

Public Meeting to Share Risk Insights

Duane Arnold Energy Center (DAEC) Derecho

May 27, 2021



Objectives

- Consistent with our Principles of Good Regulation of openness, and clarity, we are sharing risk insights from our regulatory response to the August 10th Derecho.
 - Openness
 - Transparent and publicly available information on our evaluations and analysis.
 - Clarity
 - Evaluation considered a sampling of sites with different design characteristics to understand generic implications to the fleet.
 - Characteristics chosen to get a broad understanding to support analysis and gather risk insights that could benefit overall fleet.
 - Risk insights can significantly vary based on site, plant design, and plant operating characteristics.

Agenda

<i>Time</i>	<i>Topic</i>	<i>Speaker</i>
1:00pm	Meeting Kick-Off	J. Wiebe – 5 mins
	Welcome Remarks	M. Franovich – 5 Mins
	Meeting Objectives	A. Zoulis – 10 mins
	Event Summary	NextERA – 15 mins
	NRC Activities following Event	S. Weerakkody – 10 mins
	Risk Insights from ASP Analysis	C. Hunter – 15 mins
	Risk Insights from LIC-504 Analysis	M. Leech – 20 mins
	Owner's Group Discussion	PWROG/BWROG – 20 mins
2:40pm	Break	10 mins
2:50pm	Panel Discussion	Industry/NRC – 40 mins
3:30pm	Public Comments	NRC/Public – 30 mins

NRC Activities Following Event

Sunil Weerakkody
Senior Level Advisor
US NRC
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Office of Nuclear Reactor Regulation

NRC Responses to DAEC Derecho

- Different Entities of NRC coordinated different activities to fulfill NRC mission.
 - Region III
 - Performed Management Directive (MD) 8.3 evaluation to determine level of follow-up inspection needed.
 - Office of Nuclear Regulatory Research (RES)
 - Performed the Accident Sequence Precursor (ASP) analysis to determine the overall risk-significance of the event.
 - Office of Nuclear Reactor Regulation (NRR)
 - Used NRR Office Instruction LIC-504, “Integrated Risk-Informed Decision Making for Emergent Issues.”

NRC Region III Actions

- MD 8.3 Evaluation – Decision Documentation for Reactive Inspections
 - Resident on-site within 1 hour of the storm.
 - Conducted inspections to assess immediate actions, plant stability, verify safety barriers, and evaluate radiological impacts.
 - ADAMS Accession No. [ML21022A415](#), August 11, 2020.
- DAEC Integrated Inspection Report
 - No findings or violations of more than minor significance were identified during this inspection.
 - ADAMS Accession No. [ML20314A150](#), November 6, 2020.
- Non-Concurrence on MD 8.3 Evaluation (NCP 2020-07)
 - ADAMS Accession No. [ML21022A418](#), January 22, 2021.

Office of Nuclear Reactor Research Actions

- Accident Sequence Precursor (ASP) Analysis
 - Mean conditional core damage probability (CCDP) was 8×10^{-4} .
 - High (comparative) risk-significance although emergency systems remained functional after the event and there were no violations/findings.
 - ADAMS Accession No. [ML21056A382](#), March 4, 2021.

