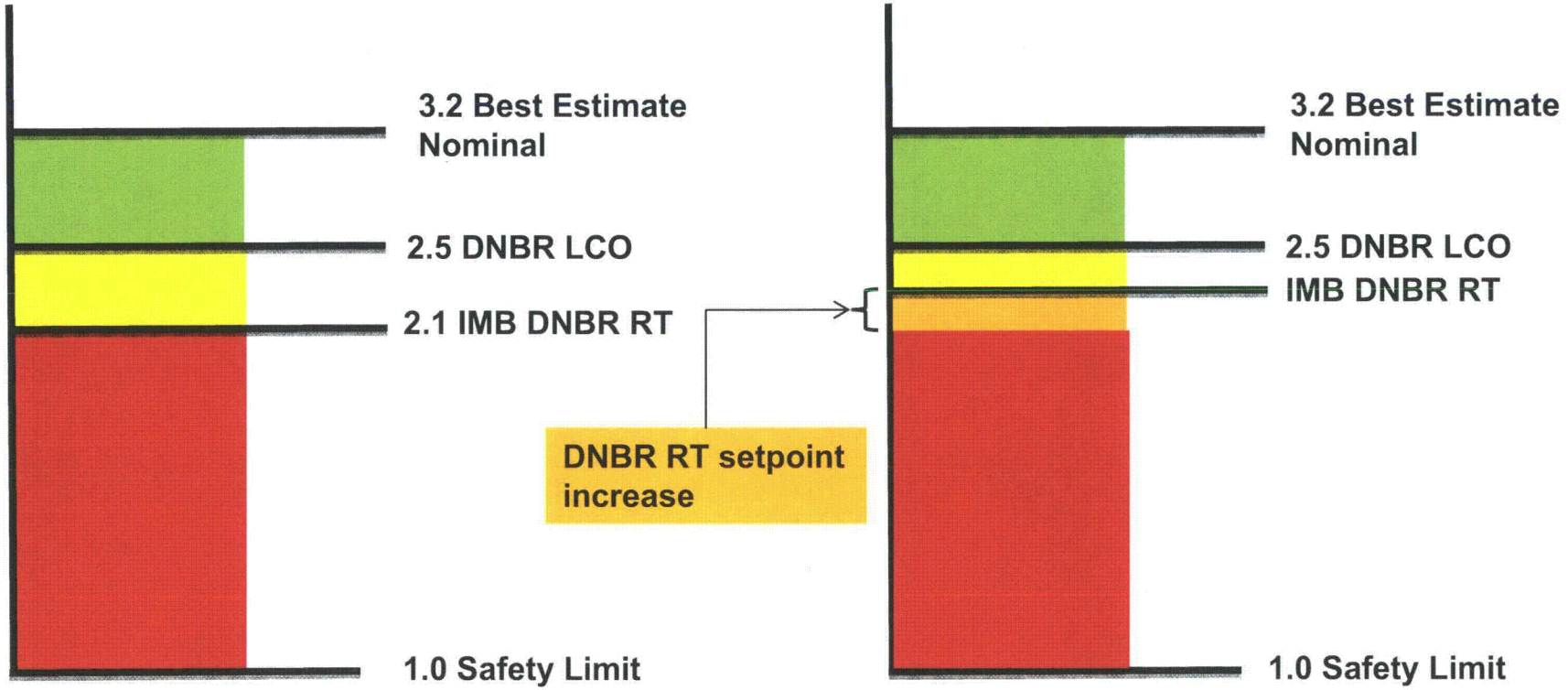
- **The loss of information, in some cases, reduces the resolution of the PS assessment of the core conditions**
  - Symmetric events –no impact as the PS monitored DNBR is essentially the same
    - Remaining SPNDs continue to see the event similarly
  - Asymmetric events – will give rise to more pronounced increase in the magnitude of the error between the monitored and the reference DNBR
    - SPNDs more distant from location of maximum DNBR degradation provide the PS response
- **Level of protection of the Safety Limits is the same for both cases**
- **Trip threshold increase is a direct result of the application of the ANP-10287P methodology which is designed to protect at the 95/95 level.**

Example - Transient PS Response and RT Threshold



- The reference DNBR remains the same
- The modified trip threshold will provide for an equivalent trip time that accommodates the increased uncertainty
- The safety limit is respected with the same coverage and confidence

Example Illustration – Imbalance / Rod Drop 1 of 4 Trip Threshold Modification



- Level of protection of the safety limit is unchanged.
- The impact is seen as a reduction in operating margin

Summary

- The undetected failure of the most limiting SPND is implemented as a modification of inputs to the existing ANP-10287P methodology
  - ANP-10287P describes the statistical techniques utilized in U.S. EPR setpoint methods, as well as the design basis for the incore trip and LCO functions
  - These are not altered by consideration of an undetected failure
  - The incore trip thresholds will be increased (HLPD) and decreased (Low DNBR) as dictated by the ANP-10287P methodology to provide the required safety limit protection.
- Changes to the FSAR
  - Update of the modified trip thresholds
  - Inclusion of an additional section in Chapter 15 to describe the manner in which the undetected SPND failure is addressed in the safety analyses.