



JENSEN HUGHES

Advancing the Science of Safety

APPROACH TO HRA FOR HIGH WIND EVENTS

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September 27, 2017

OVERVIEW

- Attributes of High Wind Events
- EPRI Bins
- Timing
- PSF Adjustments
- Uncertainty



HIGH WIND EVENTS

SOUTHEASTERN UNITED STATES

- Tornadoes
 - Lead time of 13 minutes¹ from the time the tornado warning is issued until it touches the ground
 - Duration of ~30 minutes
- Hurricanes
 - Ample warning, days in advance
 - Durations can vary widely ~2-10 hours
- Straight Line Winds
 - Severe Thunderstorms
 - Hours of warning
 - Durations can vary, but winds > 73mph ~30 minutes

¹National Oceanic and Atmospheric Administration (NOAA), <http://www.noaa.gov/stories/tornadoes-101>



FEASIBILITY

- Tornadoes and Straight Winds
 - Within 1 hour of the high wind event
 - Actions outdoors, an unprotected structure (e.g., non-Category I), or require transit through one of these areas are failed if they occur within 1 hour
 - Credit can be given to these actions after the storms passes
- Hurricanes
 - Actions outdoors, an unprotected structure (e.g., non-Category I), or require transit through one of these areas are failed if they occur within 2-10 hours
- SSC impact
 - Something to consider
 - Typically handled by the fragility analysis



EPRI DAMAGE BINS

Table 4-2
Damage state definitions for screening

| Damage State Bin # | External Event Damage State Description |
|--------------------|---|
| 1 | No damage to the plant safety-related SSCs or non-safety SSCs required for operation. Limited damage to non-safety, non-seismic designed SSCs like residences and office buildings. |
| 2 | No expected damage to the plant safety-related SSCs or to rugged industrial type non-safety SSCs required for operation. Damage may be expected to non-safety SSCs not important to plant operations and to the switchyard (e.g., LOOP expected). Some falling of suspended ceiling panels. |
| 3 | Widespread damage to non-safety related SSCs and/or some damage expected to safety related SSCs. Significant number of vibration trips and alarms requiring resetting. |
| 4 | Substantial damage to safety related and non-safety SSCs. This is particularly applicable to external events susceptible to a cliff-edge effect. |

An Approach to Human Reliability Analysis for External Events with a Focus on Seismic. EPRI, Palo Alto, CA: 2016. 3002008093.

- Utilize a “one bin fits all” approach and use Bin 2



TIMING ADJUSTMENTS

TORNADO

- Sudden in nature and operators would not have time to prepare
- In-MCR Actions
 - Penalties added to Tdelay and Tcog
 - No penalty added for Texe
- Ex-MCR Actions
 - Penalties added to Tdelay, Tcog, and Texe



TIMING ADJUSTMENTS

STRAIGHT WINDS AND HURRICANES

- Hours or days to prepare and review LOOP procedures
- In-MCR Actions
 - No penalty added for Tdelay, Tcog or Texe
- Ex-MCR Actions
 - Penalties added to Texe
 - No penalty added for Tdelay or Tcog



OTHER ADJUSTMENTS

- CBDTM selections adjusted for high workload and multiple procedures
- Emergency lighting and at least moderate stress
- Plant damage assessment
 - Assumed 1 hour
 - If cue comes after the plant damage assessment, then stress levels can be reduced as plant operational availability is known.



UNCERTAINTY

- Timing penalties for T_{delay} and T_{exe} are based on analyst judgment
- Timing increases for different types of high wind events is not known. Would the execution timing adjustment for a tornado would be very different from a hurricane?
- Conservatively assumed that any action which takes place outside of a protected structure is failed during a high-wind event.
- Plant damage assessment is completed in 1 hour
- Reduce power before high winds (hurricane) arrives onsite



ADDITIONAL AREAS FOR GUIDANCE

- Crediting FLEX
- Long-term impacts of operator availability
 - Inability for extra crews to reach site due to downed trees, power lines, etc.
 - Fatigue may need to be considered for long term actions



QUESTIONS?

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