

Technical Issues with Proposed Revision to NRC Regulatory Guide 1.59, “Design Basis Floods for Nuclear Power Plants”

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Outline

- Overview of major influences
 - Advances in data, models and methods
 - Lessons learned
 - Recent new reactor license reviews
 - Post-Fukushima flood hazard reevaluations
- Selected Topics
 - Precipitation
 - Sight-specific PMPs
 - Local Intense Precipitation
 - Inland flooding
 - Riverine flooding
 - Dam Failure
 - Ice effects
 - Coastal flooding
 - Storm surge
- Current status

Advances in Data, Models and Methods

Archived QA'd Digital Data

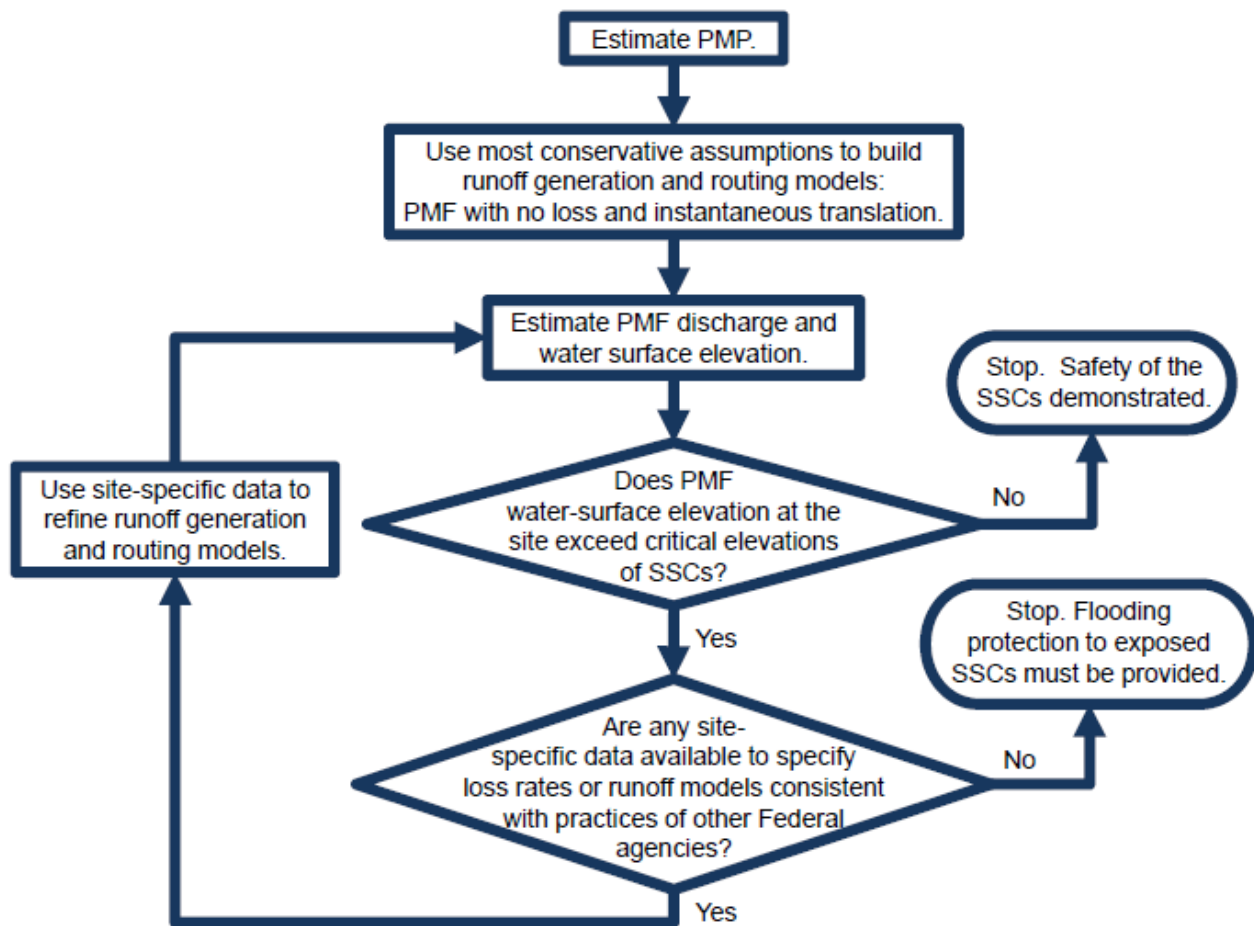
- Topography (NASA, USGS, States)
 - Digital Terrain Data (Digital Elevation Models, DEMs)
 - Radar topography, LiDAR
- Bathymetry (NOAA)
 - Bathymetric Digital Elevation Models, Coastal Elevation Models
 - Ocean basins, coastal areas, estuaries, rivers
 - Combined Bathymetry & Topography
- Watershed delineation
 - National Hydrography Dataset (USGS)
- Land Cover, Land Use, and Soils Information
 - National Land Cover Dataset (NLCDs)
 - Web Soil Survey (USDA/NRCS)
- Streamflow (USGS)
 - Current conditions, historical data
- Tides and Currents (NOAA)
 - Current conditions, historical data, trends
- Storms (NOAA)
 - HURDAT database (hurricane tracks, parameters)
- Precipitation (NOAA)
 - Gage, radar and combined radar and gage data