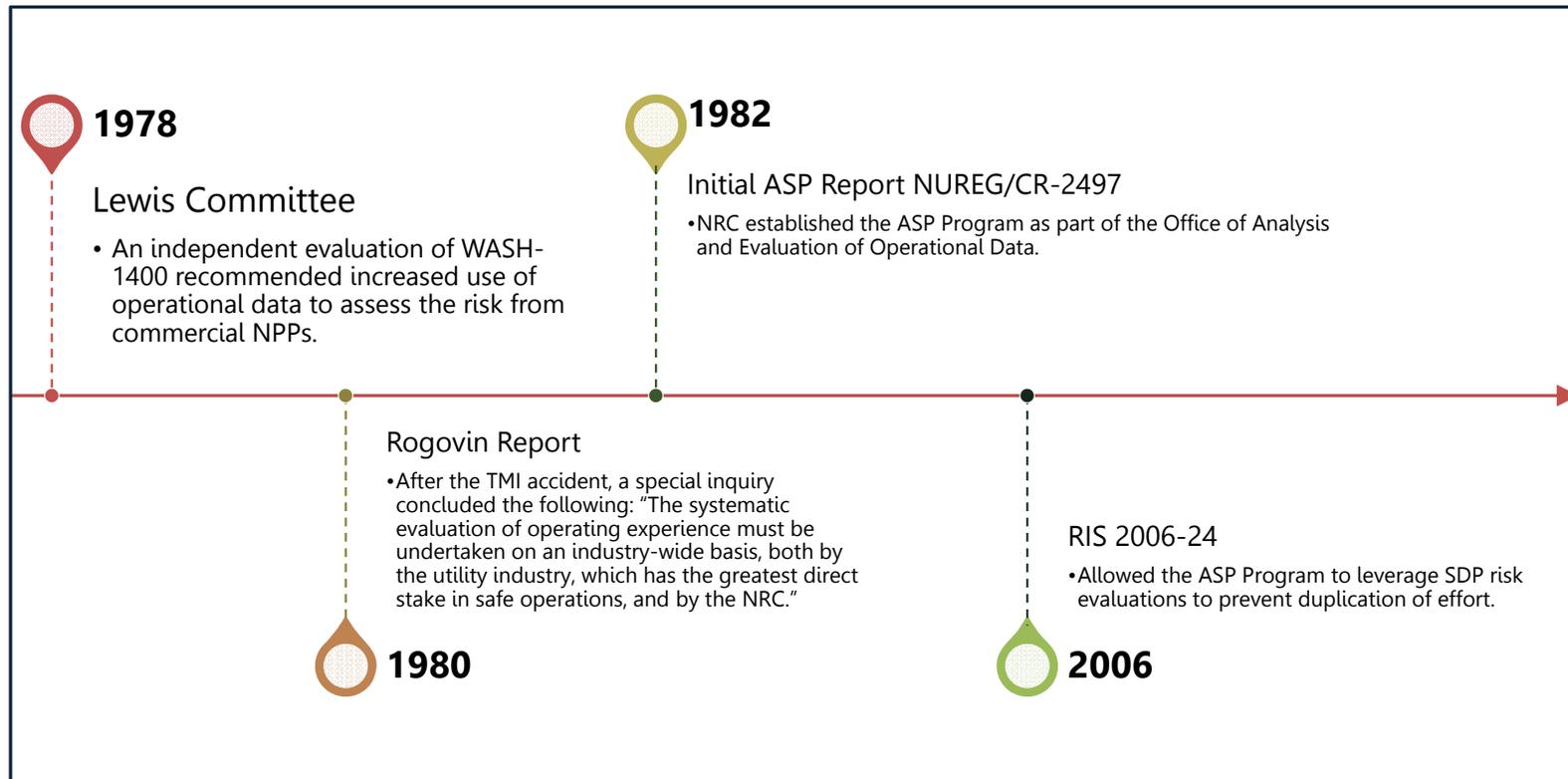
Office of Nuclear Reactor Regulation Actions

- LIC-504 – Determination of the Need for Prompt Regulatory Actions in Response to Insights Gleaned from Duane Arnold Nuclear Power Plant.
 - ADAMS Accession No. [ML20315A117](#), November 25, 2020.
- Duane Arnold Energy Center LIC-504 Team Recommendations.
 - Issue an information notice to licensees about the risk insights gained through the NRC’s analysis of the DAEC derecho event.
 - Share risk insights obtained from the LIC-504 analysis with the NRC’s regional staff.
 - Identify opportunities to engage with external stakeholders (e.g., PRA practitioners, Owners groups) about the insights gained during this evaluation.
 - Update two SPAR models during fiscal year 2021 and 2022 as part of the normal update process to further enhance staff’s understanding of risk insights gained from LIC-504.
 - ADAMS Accession No. [ML21078A127](#), March 30, 2021.

