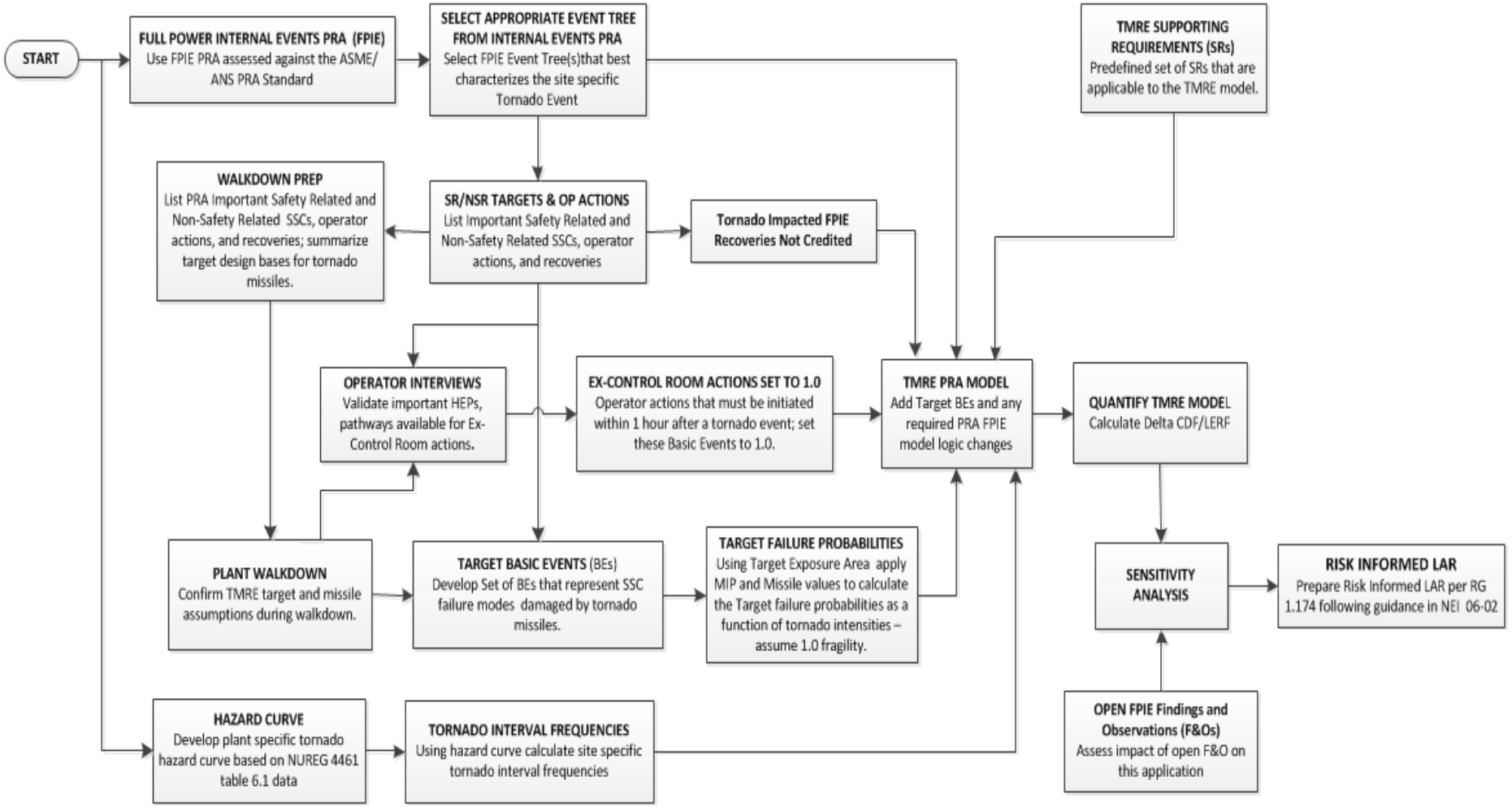
# NEI Tornado Missile Risk Evaluator (TMRE)
# Public Meeting Between the NEI TMRE Task Force and the NRC Staff