Advances in Modeling Tools

- Advances in computing resources
 - Hardware
 - Operating systems
 - Communications
- Advances in computational science
 - Solution algorithms
 - Data structures
 - Mesh generation
- High-fidelity, mechanistic, multidimensional numerical simulation codes
 - Comprehensive hydrologic models for large watersheds
 - Detailed unsteady hydraulic models
 - Coupled wind-wave-surge models
 - Tsunami wave propagation and inundation models

Advances in Methods

- Hierarchical Hazard Assessment Method
 - Stepwise, progressively refined series of analyses
 - Aimed at demonstrating that the SSCs important to safety are adequately protected from the adverse effects of severe floods expected at the site.



Advances in Methods

- Probabilistic Approaches
 - Currently limited discussion in RG
 - Joint Probability Method for Storm Surge
 - Probabilistic Seismic Hazard Assessment (PSHA) for seismic dam failure scenario
 - Topic of current research
 - NRC PFHA Research Program
 - EPRI Flooding Research Program
 - Include in future RG revision

Lessons Learned From Recent Activities and Events

New Reactor License Reviews

- Early Site Permits (ESPs)
 - 5 issued since 2003
 - Clinton ESP Site (Exelon)
 - Grand Gulf ESP Site (System Energy Resources)
 - North Anna ESP Site (Dominion)
 - Vogtle ESP Site (Southern Nuclear)
 - PSEG ESP Site (PSEG)
 - 1 currently under review
 - Clinch River Nuclear Site (TVA)
- Combined Operating Licenses (COLs)
 - 7 issued since 2012
 - Fermi 3 (DTE)
 - Levy 1&2 (Duke)
 - North Anna 3 (Dominion)
 - South Texas Project 3&4 (STPNOC)
 - V. C. Summer 2&3 (SCE&G)
 - Vogtle 3&4 (Southern Nuclear)
 - Lee 1&2 (Duke)
 - 1 currently under review
 - Turkey Point 3&4 (FPL)

Research Reports

- NUREG/CR-6966 (2009)
 - Tsunami Hazard Assessment at Nuclear Power Plant Sites
- NUREG/CR-7046 (2011)
 - Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plant Sites
- NUREG/CR-7134 (2012)
 - Estimation of Very-Low Probability Hurricane Storm Surges for Design and Licensing of Nuclear Power Plants in Coastal Areas
- NUREG/CR-7222 (2016)
 - Tsunami Hazard Assessment Based on Wave Generation, Propagation, and Inundation Modeling for the U.S. East Coast
- NUREG/CR-7223 (2016)
 - Tsunami Hazard Assessment: Best Modeling Practices and State-of-the-Art Technology
- NUREG/CR-7131 (2018)
 - Review of Probable Maximum Precipitation Procedures and Databases Used to Develop Hydrometeorological Reports
- NUREG/CR-7132 (2018)
 - Application of Radar-Rainfall Estimates to Probable Maximum Precipitation in the Carolinas
- NUREG/CR-7133 (2018)
 - Synthesis of Extreme Storm Rainfall and Probable Maximum Precipitation in the Southeastern U.S. Pilot Region