ASP Analysis Risk Insights

Chris Hunter
Senior Reliability and Risk Analyst
US NRC
Division of Risk Assessment
Office of Regulatory Research

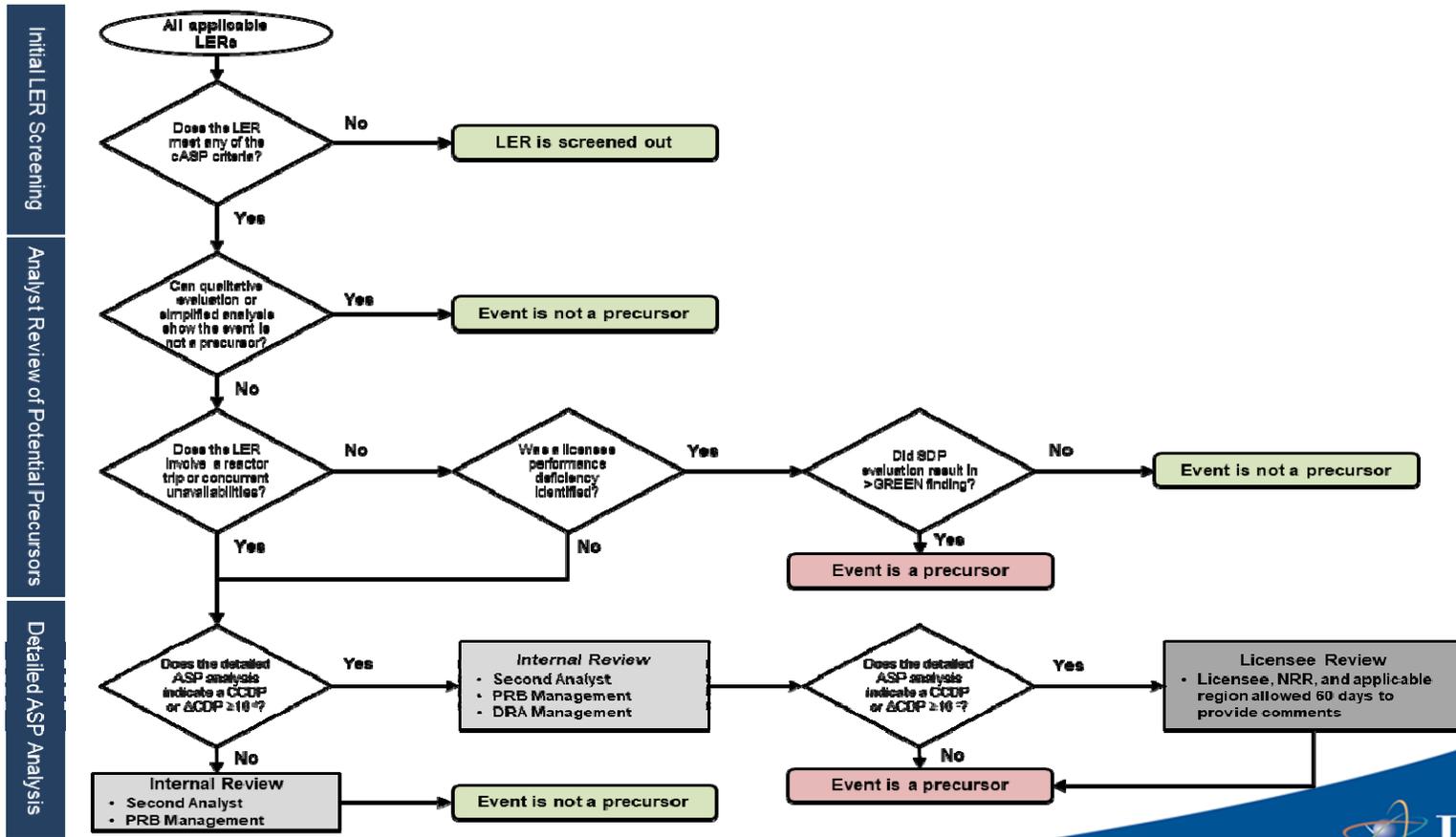
ASP Program History



What is Precursor?

- An accident sequence precursor is an initiating event and/or degraded condition that increases the likelihood for core damage.
 - The precursor threshold is a conditional core damage probability (CCDP) or increase in core damage (Δ CCDP) of greater than or equal to 10^{-6} .
 - Threshold for initiating events is plant-specific and can be higher.
 - Analyses consider concurrent degraded conditions or unavailabilities due to maintenance.
 - Maximum exposure time of 1 year is used for degraded conditions.

