

# Status of the U.S. NRC's ASP Program

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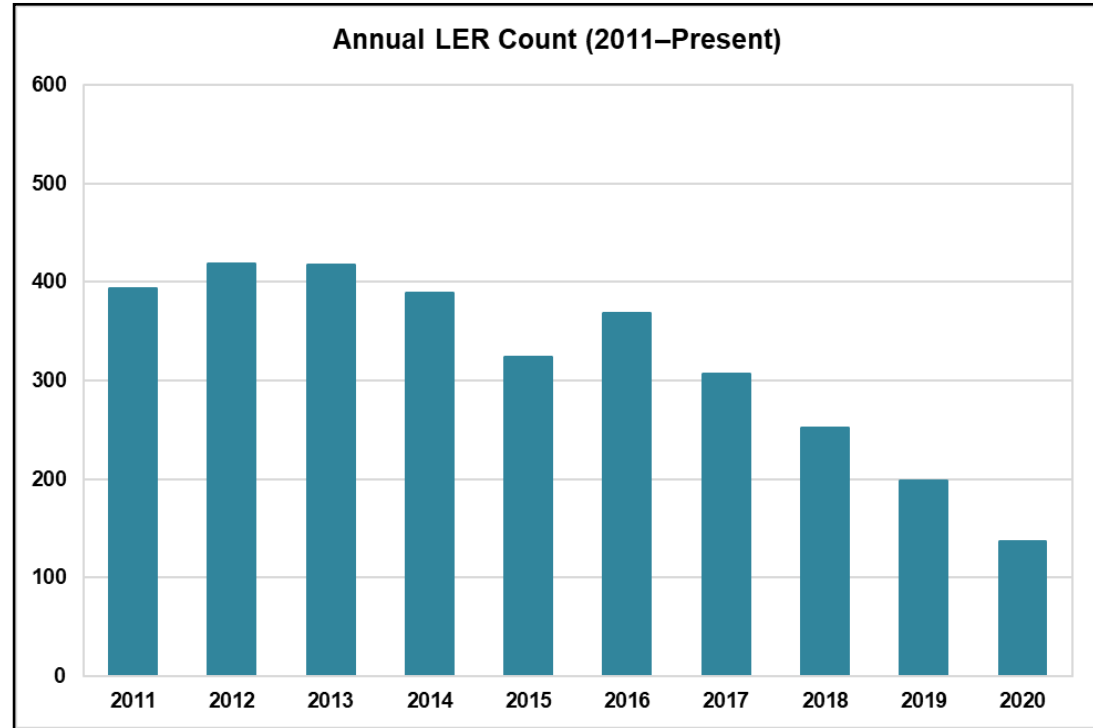


# Program Status and Challenges

- Began evaluating hazards that are not currently included in all NRC SPAR models (internal fires, floods, etc.).
  - No events were determined to be precursors based on this additional evaluation in 2020.
  - Most of the events evaluated were associated with plants that did not have recent risk information provided to the NRC from risk-informed license amendment requests.
- Continue to see decrease in LERs reported.
  - Recent experience shows that events that have historically been reported may not be in the future.
  - It is a known limitation that some risk significant events may not always be reported in LERs (e.g., single train failures).
  - Given these considerations, we are exploring the use of additional information sources for degraded conditions.

# LER Data

Calendar Year	# of LERs Reviewed	# of Potential Precursors	# of LERs Screened-Out	% LERs Screened-Out
2016	368	62	306	83%
2017	307	48	259	84%
2018	252	38	214	85%
2019	199	35	164	82%
2020	137	29	108	79%

