RIC 2010
Hierarchical Flood Hazard Assessment

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Background

- 10 CFR 52.79(a)(1)(iii) for Combined License applications
  - The seismic, meteorological, **hydrologic**, and geologic characteristics of the proposed site with appropriate consideration of the **most severe of the natural phenomena** that have been historically reported for the site and surrounding area and **with sufficient margin** for the limited accuracy, quantity, and time in which the historical data have been accumulated.
- 10 CFR 52.17(a)(1)(vi) for Early Site Permit applications
- 10 CFR Part 50, Appendix A, General Design Criterion 2
- 10 CFR Part 100

Hierarchical Hazard Assessment Approach

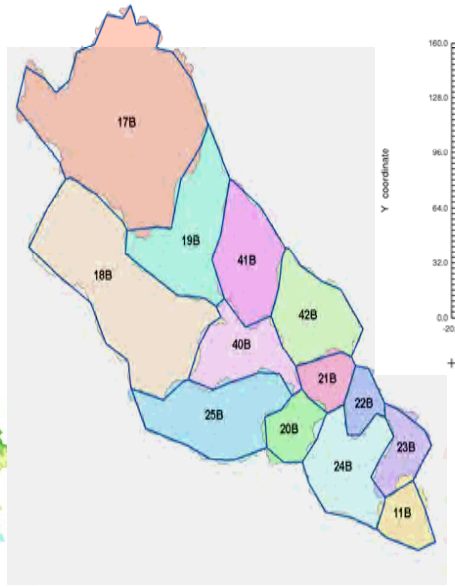
- Objective of Flood Hazard Assessment
  - provide reasonable assurance that plant SSCs would be safe
  - account for worst historical flood hazard
  - account for limited datasets
  - demonstrate sufficient margin
- How do we meet these objectives?
  - analysis of historical data and observations
  - consideration of all plausible flood causing phenomena
  - floods generated by probable maximum events
  - use conservative assumptions

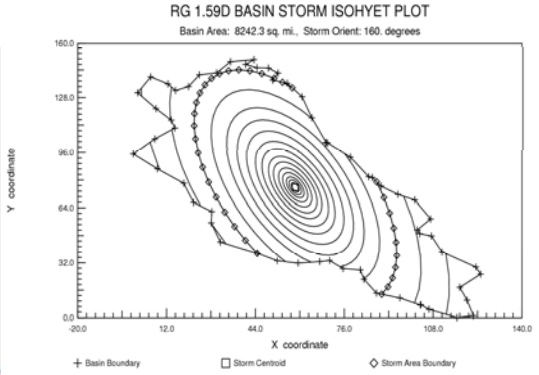
Hierarchical Hazard Assessment Approach

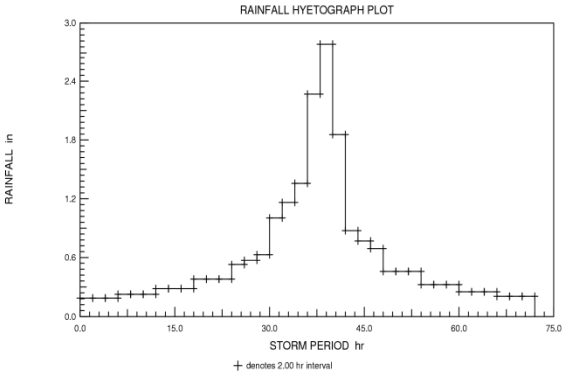
- What is HHA?
  - a set of iterative, progressively refined flood estimation steps
    - **Step 1**: identify flood causing phenomena by inspection of historical data and an assessment of all plausible hydrological, geoseismic, and structural failure processes in the vicinity of the site; document implausibility
    - **Step 2**: for each flood causing phenomenon, perform a conservative estimation of the flood hazards using ANSI/ANS-2.8-1992 combinations
    - **Step 3**: if any safety-related SSC is exposed to adverse effects of flood hazards, perform a more site-specific flood analysis ensuring that the flood-producing conditions are at least as conservative as and are consistent with what Federal agencies use in similar design considerations and repeat Step 2; else perform Step 4
    - **Step 4**: specify site characteristics for flood hazards

An Example of HHA

- Probable Maximum Flood (PMF) at a site
  - PMF is caused by a Probable Maximum Precipitation (PMP) event
  - Step 1:
    - estimate PMP hyetographs for subbasins of upstream drainage area







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An Example of HHA (cont.)

- PMF at a site
  - Step 1:
    - flood causing phenomemon: PMF in the drainage area above the site
  - Step 2:
    - estimate PMF using conservative assumptions: no precipitation loss, instantaneous translation of surface runoff to the site, no attenuation as flood peak passes through storage reservoirs; estimate coincident wind-wave effects consistent with ANSI/ANS-2.8-1992
    - let us say this conservative estimation resulted in inundation of site grade
  - Step 3:
    - use site specific data: route surface runoff using peaked unit hydrographs
    - flood level drops, but still presents hazards to some SSCs
    - use site specific data: precipitation loss rate consistent with US Army Corps
    - flood level drops more, only SSC still inundated is safety-related intake
    - no more site-specific data to use

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An Example of HHA (cont.)

- PMF at a site
  - Step 4:
    - estimate flood hazards for the safety-related intake: hydrostatic forces (water levels), hydrodynamic forces (velocities), scouring potential, duration of inundation, and lead time for action
- HHA should be applied to all plausible flood causing phenomena
  - site flooding under local intense precipitation
  - flooding in rivers and streams; flooding from dam breaches and failures
  - storm surges, seiches, tsunamis, ice-induced events, channel diversions

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Recently Encountered Unique Issues

- Sequential combination of PMSS and Dam Breach
  - ANSI/ANS-2.8-1992 recommends that two extreme events should not be postulated to occur concurrently if they are independently caused
  - however, sequential combination is possible:
    - normal water surface elevation in cooling lake higher than site grade
    - under PMH-induced storm surge, site is wet
    - unreinforced outer face of cooling lake embankment subject to wave action and erosion
    - breach of embankment leads to a flood at site coincident with PMSS
- Small margin between site grade and PMF water levels
  - how small a margin is acceptable?
  - better approaches for estimation of unit hydrographs

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Observations and Conclusion

- HHA provides a consistent framework for assessment of flood hazards
- HHA provides assurance that all plausible flood causing phenomena have been investigated
  - analysis of historical data and observations
  - documentation of implausible flood causing phenomena
- HHA documents the level of conservatism built into the flood hazard analyses
  - clear documentation of site specific data used in flood hazard analyses
- HHA documents the conditions under which safety margins are estimated