ASP Process



Duane Arnold ASP Analysis

- The preliminary ASP analysis resulted in a mean CCDP of 1×10^{-3} .
 - Risk dominated by Station Blackout (SBO) scenarios.
 - Offsite power recovery credit not provided within 24 hours.
- Identified several key analysis uncertainties.
 - Performed sensitivities to evaluate the impact of these uncertainties.
- Sent the preliminary ASP analysis to the licensee for a 60-day review per Regulatory Issue Summary 2006-24.
 - NRR and Region 3 given opportunity to provide additional comments.
- The licensee and PWROG provided comments.
 - Final ASP analysis was modified based on offsite power recovery could be credited within 24 hours, resulting in final mean CCDP of 8×10^{-4} .
 - ADAMS Accession No. [ML21042A079](#), February 9, 2021.

Uncertainties/Sensitivities

Key Uncertainty		Mean CDP	% Change
No FLEX Credit		7.8×10^{-3}	~+900%
No FLEX Credit for Successful High Pressure Coolant Scenarios		1.7×10^{-3}	+120%
FLEX Hardware Reliability Multiplier	x2 increase	7.7×10^{-4}	-3%
	x5 increase	9.3×10^{-4}	+18%
	x10 increase	1.2×10^{-3}	+57%
FLEX Human Error Probabilities	x5 increase	1.9×10^{-3}	+135%
	x5 decrease	5.8×10^{-4}	-27%
72-Hour AC Power Recovery Requirement		1.1×10^{-3}	+34%
Potential Effects of Bypassing Emergency Service Water Strainer		1.5×10^{-3}	+89%

LIC-504 Analysis Risk Insights

Matt Leech
Reliability and Risk Analyst
US NRC
Division of Risk Assessment
Office of Nuclear Reactor Regulation

The LIC-504 Analysis

- The Accident Sequence Precursor Analysis conducted by the Office of Research focuses on examining the risk from the specific event for the Duane Arnold plant.
- The LIC-504 conducted by the office of Nuclear Reactor Regulation (NRR) examined several plants by running a similar scenario to the one Duane Arnold experienced during the derecho and examining the risk results.

First Step of the LIC-504

- The first step of the LIC-504 was to determine if immediate shutdown orders or other prompt actions were needed.
- Initially we took a group of 7 plants that had similar characteristics to Duane Arnold. These were single unit sites, without Station Blackout Diesels, and Ultimate Heat Sink systems that could potentially experience storm debris from a derecho.
- They were of mixed design: Pressurized Water Reactors including designs by Westinghouse, and Combustion Engineering; Boiling Water Reactors (BWR) including BWR-4 design with Mark 1 containment, and BWR-6 with a Mark 3 containment.
- Performed a conservative upper bound analysis and concluded that there is no need to issue orders to shut down or impose prompt compensatory measures. This conclusion was documented in ADAMS Accession Number ML20315A117 in November of 2020.

Next Step of the LIC-504

- To support the next step of LIC-504, we refined the analysis and reduced conservatism. The objective is to generate risk insights and provide recommendations.
- The risk analysis in this step reduced conservatism in a variety of areas:
 - Provided credit for Diverse and Flexible Mitigation Capability, or FLEX, equipment and strategies
 - Refined the models on a case-by-case basis using readily available information to improve accuracy
 - Credited operator's ability to bypass the strainers at plants that had bypass capability.

DAEC LIC-504 Analysis Process

For each plant we were analyzing the following:

We were solving the model for a weather-related Loss Of Offsite Power (LOOP) with offsite power recovery not possible for 24 hours.

