ISSUE STATEMENT

External hazards such as high winds and flooding present the potential to be common-cause initiators for nuclear power plants. That is, they can cause damage simultaneously to systems that would otherwise encompass redundant means to maintain the safe status of a plant. Although this potential has long been recognized, it has been illustrated most dramatically and most recently by the earthquake and resulting tsunami that led to fuel damage at the Fukushima Daiichi nuclear station in Japan.

Although the consideration of these external hazards is not new, in the past they have generally not received the same level of attention as accidents initiated within plant systems, internal fires, and seismic events. External hazards have typically been addressed by a combination of limited probabilistic assessment of the hazard combined with deterministic measures to protect against their effects. As the risks associated with those contributions that have been studied in more detail have decreased over time, the relative importance of other external hazards has increased. This has led to a need to develop a more systematic approach to determining which hazards are relevant for a particular site; better methods for evaluating the potential magnitude and likelihood of some of these events; and better methods for evaluating their impacts on nuclear power plant systems and structures.

It is also recognized that there are certain irreducible uncertainties associated with the characterizations for some external hazards. For example, the potential for severe external flooding due to prolonged rainfall is assessed based on a database that is typically only a few hundred years old. Events that could challenge safe operation of a nuclear power plant may, however, be of interest even if their recurrence intervals are tens to hundreds of thousands of years. Therefore, a part of the issue associated with external hazards is the need to identify appropriate provisions that will be effective even under conditions associated with events that are expected to be very low in likelihood, but for which that assessment of likelihood is subject to large uncertainty.

DRIVERS

Public Perception

Acceptance of nuclear energy as an important source for generating electricity is profoundly influenced by confidence in the industry’s ability to manage technically complex issues. External events that affect nuclear power plants receive strong, worldwide media attention. It is essential that risks be understood and properly managed to demonstrate the continued safe operation of nuclear power plants.

Support for Effective Risk-Informed Decision Making

The risks associated with events traditionally evaluated in detail have decreased as a result of system modifications and improved operating practices. That has increasingly led to the need to consider other possible hazards that might previously have received less attention. A proper understanding of the relative risks of potential threats is essential so that resources are applied most effectively to manage these risks.

New Information and Understanding

Actual events and evaluations of trends have led to an understanding that, at least in some cases, earlier assessments may have underestimated some hazards. Moreover, the degree to which there are uncertainties in some hazard characterizations is better understood than it may have been when current plants were designed and built. The need to ensure that the impacts of this new understanding are addressed is reinforced by the 2011 event in Japan and by other recent experiences.

RESULTS IMPLEMENTATION

Use of the results of research efforts relating to the assessment of external events will include the following:

- Utilities will have an improved basis for determining what types of external events they should consider on a plant-specific basis, taking into account both safety and economic perspectives.
- Utilities, plant designers and regulators will have improved methods for assessing the potential for and effects of external hazards, for those hazards highest in priority (expected to include external flooding and high-wind events).
- Application guidance and pilot studies will be available to support utility use of improved methods for evaluating external events.
PROJECT PLAN

This project will integrate information from near-term actions related to external hazards prompted by the March 2011 tsunami that impacted nuclear power plants in north-east Japan, existing activities to increase understanding of external events, and ongoing research and development needs.

The first major activity under this plan will be to improve and test the methods used to determine which external hazards are of potential concern to a particular plant site. There is at least a perception that methods currently used are not adequate to identify hazards beyond those that are within the envelope for the plant design. The information assembled in improving the methods for identification of relevant external hazards will then be used to establish priorities for the further collection of hazard data and development of assessment methods.

The state of knowledge of important external event sources will be evaluated to assess the potential for improved event source information from both historical and mechanistic perspectives. Methodologies for compiling the data sources and applying them will be reviewed to identify potential improvements. Potential source information and methodology improvement opportunities will be prioritized based on their feasibility and usefulness in addressing safety and economic risks. High priority gaps in the understanding of plant impacts and plant response will be identified and research conducted to address these.

Potential research collaboration partners, such as the U.S. NRC Office of Nuclear Regulatory Research (RES) and the EDF Research and Development organization, among others, have been engaged. It is anticipated that longer term developmental activities will be conducted by EPRI working with other research partners, including nuclear utilities.

RISKS

Risks associated with pursuing this work and with the intended results include the following:

- **Timing** – the perceived urgency in responding to recent events could precipitate plant operator and regulatory actions without the benefit of the results of this work. This risk can be managed by prioritizing research to produce timely results for areas of high priority, and by collaborating with regulatory research efforts.

- **Delay in industry actions** – without operational drivers, complex technical issues benefiting from consensus positions can stagnate. This risk can be managed by establishing clear, realistic expectations regarding the nature and timing of results that will be obtained and by ensuring continued effective participation by members.

RECORD OF REVISION

This record of revision will provide a high level summary of the major changes in the document and identify the Roadmap Owner.