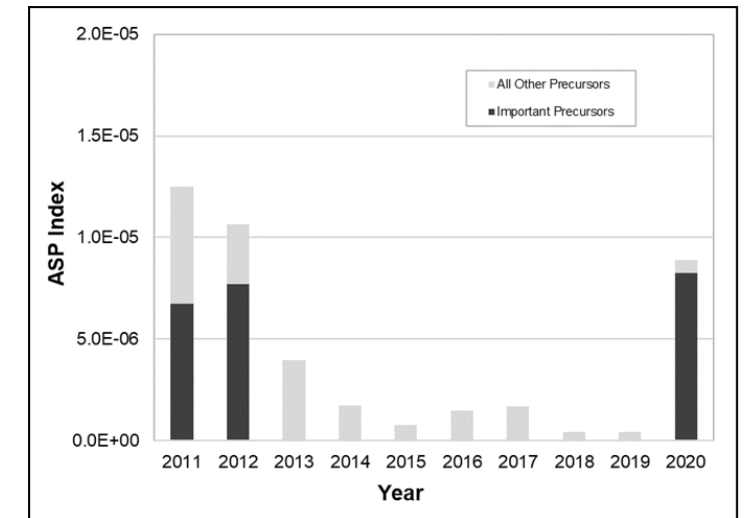
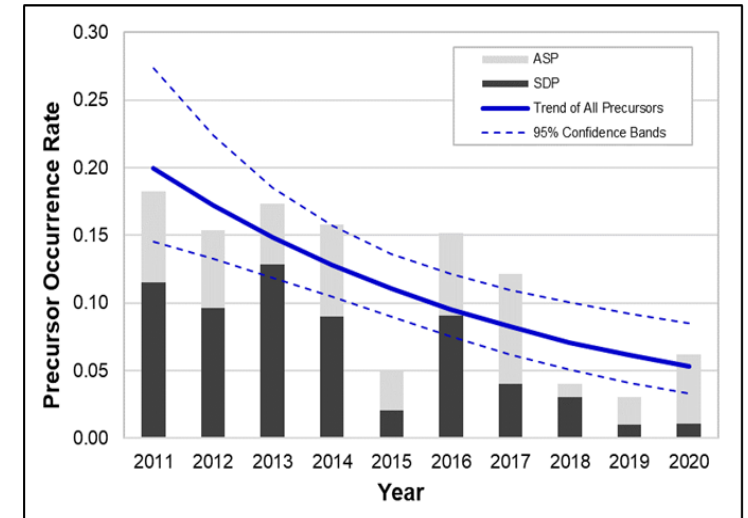


