BRIEFING ON THE U.S. NUCLEAR REGULATORY COMMISSION'S ACCIDENT SEQUENCE PRECURSOR (ASP) PROGRAM

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Purpose of Briefing

- To provide an update of the ASP program and to discuss some of the ASP trends
- To discuss the ASP analyses of two events of interest
  - Degraded head and other conditions at Davis-Besse
  - Grid disturbance of August 2003
- To briefly discuss the Risk Assessment Standardization Project (RASP)

ASP Program Background

ASP has been a part of NRC events analysis activities for about 25 years, and it has a variety of internal and external users.

- The primary objective of the ASP Program is to systematically evaluate operating experience to identify and document events likely to lead to core damage. Analyses are performed to define and project potential accident scenarios, determine risk exposure, and assess risk mitigation measures.

- ASP analyses are also used to support:
  - Performance measures in the Annual Performance and Accountability Report to Congress
  - Industry trends program
  - Decisions to develop generic communications
  - Studies to determine the safety significance of potential regulatory issues
  - A partial check on PRA scenarios

ASP RESULTS, TRENDS & INSIGHTS

Summarized from SECY-05-0192

- No *significant* precursors were identified in either FY 2003, FY 2004 or FY 2005. Davis-Besse was a significant precursor in FY 2002

- Four precursors identified in FYs 2002–2004 had a CCDP greater than $1x10^{-4}$. Includes Davis-Besse, the potential common mode failure of AFW at Point Beach 1& 2, and another potential common mode failure of AFW at Point Beach 2.

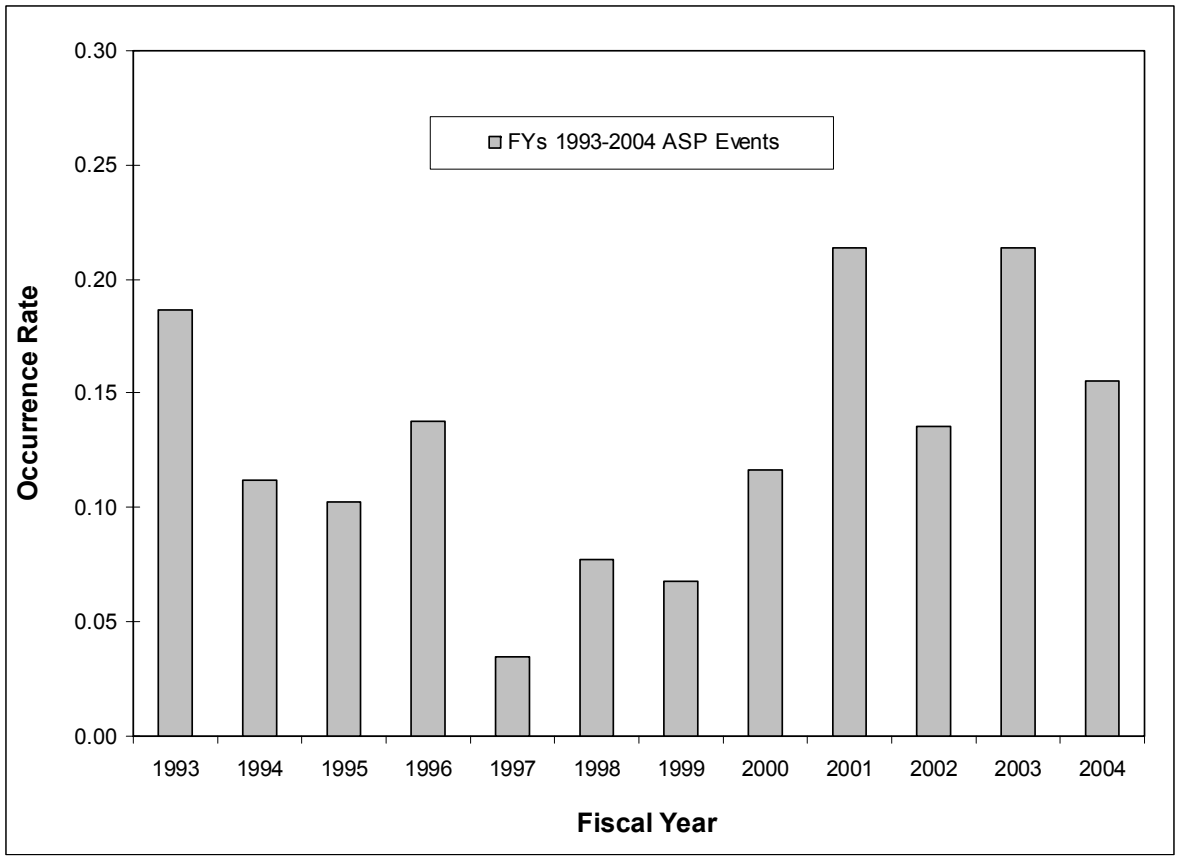
- No trend was identified in the rates of occurrence of all precursors during the period from FY 1993 through FY 2004.