<table>
<thead>
<tr>
<th>REVISION</th>
<th>DESCRIPTION OF CHANGE</th>
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| 0        | Original Issue: August 2011  
Roadmap Owner: Stuart Lewis |
| 1        | Revision Issued: December 2011  
Roadmap Owner: Stuart Lewis  
Changes: Relocated public perception paragraph within “Drivers”. Editorial changes to “Project Plan”. Identified EDF R&D as collaborative partner in “Drivers”. Updated the associated activity schedule diagram. |
| 2        | Revisions Issued: August 2012  
Roadmap Owner: Stuart Lewis  
Changes: Updated the status of the associated activity schedule flowchart to show funding for Wind studies in 2013. |
| 3        | Revisions Issued: August 2013  
Roadmap Owner: Ken Huffman  
Changes: Updated the flow chart by adding a Screening Guidance Testing activity, extended duration of High Winds and eliminated Tsunami/Seiche OEH Source and Methods State of Knowledge activities, changed Other Utility Members’ R&D and EPRI OEH Technology Projects to a funded activity and revised the examples for Hazard Source Updates, Developments and Hazard Effects Developments. Revised the Project Plan description to reflect testing of screening methods, deleted reference to PTHA as a recently applied method and clarified that development activities will be conducted by EPRI as well as by EPRI with partners. |
Revisions Issued: January 2014  
Roadmap Owner: Ken Huffman  

Changes: Updated the flow chart by – deleting the elements associated with R&D Prioritization as these are addressed through advisory structure activities; incorporated Pilot Applications in Collaborative R&D EPRI, NRC, Utilities, National Agencies; and extended the duration of Hazard Source Updates, Developments and Hazards Effects Developments consistent with High Winds project projections. Revised the Project Plan description to correct the spelling of “Daiichi” in the Issue Statement and in Results Implementation clarified hazards highest in priority to be (expected to include external flooding and high-wind events).

Revisions Issued: August 2014  
Roadmap Owner: Ken Huffman  

Changes: Updated the flow chart by – moved forward utility Hazard Method Pilots, repositioned the screening guidance testing and updated the revised screening guidance milestone, extended the OEH Source and Methods State of Knowledge block for high winds and extended the associate Gap Analysis and Generic/Non-generic Potential Actions. Associated with Other Activities with On-Going R&D, Data Collection and Development – added organizations OECD and AMSAPSA. Included a statement on plant impacts and plant response in the Project Plan.

Revisions Issued: December 2014  
Roadmap Owner: Ken Huffman  

Changes: Updated the project chart by – extending the High Winds activities for OEH Source Data and Methods State of Knowledge through 2016, slightly extended the schedule of the Significance Evaluation activity and milestone, deleted AMSAPSA from the list of Others Activities and changed the Revised Screening Guidance milestone to a funded activity.

Revisions Issued: August 2015  
Roadmap Owner: Ken Huffman  

Changes: Updated the project chart by – revising the titles of the second and third overall activity blocks to RSM and Collaborative R&D EPRI, NRC, Utilities respectively; extended the schedule for Screening Guidance; deleted the activity Significance Evaluation; added the activity External Hazards: Information Compilation and Analysis and extended the duration of the Flooding activities. Revised the Drivers description by changing the characterization of considering other possible hazards from opportunity to need.

Revisions Issued: December 2015  
Roadmap Owner: Ken Huffman  

Changes: Revised Screening Guidance milestone marked as complete.
Risk Assessment Methodologies for External Hazards Other Than Fire and Seismic

Utilities

- Fukushima Daiichi Related Event Response Actions
  - Lessons Learned INPO IER Responses
  - U.S. NRC Near Term Recommendations, Tier 1 Action Requirements
  - International Stress Tests

Utility Studies, Strategies, Actions

- DCNPP PTHA
- FCNPP Flood Experience
- Plant Specific Actions & Lessons Learned
- Source Data Pilots
- Hazard Method Pilots
- Initial U.S. Plants’ Flooding Hazard Reevaluations

EPR Risk and Safety Management

- OEH Significance Update
  - Screening Guidance
  - Screening Guidance Testing
  - Revised Screening Guidance
  - External Hazards: Information Compilation and Analysis
    - Non-Generic Potential Actions
    - Generic Potential Actions
  - Gap Analysis
    - Flooding
    - High Winds
    - Other

Legend

- Completed Key Milestones
- Funded EPRI Work
- Key Milestones
- Unfunded EPRI Work

Collaborative R&D

- EPR/L R&D, Utilities
  - NRC - EPRI MOU
  - EDF R&D - EPRI Technical Exchange
  - Hazards Source Data Updates, Developments
    - Examples
      - Straight Winds
      - Hurricanes (Typhoons)
      - Riverine Flooding
      - Plant Response To Flooding
      - Wind Fragilities
  - Other Utility Members’ R&D & EPRI OEH Technology Projects
  - Hazards Methods Developments
    - Examples
      - Tomatoes

Others Activities

- IAEA, NOAA, USGS, US ACE OECD
  - On-Going R&D, Data Collection, Development