**May 11, 2016**

# Agenda

- Probabilistic Risk Assessment (PRA) Topics associated with the TMRE
- Responses to Questions Identified during the March 23rd TMRE Tabletop
- License Amendment Request Template
- Basis for extending 3 year discretion period
- Path Forward

# TMRE PROCESS



# Initiating Event/Hazard Analysis Supporting Requirements

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| **IE-A** | *The initiating event analysis shall provide a reasonably complete identification of initiating events.* |
| IE-A1 | *Tornado initiating events will be consistent with the intervals defined in the TMRE process. TMRE considers all tornadoes will result in a LOOP. Tornado initiating event frequencies will be based on a hazard curve that uses site specific data provided in table 6.1 of NUREG 4461 [IE-C1].* |
| IE-A10 | *For multi-unit sites with shared systems, INCLUDE multi-unit site initiators (e.g., multi-unit LOOP events or total loss of service water) that may impact the model. Assume both sites are exposed to the same tornado intensity unless a basis can be substantiated to assume otherwise.* |
| **IE-B** | *The initiating event analysis shall group the initiating events so that events in the same group have similar mitigation requirements (i.e., the requirements for most events in the group are less restrictive than the limiting mitigation requirements for the group) to facilitate an efficient but realistic estimation of CDF* |
| IE-B5 | *DO NOT SUBSUME multi-unit initiating events if they impact mitigation capability. Two unit sites should consider proximity of each unit to each other, the footprint of potential tornadoes for the region, and the systems shared between each unit.* |
| **IE-C** | *The initiating event analysis shall estimate the annual frequency of each initiating event or initiating event group.* |
| IE-C1 | *Tornado initiating event frequencies will be based on a hazard curve that uses site specific data provided in table 6.1 of NUREG 4461* |
| IE-C2 | *Evaluation of the frequency of occurrence of different intensities of tornadoes is based on a site specific evaluation reflecting recent available data and site-specific information. The most recent NOAA tornado data for the site should be reviewed to determine if site specific NUREG 4461 tornado data needs to be adjusted.* |
| IE-C3 | *Do not credit recovery of offsite power.* |
| IE-C15 | *CHARACTERIZE the uncertainty in the tornado initiating event frequencies and PROVIDE mean values for use in the quantification of the PRA results. NUREG 4461, Tornado Climatology, data includes uncertainty.* |

# Accident Sequence Analysis Supporting Requirements

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| **AS-A** | *Utilize the accident sequences (typically LOOP) provided in the internal events model and adjust as necessary to consider the consequences of a tornado event.* |
| AS-A1 | *Modify the internal events accident sequences in compliance with this SR* |
| AS-A3 | *Review the FPIE success criteria and modify the associated system models as necessary to account for the tornado event and its consequences.* |
| AS-A4 | *Review the FPIE success criteria and modify the associated operator actions as necessary to account for the tornado event and its consequences.* |
| AS-A5 | *Modify the FPIE accident sequence model in a manner that is consistent with the plant-specific: system design, EOPs, abnormal procedures, and plant transient response. Account for system functions that, as a consequence of the tornado event, will not be operable or potentially degraded, and operator actions that will not be possible or impeded.* |
| AS-A10 | *Capability Category I. In modifying the accident sequence models, INCLUDE, for each tornado initiating event, INDIVIDUAL EVENTS IN THE ACCIDENT SEQUENCE SUFFICIENT TO BOUND SYSTEM OPERATION, TIMING, AND OPERATOR ACTIONS NECESSARY FOR KEY SAFETY FUNCTIONS.* |
| **AS-B** | *Dependencies that can impact the ability of the mitigating systems to operate and function shall be addressed.* |
| AS-B1 | *For each tornado event, IDENTIFY mitigating systems impacted by the occurrence of the initiator and the extent of the impact. INCLUDE the impact of initiating events on mitigating systems in the accident progression either in the accident sequence models or in the system models.* |
| AS-B3 | *IDENTIFY the phenomenological conditions created by the accident progression. Consider concurrent impacts related to the weather phenomena – for example potentially intense rain which could impact areas that have damaged barriers which would have otherwise precluded entry of water. Also high winds and rains after the tornado event could result in hazardous conditions (e.g. debris and structural instabilities) for actions outside the control room.* |
| AS-B7 | *Review FPIE time phased dependencies to identify model changes needed to address all the concurrent system functions failed by the tornado event; e.g. LOOP, instrument air, fire protection……etc. Do not model offsite recovery.* |