- Trending of precursors by CCDP bins yielded mixed results. If a trend is considered statistically significant, it is very unlikely that the trend is a result of chance alone. Trending analysis of precursors in the CCDP bins yielded the following results:

CCDP > 1×10^{-3}	No trend
1×10^{-3} > CCDP > 1×10^{-4}	Decreasing trend - statistically significant
1×10^{-4} > CCDP > 1×10^{-5}	No trend
1×10^{-5} > CCDP > 1×10^{-6}	Increasing trend - statistically significant

ASP RESULTS, TRENDS & INSIGHTS

No trend was identified in the rates of occurrence of all precursors during the period from FY 1993 through FY 2004

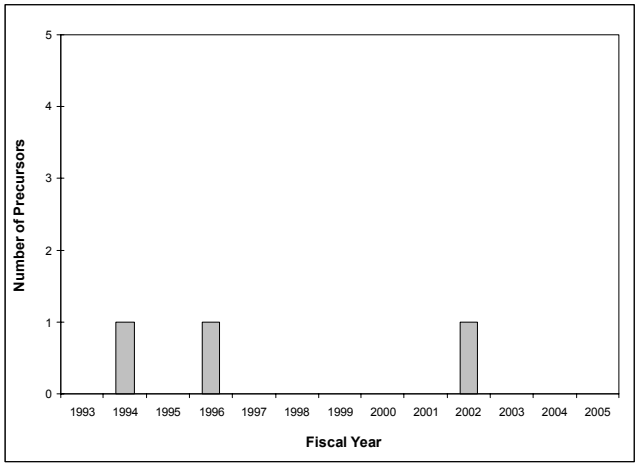


*2004 contains preliminary data

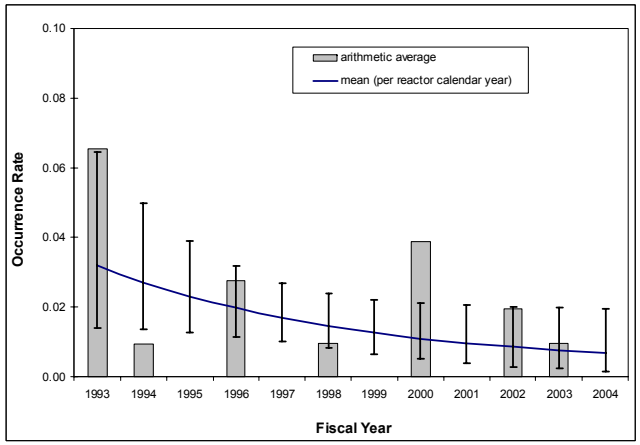
Source: SECY-05-192

ASP RESULTS, TRENDS & INSIGHTS

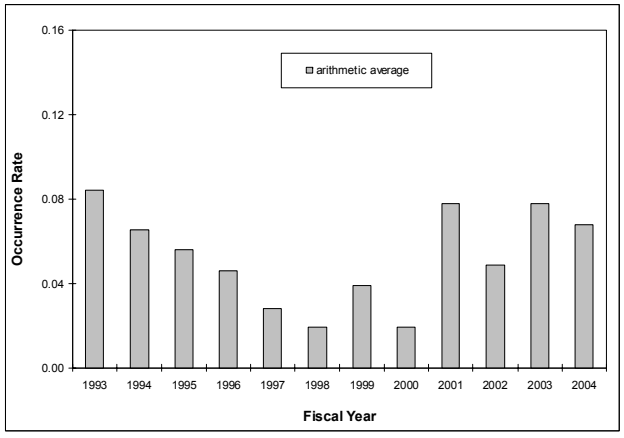
Trending of precursors by CCDP bins



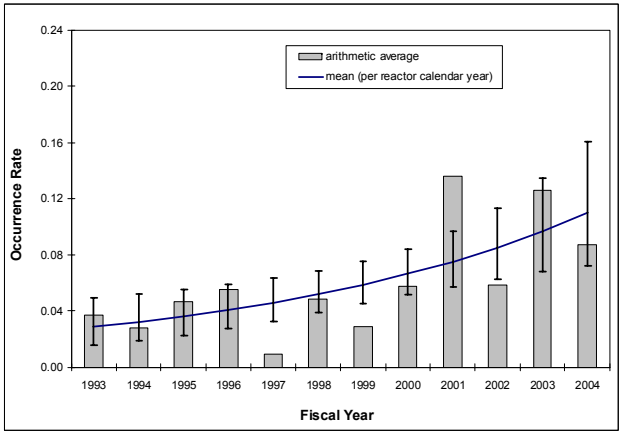
Precursors in CCDP bin 10^{-3}



Precursors in CCDP bin 10^{-4}



Precursors in CCDP bin 10^{-5}



Precursors in CCDP bin 10^{-6}

Source: SECY-05-192

ASP RESULTS, TRENDS & INSIGHTS

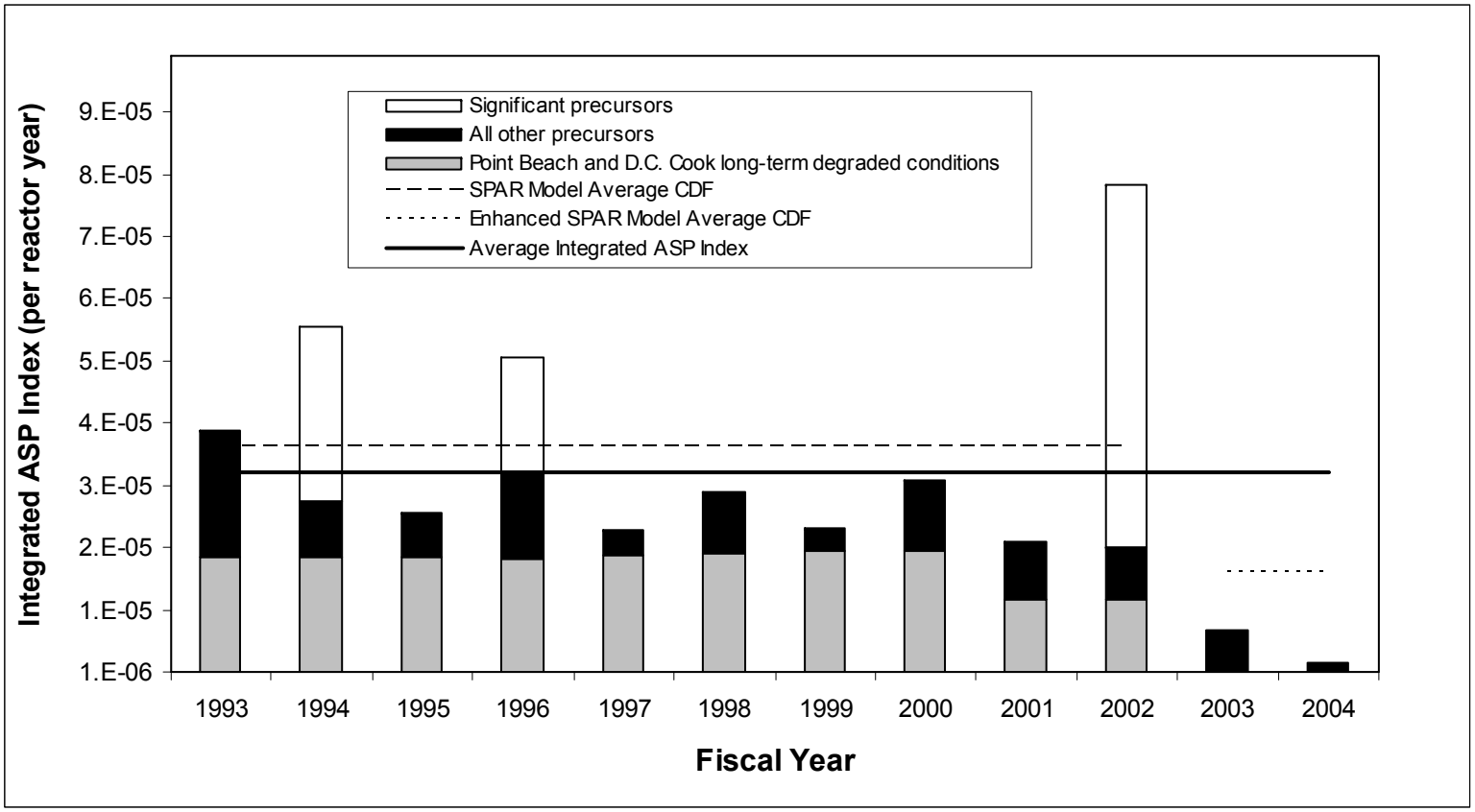
Detailed study into trends to be performed in FY 2005/2006