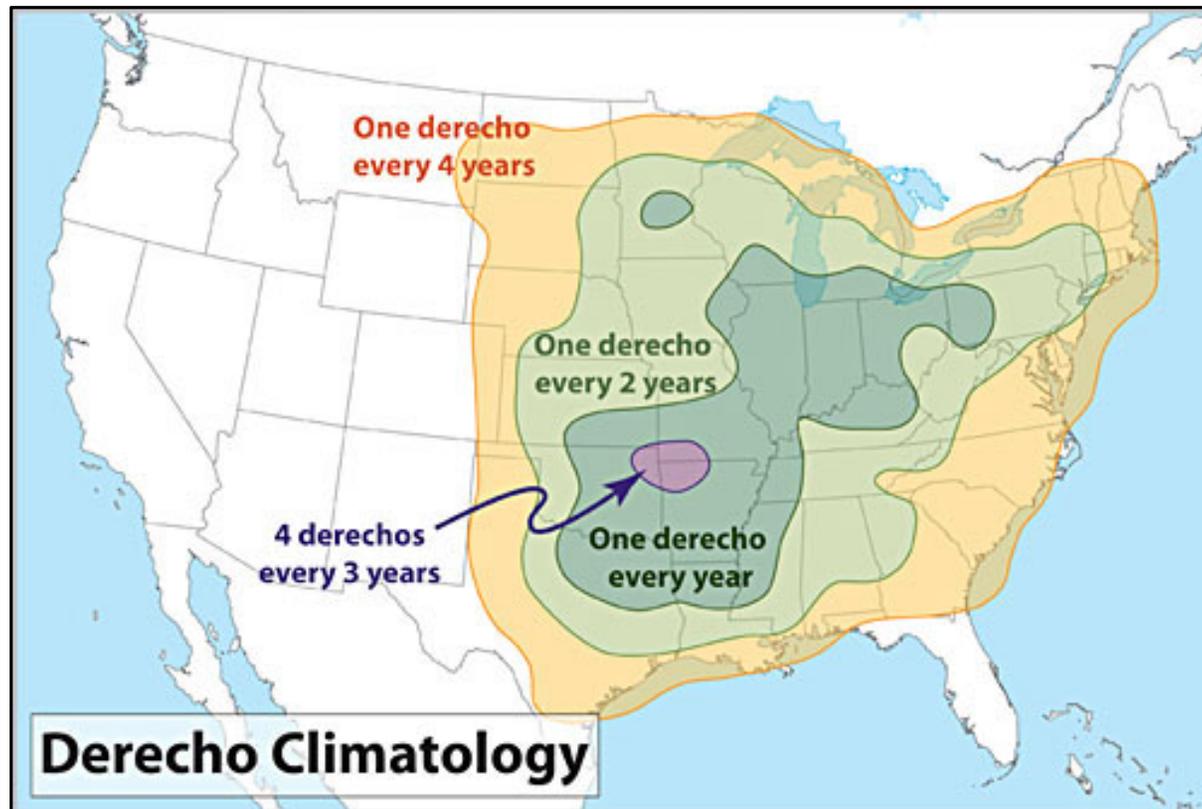
We also changed the probability for an Emergency Service Water (ESW) strainer to fail at various failure rates

And examined the results

Analysis Uncertainties

- LIC-504 had some uncertainties that could significantly influence the results.
 - What failure probability to assign to the Emergency Service Water strainers to fail?
 - Very influential to the results.
 - What initiating event frequency to use for the event?
 - The industry average Weather-Related Loss of Offsite Power frequency was used.
 - Likely conservative because some Weather-Related Loss of Offsite Power events would not be as severe as a derecho that could impact the Emergency Service Water.
- All sites do not have the same level of risk to a derecho, especially how it will impact their Ultimate Heat Sink.

Derecho Frequency



Risk Insights

- The following design attributes reduce the risk significantly for this type of derecho event.
 - The ability for operators to bypass a clogged strainer.
 - Availability of an alternate source of cooling water to Emergency Diesel Generators (e.g., fire protection water).
 - The availability of additional diesel generators (not including FLEX diesels) that are not dependent on Emergency Service Water for cooling.
 - Service water intake traveling screens on a safety related power supply.
- FLEX provided a significant reduction in risk for this type of event
 - Risk reductions varied between a factor of 1.5 to 11.5.

LIC-504 Recommendations

- The LIC-504 final closure memo was finished and made publicly available April 2021
- It had three main recommendations
 - Issue an Information Notice of the risk insights to share with industry
 - Share insights with our regional inspectors
 - Share insights with external stakeholders about the risk insights gained from the evaluation.