# Success Criteria Supporting Requirements

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| **SC-A** | *The overall success criteria for the PRA and the system, structure, component, and human action success criteria used in the PRA shall be defined and referenced, and shall be consistent with the features, procedures, and operating philosophy of the plant.* |
| SC-A4 | *Consider impact on both units for the same tornado including the mitigating systems that are shared.* |
| **SC-B** | *The thermal/hydraulic, structural, and other supporting engineering bases shall be capable of providing success criteria and event timing sufficient for quantification of CDF and LERF, determination of the relative impact of success criteria on SSC and human actions, and the impact of uncertainty on this determination.* |
| SC-B2 | *Utilize expert judgment wherever the behavior (fragility) of a component in response to a tornado cannot be analytically evaluated.* |

# Systems Analysis Supporting Requirements

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| **SY-A** | *The systems analysis shall provide a reasonably complete treatment of the causes of tornado related system failure and unavailability modes represented in the initiating events analysis and sequence definition* |
| SY-A4 | *Capability Category II. Walkdowns focusing on targets vulnerable to tornado missiles will be performed. Walkdown will include a missile inventory and a review of pathways available to the operators for x-control room actions.* |
| SY-A11 | *New basic events will be added to address all the failure modes of the system targets exposed to tornado missiles; safety related and non-safety related.* |
| SY-A12 | *DO NOT INCLUDE in a system model component failures that would be beneficial to system operation, unless omission would distort the results. For example, do not assume a vent pipe will be sheered by a high energy missile verses crimped unless it can be shown this is true for all missiles at all speeds. Exceptions would be components that are intentionally designed to "fail" favorably when struck by a missile; e.g. a frangible plastic pipe used as a vent is designed to break off and not crimp when struck by a missile.* |
| SY-A13 | *Consider the target's potential to cause a flow diversion when struck by a tornado missile.* |
| SY-A14 | *Missile targets will be assessed for all failure modes - some new failure modes may be identified that are not in the FPIE model..* |
| SY-A15 | *(a) A target may be excluded from the system model if the total failure probability of the component failure modes resulting in the same effect on system operation is at least two orders of magnitude lower than the highest failure probability of the other components in the same system train that results in the same effect on system operation.*<br>*(b) One or more failure modes for a target may be excluded from the systems model if the contribution of them to the total failure rate or probability is less than 1% of the total failure rate or probability for that component, when their effects on system operation are the same.* |
| SY-A17 | *Post initiator HFEs will be modified to account for the tornado event.* |

# Systems Analysis Supporting Requirements

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|---|---|
| **SY-B** | *The thermal/hydraulic, structural, and other supporting engineering bases shall be capable of providing success criteria and event timing sufficient for quantification of CDF and LERF, determination of the relative impact of success criteria on SSC and human actions, and the impact of uncertainty on this determination.* |
| SY-B7 | *Capability Category I. BASE support system modeling on the use of CONSERVATIVE SUCCESS CRITERIA AND TIMING. Sensitivity studies will be performed to identify where conservative assumptions may be distorting risk and adjusted accordingly.* |
| SY-B8 | *Consider spatial relationships between components to identify correlated failures. Where the same missile can impact targets that are in close proximity to each other.* |
| SY-B14 | *Statistical correlation of tornado missile damage between redundant and spatially separated components is NOT required.* |
| SY-B15 | *INCLUDE new operator interface dependencies across systems or trains related to the tornado event.* |