- Trends to be investigated include:
  - Precursors involving initiating events are decreasing.
  - Precursors involving conditional unavailability of equipment may be increasing.
  - Precursors involving loss of offsite power are increasing.
  - No apparent trend related to plant type (BWR vs. PWR).
  - Trend of all precursors is very low for some years.
  - Causes of precursors to be investigated.

- Investigation will include contributions from:
  - Introduction of the Significance Determination Process in April 2000.
  - Revision of the SPAR models (Rev 3 in 2001).
  - Changing licensee performance.
  - Plant aging.
  - Industry/NRC initiatives (e.g., maintenance rule).
  - Outliers in plant performance.
  - Changes in ASP screening criteria and analysis methodology.

ASP INDEX

(The total CCDP of all precursors divided by the total number of Rx years)



Source: SECY-05-192

ASP RESULTS, TRENDS & INSIGHTS
Summary of Observations

- We observed:
  - One potentially significant precursor in 2002 (Davis-Besse).
  - No indication of an increase in the severity of precursors.
  - No significant trend in the number of precursors over the last 10 years.

- Several significant ASP analyses are highlighted for the rest of this presentation.
  - Davis-Besse required a unique analytic approach to quantify this significant precursor.
  - ASP results and insights were used in the Agency's action plan for resolving electrical grid concerns.