Post-Fukushima Flooding Reevaluations

- Tohoku Earthquake and Tsunami (2011)
- NRC Near-Term Task Force (NTTF) Report (2011)
- NRC Japan Lessons Learned Project Directorate (JLD) (2011)
- NRC 50.54 (f) Letter (2012)
 - NRC NTTF Report Recommendation 2.1: Flood Hazard Reevaluations
 - NRC NTTF Report Recommendation 2.3: Flood Protection Walkdowns
- NTTF R2.1 Implemented in 2 phases
 - Phase 1
 - Reevaluate flooding hazards using updated flooding hazard information and present-day regulatory guidance and methodologies and, if necessary, to perform a risk evaluation (integrated assessment)
 - Phase 2
 - Determine whether additional regulatory actions are necessary (e.g., update the design basis and SSCs important to safety) to provide additional protection against the updated hazards

Interim Guidance & Lessons Learned

- Interim Staff Guidance (ISGs)
 - JLD ISG 2012-06
 - Guidance for Performing a Tsunami, Surge, or Seiche Hazard Assessment
 - JLD ISG 2013-01
 - Guidance For Assessment of Flooding Hazards Due to Dam Failure
- Lessons Learned Focus Groups (2016-2017)
 - Probable Maximum Precipitation
 - Local Intense Precipitation Flooding & Site Drainage
 - Riverine Flooding
 - Riverine Flooding with Dam Failures
 - Storm Surge, Tsunami, Seiche
 - Combined Event Flooding

Other Events

- Hurricane Katrina (2005)
- Hurricane Ike (2008)
- Mississippi River Flooding (2011)
- Missouri River Flooding (2011)

RG Updates for Selected Topics

Selected Topic: PMP

- In past, generalized PMP estimate obtained from National Weather Service (NWS) Hydrometeorological Reports (HMRs) for given location, area size and duration
- HMRs recognized as lacking current data
 - Regional, state-wide, and site-specific PMP studies being performed
- RG Update provides limited guidance on
 - Storm selection
 - In-place moisture maximization
 - Storm transposition

Selected Topic: LIP

- In past, no detailed guidance on flooding due to local intense precipitation (LIP)
- RG Update provides guidance on
 - Design storm duration and temporal distribution
 - Level of modeling detail
 - Modeling approaches
 - Presentation of results (inundation maps)

Selected Topic: River Flood

- RG Update incorporates research findings from NUREG/CR-7046
- Includes detailed guidance
 - Data sources for hydrologic/hydraulic model inputs
 - Watershed delineation
 - Land cover
 - Soils
 - Precipitation
 - Topography
 - Hydrologic and Hydraulic model application
 - NPP Site inundation maps
 - Associated effects

Selected Topic: Dam Failure

- RG Update includes detailed guidance incorporated from JLD ISG 2013-01
 - Screening methods
 - Failure mechanisms
 - Hydrologic failure
 - Seismic failure
 - Sunny-day failure
 - Breach estimation methods
 - Flood wave propagation
 - NPP site inundation and associated affects

Selected Topic: Ice Effects

- RG Update includes guidance derived from mainly from USACE Cold Regions Research and Engineering Laboratory (CRREL) data and publications
 - USACE Ice Jam Database
 - Screening methods
 - Types of ice and ice effects
 - Identifying common locations and conditons for ice dam/jam formation
 - Flooding due to ice jam/dam formation
 - Flooding due to ice jam/dam failure

Selected Topic: Storm Surge

- RG Update incorporates research from NUREG/CR-7134 and guidance from JLD-ISG-2012-06
- Multiple approaches
 - Probable Maximum Hurricane (PMH, NWS-23 method)
 - Probabilistic (Joint Probability Method)
 - Hybrid method
 - NUREG/CR-7134
- Modeling choices
 - High-fidelity coupled wind-wave-surge model vs simpler models
 - Tides
 - Sea-level Rise
- Sources of modeling input
 - Bathymetry and topography
 - Storm databases
 - Tides and currents

Current Status

- 2012-05
 - DG-1290 issued for internal comment
- 2013-01
 - JLD ISG on storm surge, tsunami, seiche
- 2013-07
 - JLD ISG on flooding due to dam failure
- 2014-05
 - Internal comments received
 - Incorporate ISGs
 - Incorporate lessons learned from post-Fukushima flooding reevaluations
- 2016-06 to 2017-03
 - Internal focus groups
 - Gather post-Fukushima flooding reevaluations lessons learned
- 2017-12
 - DG-1290 re-issue for internal review
- 2018-Q1
 - DG-1290 issue for public comment