# Human Reliability Analysis Supporting Requirements

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| **HR-E** | *A systematic review of the relevant procedures shall be used to identify the set of operator responses required for each of the tornado accident sequences* |
| HR-E3 | *Operators will be interviewed and simulator observations conducted (as necessary) to assess the need for changes to operator actions for the tornado initiating events.* |
| HR-E4 | *Operators will be interviewed and simulator observations conducted (as necessary) to assess the need for changes to operator actions for the tornado initiating events.* |
| **HR-G** | *The assessment of the probabilities of the post-initiator HFEs shall be performed using a well-defined and self-consistent process that addresses the plant-specific and scenario-specific influences on human performance, and addresses potential dependencies between human failure events in the same accident sequence.* |
| HR-G5 | *Operators will be interviewed and simulator observations conducted (as necessary) to assess the need for changes to operator actions needed for the tornado initiating events.* |
| HR-G7 | *Dependencies will be recalculated when the model is quantified or modified by inspecting cutsets.* |
| **HR-H** | *Recovery actions (at the cutset or scenario level) shall be modeled only if it has been demonstrated that the action is plausible and feasible for those scenarios to which they are applied. Estimates of probabilities of failure shall address dependency on prior human failures in the scenario.* |
| HR-H1/H2 | *Do not credit recovery actions that are inhibited in any way by the consequences of a tornado unless an explicit basis justifying inclusion is developed.* |

# Data Analysis and Quantification Supporting Requirements

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| **DA-A** | *Each parameter shall be clearly defined in terms of the logic model, basic event boundary, and the model used to evaluate event probability.* |
| DA-A1 | *Develop new basic events for tornado missile targets (all failure modes) in accordance with this SR.* |
| **QU-A** | *The level 1 quantification shall quantify core damage frequency and shall support the quantification of LERF.* |
| QU-A5 | *Do not credit recovery actions that are inhibited in any way by the consequences of a tornado unless an explicit basis justifying inclusion is developed.* |
| **QU-D** | *The quantification results shall be reviewed, and significant contributors to CDF (and LERF), such as initiating events, accident sequences, and basic events (equipment unavailabilities and human failure events), shall be identified. The results shall be traceable to the inputs and assumptions made in the PRA.* |
| QU-D5 | *Review nonsignificant cutset or sequences to determine the sequences are valid* |
| QU-D7 | *Review BE importance to make sure they make logical sense.* |
| **QU-E** | *Uncertainties in the PRA results shall be characterized. Sources of model uncertainty and related assumptions shall be identified, and their potential impact on the results understood.* |
| QU-E1 | *Identify sources of uncertainty related to MIP, missiles and operator actions.* |
| QU-E2 | *Identify assumptions made that are different than those in the internal events model* |
| QU-E4 | *Identify how the model uncertainty is affected by assumptions related to MIP, missiles and operator actions* |

# Questions from March 23rd TMRE Tabletop

## Consideration of PRA statistical correlation sensitivity

- Statistical correlation of one tornado damaging redundant targets is not a significant consideration
- For example, Plant B1 in NP-768 includes two small pump buildings sharing a common wall (Targets 6 and 8)
  - Union strike probability (likelihood that either target being struck by a missile during one tornado) was approximately 400 times higher than intersection strike probability (both targets being struck by missiles during one tornado) (NP-768, Table 3-23)
  - Very low likelihood that two redundant targets will both be struck by missiles during a single tornado

# Questions from March 23rd TMRE Tabletop

## Consideration of the plant stack as a missile

- TMRE methodology utilizes a bounding population of damaging missiles for robust and less robust targets
- The actual population of missiles onsite that could damage targets not having the missile protection features described in the CLB is bounded by the TMRE damaging missile populations

# Questions from March 23rd TMRE Tabletop

## Consideration of F0 and F1 Tornados

- Tornado missile fields are typically generated at tornado intensity level 2 and above
- TMRE addresses tornado intensity levels 2 and above generating damaging missiles
- TMRE guidance document will specify consideration of lower intensity tornados if meaningful damaging missiles can be generated at those tornado intensity levels for a specific site

# Questions from March 23rd TMRE Tabletop

## Consideration of "robust" and "less robust" targets

- A robust target is only susceptible to damage from the most energetic missiles
  - Examples of robust targets include heavy gauge pipe, etc.
  - The damaging missile population considered within the TMRE for robust targets will bound the number of energetic missiles
- A less robust target is susceptible to damage from a wide range of missiles
  - Examples include components, cabling, tubing, etc.
  - The damaging missile population considered within the TMRE for less robust targets will bound a broad range of missiles

# Questions from March 23rd TMRE Tabletop

## Consideration of "large" and "small" targets

- The prior utilization of "psi" included separate factors based on target size and exposure – that granularity in psi could not be supported with data
- TMRE methodology directly considers target size and exposure
- TMRE utilizes the standardized bounding Missile Impact Parameter and number of available damaging missiles
  - Target size and target exposure are addressed through the target area utilized within the TMRE analysis methodology