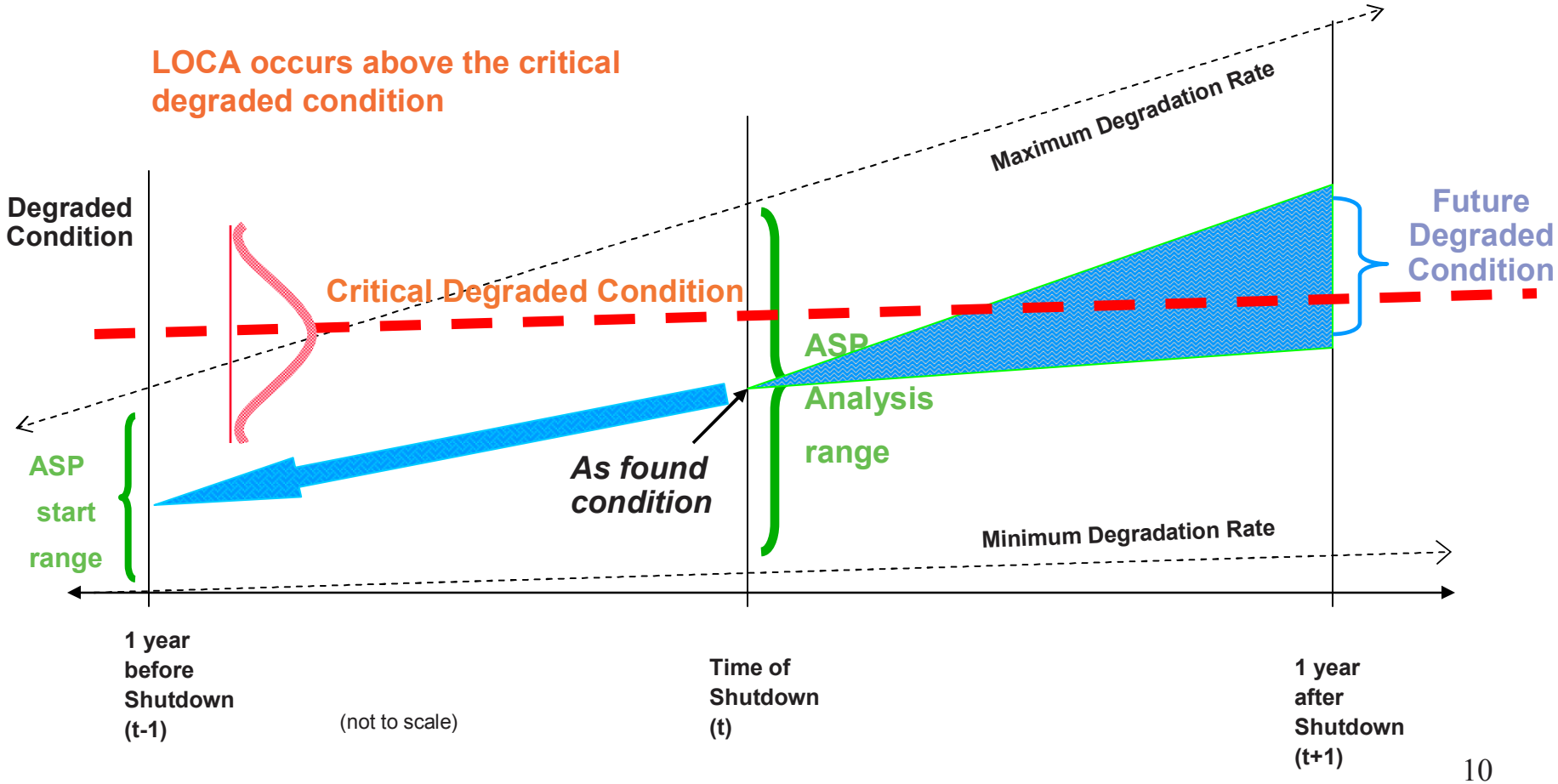
Analysis of Conditions at Davis-Besse

This analytic approach yields a realistic, integrated risk analysis of three conditions at Davis-Besse

- Latent debris in containment caused by unqualified coatings, uncontrolled fibrous material and other debris that could clog the emergency sump following a loss-of-coolant accident
  - Sump failure probabilities (based on GSI-191 research) are the subject of ongoing industry and NRC work
- A design deficiency in the high-pressure injection (HPI) pumps that could cause pump failure during the recirculation mode of emergency core cooling
  - Testing and analysis proved that HPR would fail if there was any fiber in the sump water, thus failure was assumed for all LOCAs
- CRDM nozzle cracking and leakage that led to cavity formation and could have resulted in a LOCA
  - Used expert elicitation to determine distribution of possible conditions of the head in February 2001 and degradation rates
  - Used Monte Carlo analysis of alternative scenarios to determine failure mode (SLOCA, MLOCA or LLOCA) probabilities
  - Used analytic tool developed by RES to estimate probability of MLOCA from CRDM ejection

Conceptual Representation of the Approach to Identify Potential Conditions

The range of possible conditions at three different times are presented here. The As-Found condition is one possible outcome of the corrosion and cracking problem in the vessel head.