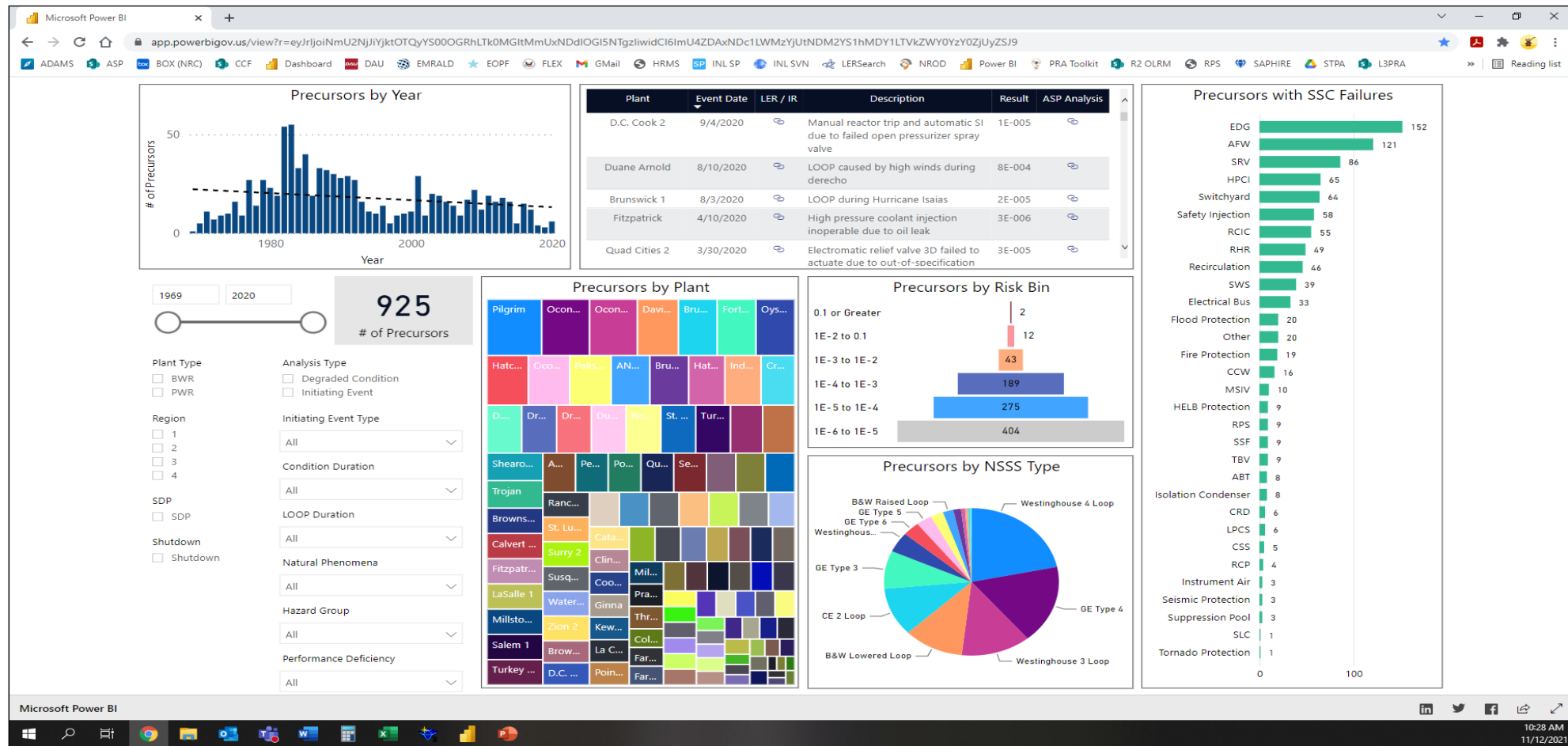


# ASP Results and Trends

# Precursor Trends

- The occurrence rate for total precursors and most precursor subgroups is decreasing for the past decade (2011–2020).
  - No trends detected for precursors associated with emergency diesel generator (EDG) failures or those occurring at BWRs.
- There is no trend for the risk from all precursors as shown by ASP index.
  - The majority (53%) of total risk associated due to precursors is dominated by 6 precursors with  $CCDP/\Delta CDP \geq 10^{-4}$ .
  - The other 114 precursors contribute the remaining 49%.





# ASP Program Dashboard



# Recent Events

# Duane Arnold LOOP

- High winds (100+ mph) from a derecho resulted in weather-related LOOP in August 2020.
  - Offsite power was restored to safety-related buses in approximately 25 hours.
- Some damage occurred to SSCs (e.g., reactor building, FLEX building, cooling towers).
  - FLEX equipment remained available.
- Increased debris loading resulted in clogging of the train 'B' essential service water (ESW) strainers.
  - ESW flow decreased by 300 gpm; however, EDG remained running with no performance issues observed.
  - Clogged strainers were manually bypassed by operators.



# Final ASP Results

- The final analysis resulted in mean CCDP of  $8 \times 10^{-4}$ .
  - Dominant accident sequence was the postulated failure of both EDGs resulting in a SBO with the postulated failures of both high-pressure injection sources.
    - This accident sequence accounts for approximately 35% the total CCDP for this event.

5%	Median	Pt. Estimate	Mean	95%
$1 \times 10^{-4}$	$6 \times 10^{-4}$	$6 \times 10^{-4}$	$8 \times 10^{-4}$	$2 \times 10^{-3}$

Key Uncertainty		Mean CCDP	% Change
No FLEX Credit		$7.8 \times 10^{-3}$	~+900%
No FLEX Credit for Successful HPCI Scenarios		$1.7 \times 10^{-3}$	+120%
FLEX Hardware Reliability Multiplier	x2 increase	$7.7 \times 10^{-4}$	-3%
	x5 increase	$9.3 \times 10^{-4}$	+18%
	x10 increase	$1.2 \times 10^{-3}$	+57%
FLEX HEPs	x5 increase	$1.9 \times 10^{-3}$	+135%
	x5 decrease	$5.8 \times 10^{-4}$	-27%
72-Hour AC Power Recovery Requirement		$1.1 \times 10^{-3}$	+34%
Potential Effects of Bypassing ESW Strainer		$1.5 \times 10^{-3}$	+89%

# Waterford LOOP During Hurricane Ida

- High winds, heavy rain, and localized flooding as part of Hurricane Ida resulted in a LOOP on August 29, 2021.
  - Reactor was already shutdown (Mode 4) as part of storm preparations.
  - Plant responded as designed.
  - Offsite power was restored to the safety buses in ~54 hours.
- SPAR model FLEX modeling was changed based on review of the licensee's final integrated plan.
  - In addition, similar changes to the ones made for the Duane Arnold ASP analysis were made to the Waterford SPAR model.

# Preliminary Results and Uncertainties

- Analysis is ongoing; however, there are some key open questions.
  - Availability of some FLEX equipment.
  - Temporary emergency diesel.
- Potential Changes
  - Determine if the turbine-driven emergency feedwater pump can be credited reach safe/stable end state.
  - Is there a need to perform detailed HRA on FLEX operator actions?
    - It is not believed that the HEPs would change significantly enough to affect the results because the FLEX equipment reliability is the dominant failure contributor.
    - However, the potential impact cannot be ruled out until an HRA is performed.

# Lessons Learned and Remaining Questions

- The generic SPAR model FLEX structure requires a lot of changes to get a realistic results.
  - Examples
    - Safe/stable end state
    - Mission time
    - Extended turbine-driven pump operation
  - Consensus needs to be gained on these issues within the NRC risk analyst community before making changes to all models.
- If/when to perform an HRA for FLEX operator actions?
  - If so, what method should be used?