# Questions from March 23rd TMRE Tabletop

## Consideration associated with walkdown guidance

- Guidance document will describe expected attributes of an adequate walkdown
  - Key attributes of the EPRI high winds walkdown guidance will be referenced as one acceptable walkdown approach
  - Walkdown purpose will include confirmation of exposed targets and conservatism in TMRE damaging missile factors (specific characteristics will be provided for damaging missiles for “robust” and “less robust” targets)

# Questions from March 23rd TMRE Tabletop

- Guidance document will describe expected attributes of an adequate walkdown (continued)
  - Team complement, qualifications, and training will be recommended
  - TMRE will be bounding for operating conditions supporting use of the "At Power" internal events PRA
    - Guidance document will recommend administratively controlled exclusion zones affecting exposed targets
    - Outage duration is sufficiently short reducing potential risk contribution
  - Guidance document will recommend NRC inspection/licensing staff be invited to observe walkdown

# Questions from March 23rd TMRE Tabletop

**Consideration of the appropriate tornado intensity scales for use in the TMRE.**

- The generic Missile Impact Parameter values are developed using the H-values in NP-768 that are associated with the F' tornado intensities
- The site-specific tornado hazard curve is developed using the climatology data associated with the Enhanced Fujita (EF) tornado intensities for each site
- The tornado hazard interval frequencies associated with the F' tornado intensities used in the TMRE are taken from the tornado hazard curve

# Questions from March 23rd TMRE Tabletop

## Consideration of the regulatory relationship between the TMRE tornado hazard curves and the CLB tornado siting criteria

- The TMRE methodology applies only to targets that have missile protection that is nonconforming to the CLB missile protection requirements
  - The TMRE tornado hazard curves are only applicable to these nonconforming exposed targets
- The tornado siting criteria in the CLB is not changed based on use of the TMRE methodology for nonconforming exposed targets

# Questions from March 23rd TMRE Tabletop

## Consideration of physical target correlation relationship with the CLB

- Physical correlation within the TMRE model is defined as two separate exposed targets that are nonconforming with the CLB and are treated as one target:
  - Both nonconforming exposed targets can be hit simultaneously by one damaging missile as described in the CLB
  - For example, both targets are in close enough proximity and exposed at a low enough elevation that they can simultaneously be struck by one automobile missile

# Questions from March 23rd TMRE Tabletop

## Consideration of administrative controls over a missile free zone around nonconforming targets being addressed using the TMRE

- The TMRE guidance document will recommend establishment of administrative controls over missiles near exposed targets (safety margin enhancement)

# TMRE License Amendment Request Template

## LIC -109 Acceptance Review Procedures

- Completeness of Scope
- Sufficiency of Information
- Regulatory Basis
- Use of Approved Guidance
- Use of Precedent
- Consolidated Line Item Improvement Process

# TMRE License Amendment Request Template

## LIC-101 License Amendment Review Procedures

- Pre-Application Meeting
- Acceptance Review
- Amendment Review
  - Overall Timeliness
  - Requests for Additional Information
  - Audits
  - Withdrawal/Denial

# Basis for Extending the 3-year Discretion Period

- Bounding generic risk assessment (ML14114A556) supporting Enforcement Guidance Memorandum (EGM) 15-002 (ML15111A269)
  - Provides a bounding core damage frequency and conditional core damage probability assessment regarding SSCs not protected from tornado missiles
  - Conservative assumptions include initiating event frequency associated with 75 mph tornados
- Comparison utilizing frequency of site specific tornados that can generate damaging missiles should demonstrate that plant specific risk is reduced by more than a factor of two supporting extension to 5-year discretion

# Path Forward

- Schedule the next public meeting to discuss the remaining questions regarding the March 23rd TMRE tabletop and the license amendment expectations – 3Q2016
- Finalize basis and process to extend 3 year discretion period – 3Q2016
- Draft industry TMRE guidance document – 3Q2016
- Conduct industry workshop with NRC participation – 3Q2016
- Submit pilot TMRE application and draft TMRE guidance document – 4Q2016

# Questions