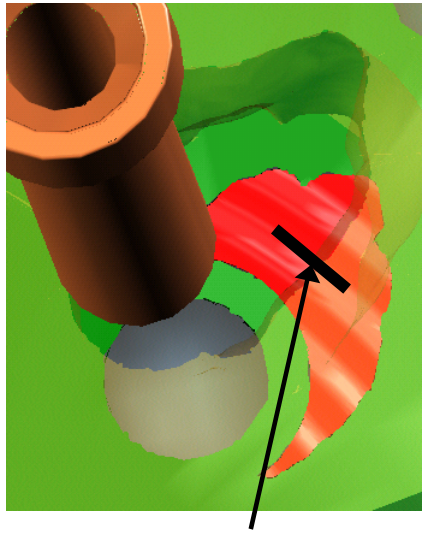
An Assessment of the Structural Integrity Challenge Posed by Boric Acid Wastage in the Davis Besse RPV Head

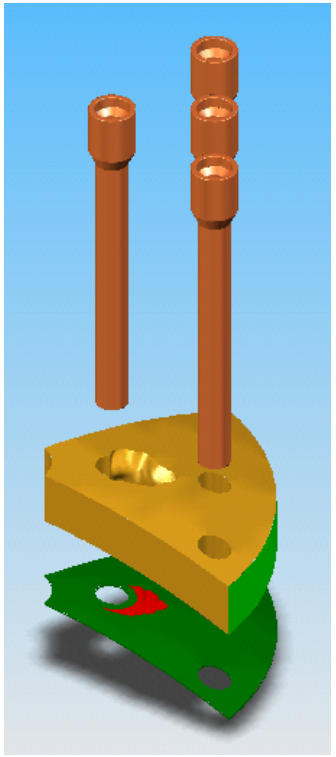
Objectives

- Assess the structural integrity of the primary reactor coolant pressure boundary for the conditions that existed at Davis Besse on February 16, 2002
- Assess the structural integrity of the primary reactor coolant pressure boundary for conditions postulated to exist at Davis Besse had it not been taken off-line for a scheduled maintenance outage on February 16, 2002
- Assess the structural integrity of the primary reactor coolant pressure boundary for conditions postulated to exist at Davis Besse for the year preceding February 16, 2002 +/- 1 year (ASP analysis)

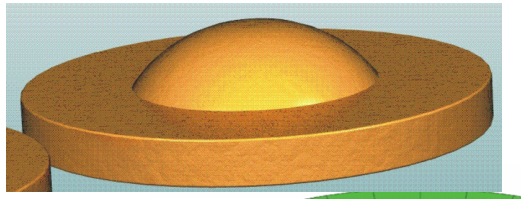
Overall Methodology

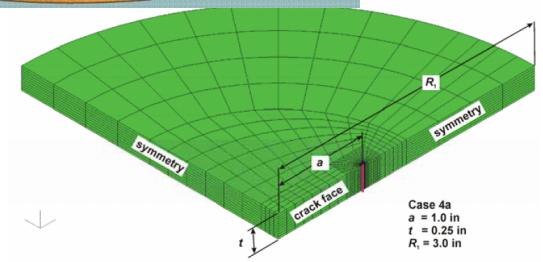
- Detailed analysis of as-found state (geometrically accurate model) provides reality benchmark
  - Predicts non-failure of as-found (16th Feb 02) state
  - Failure modes calibrated using large scale tests
  - Simplified models used in forward- and backward-looking analyses corrected relative to as-found model





- Forward looking analysis
  - Uses simplified model
  - As-found state is certain
  - Results have been reported in letter to EDO





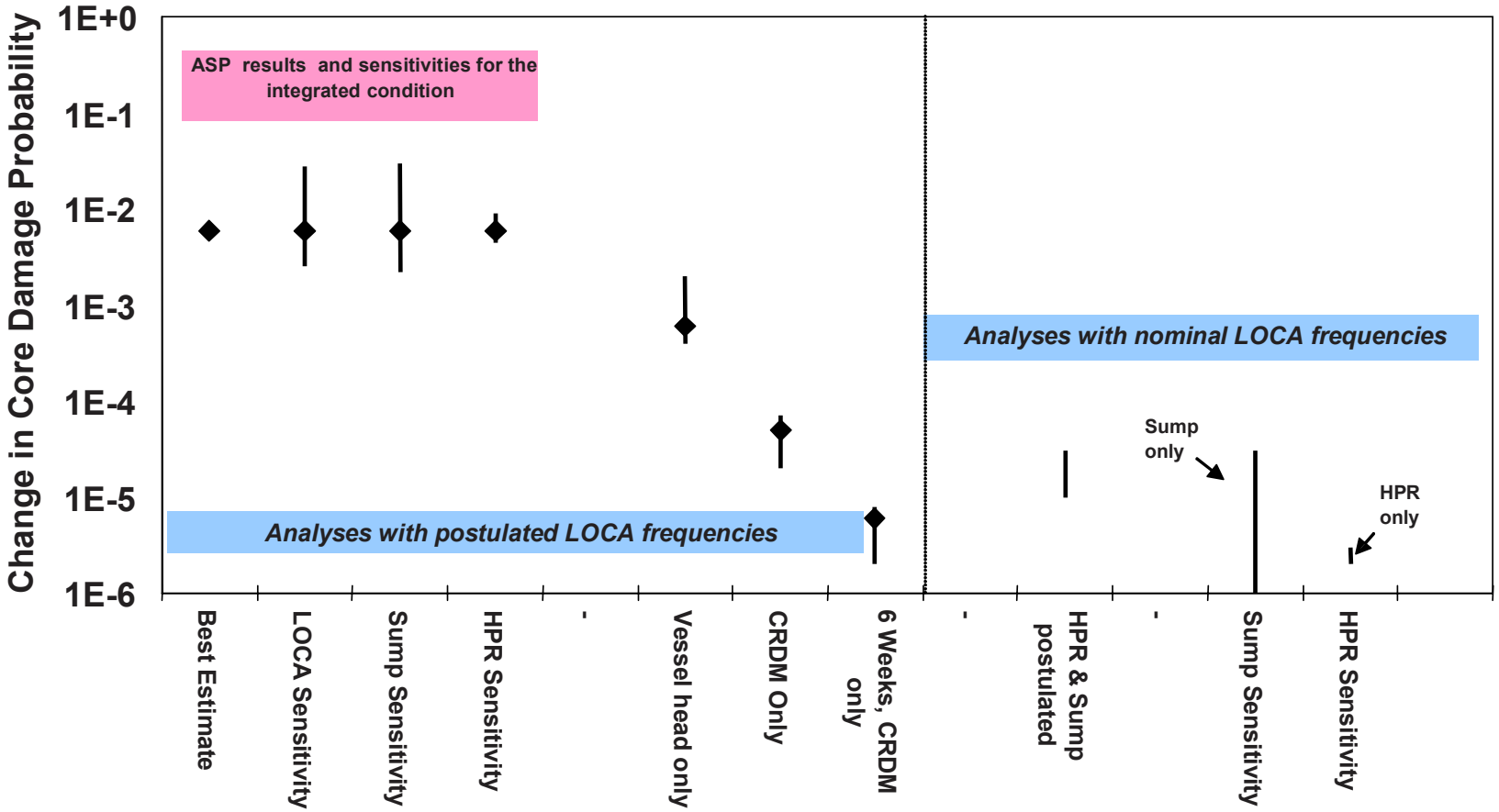
- ASP analysis: backward looking
  - Uses simplified model
  - As found state is uncertain
  - State 1 year prior to 16th Feb 02 estimated by expert judgment

Key Findings of the Structural Analysis

- No failure on day of discovery. Pressure in excess of relief valve setpoint pressure needed to fail. Factor of ~1.5 safety margin on pressure.
- For the as-found condition, median time of continued operation needed for failure is approximately 5 months (uncertainty associated with this estimate is large)
- From ASP analysis (uncertain as-found condition)
  - ~20% (+/-5%) total failure probability on day of discovery
  - Most likely failure is a small break LOCA

ASP *Results and Sensitivity Analyses*

Results of all ASP risk calculations



DAVIS-BESSE ASP RESULTS

The risk at Davis-Besse was significant, but NRC and the licensee have taken actions to correct the deficiencies.

- DB is a *Significant Precursor* - $\Delta CDP = 6 \times 10^{-3}$
  - ΔCDP greater than 10^{-3} was reported to Congress per the Annual Performance and Accountability Report criteria.
  - 11 ASP events are higher – All occurred in 1985 or before.
  - Two other *Significant Precursors* in the last 10 years – Wolf Creek Drain Down Event (1994) and Catawba LOOP (1996)

- DB had a significant loss of safety margin involving the simultaneous degradation of three important safety features:
  - RCS pressure boundary,
  - containment sump, and
  - high pressure injection system.

- Sensitivity analysis shows that the results are consistently in the high 10^{-3} or low 10^{-2} range.

ASP Analyses for the August 14, 2003 Grid Event

This analytic approach yields a consistent risk analysis of eight loss of off-site power events

- Nine plants lost offsite power due to an electrical disturbance on the grid.
  - Eight plants (Fermi, Fitzpatrick, Nine Mile Point 1 and 2, Perry, Ginna & Indian Point 2 and 3) were at power, tripped and lost off-site power.
  - Davis-Besse was in a cold shutdown and lost off-site power.
  - Oyster Creek tripped, but did not lose offsite power to the vital buses.
- All affected plants successfully coped with the loss of offsite power.
- Off-site power recovery times and non-recovery probabilities are based on potential bus restoration times, which is the time grid operators gave the plant permission to use off-site power. Grid reports were used to judge the potential reliability of power.

Results of the Final ASP Analyses

- No major equipment failures (i.e., EDGs, turbine driven pumps, batteries)
  - CCDPs range from 4×10^{-6} to 3×10^{-5}
  - LOOP durations between 1 and 6 hours
  - CCDPs are very sensitive to recovery times, and sensitive to battery capacity, alternate AC power sources, and EDG common-cause failure parameters.
- Final results are nearly an order of magnitude lower than the preliminary results due to incorporation of EDG recovery and updated unavailability data into the SPAR models

RASP will Address the Differences between ASP and SDP Processes

- ***Applicability*** — ASP considers all events, including concurrent multiple degraded conditions; SDP considers degraded conditions with licensee performance issues

- ***Information*** — ASP benefits from information sources with longer lead time (root cause analysis, research, and expert elicitation); SDP constrained to short schedule to issue final significant determinations

- ***Models*** — ASP uses SPAR models and SPAR models modified for unique condition-specific considerations; SDP uses plant-specific notebooks for Phase 2 and assortment of models for Phase 3 (SPAR models, licensee's PRA, modified notebook)

- ***Uncertainty*** — ASP estimates parameter uncertainty through SPAR models and modeling uncertainty through sensitivity analysis; SDP Phase 2 notebooks designed for higher level of tolerance for overestimating risk and SDP Phase 3 may use sensitivity analysis

The Risk Analysis Standardization Project (RASP) primary objectives

- Reduce the differences in results that currently arise when the various NRC programs (mainly ASP & SDP) analyze the same (or similar) event or condition.
- Improve the coordination among various NRC programs performing risk analyses of licensee performance deficiencies or reactor incidents.
- Reduce the time required to perform risk analyses of operating events and licensee performance issues.
- Improve internal and external risk communication.
- Provide guidelines for resolving technical issues surrounding risk assessments of operating events and conditions.

Risk Assessment of Operating Events Handbook
Table of Contents

SUMMARY
Accident Sequence Precursor (ASP) Program

- The ASP Program continues to evaluate the safety significance of operating events at nuclear power plants and to provide insights to NRC's regulatory programs.

- Since its inception, the ASP program has evaluated and documented in excess of 600 precursors which are maintained in the NRC's ASP database.

- The staff informs the Commission of the results of the ASP program in an annual SECY paper.

- The Reactor Operating Experience Task Force includes ASP analysis as a necessary function for an effective OE program and noted that "the limited evaluation of the overall ASP results for feedback to other regulatory processes is a missed opportunity to identify lessons learned."

ASP Program – Path Forward

- Improve timeliness of ASP analyses
- Achieve real time interaction with the Significance Determination Process and other events assessment activities in RES, NRR and the Regions through processes such as RASP
- Continue to concentrate on potentially significant events
- Complete study of ASP trends and insights

Attachment 1:

Results, Trends, and Insights from the Accident Sequence Precursor (ASP) Program

(Attachment 2 from SECY—05-0192)