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Comment On: NRC-2020-0237-0001
Considerations for Estimating Site-Specific Probable Maximum Precipitation at Nuclear Power Plants in the United States of America

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General Comment

Attached the are comments, edits, and suggestions from Applied Weather Associates for your consideration. Note that Applied Weather Associates appreciates the efforts to develop this document and provide a detailed summarization of the PMP develop processes. This is excellent work overall and should be a significant benefit to the NRC community. Please let me know of questions or need for further clarification on our comments.

Attachments

Applied Weather Associates Comments on draft NUREG-KM 0015

Comments on draft NUR

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REG/KM– 0015, "Considerations for Estimating Site-Specific Probable Maxi

AWA Comment/Basis

grammatical edit

Should reference be made to AWA and any other consultants who performed this work and/or examples provided?

Suggest re-wording this as the PMP development process utilize the same general method of storm based approach, storm maximization, storm transposition, etc. with updated data and methods

SSPMP is not new, private consultants have performing SSPMP for more than 50 years, with the first accepted by FERC in the US in 1993 (EPRI Michigan/Wisconsin)

wording change

Reference needed

wording change

additional wording

additional wording

additional wording/reference

additional wording

reword statement

use a different example
grammatical edit

date correction
grammatical edit

additional wording

add reference

additional wording
additional wording

Figure needs to be updated

additional wording

Description needs to be corrected

Description needs to be corrected

additional wording

Description needs to be corrected

Description needs to be corrected

Description needs to be corrected

additional wording

additional wording
grammatical edit

additional wording

additional wording

reference needed

additional wording/reference

reference needed

additional wording
grammatical edit

grammatical edit

additional wording

incorrect statement

additional wording

additional wording

additional wording

additional wording

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additional wording

additional wording

mum Precipitation at Nuclear Power Plants in the United States of America."

AWA Recommendation

extra "-" between design basis in first paragraph

After PMP estimates in 3rd paragraph, 2nd sentence, consider adding "performed by Applied Weather Associates and other consultants".

In the 3rd paragraph, 3rd sentence, propose revising to say "Whereas SSPMP estimates employ a storm based maximization and transposition process similar to the HMRs, they ultimately use different and updated methods, data sources and procedures than those found in the HMRs"

Suggest adding "for Nuclear sites"

define "notable", higher/lower and by how much and why this is important

In Note 5, consider adding that these SSPMP studies were all performed by Applied Weather Associates.

Consider adding "known as the storm based approach" at the end of the sentence before the (Schreiner and Riedel 1978) reference.

In the first paragraph and last sentence of Section 1.5, insert "or higher" after "in PMP estimates that are lower"

In the 2nd paragraph, 1st sentence on page 1.9, add "and topographical" after "with similar meteorological"

In the 2nd paragraph, 3rd sentence on page 1.9, the storm analysis process is more detailed than stated. Consider referencing the SPAS process and outputs that have been used. Also, suggest updating the wording at the end of that sentence from "such as radar-driven precipitation" to "such as a combination of rain gauges and gauge adjusted radar data".

after "surface dewpoint observations" add "or sea surface temperatures"

In the 1st paragraph, 3rd sentence on Page 1-10, the statement "Such an assumption has never been tested" is debatable. PMP level storms have occurred and been applied. Examples include Smethport, PA July 1942; Cherry Creek, CO May 1935, Thrall, TX September 1921, and Harvey August 2017. Whether these represent PMP before maximizations is of course unknown, but given the amount of rainfall and how these compare to other extreme storms and how these storms control the PMP envelop curves, it is likely these storms do represent the upper limit of rainfall for those locations.

In the 1st paragraph, 4th sentence on Page 1-10, consider using storm transposition decisions as an example of profession judgement rather than storm representative dewpoint. A likely bigger assumption is whether that storm representative dew point actually represents the moisture producing the rainfall and whether it can be maximized and still produce the same storm dynamics. Storm transposition decisions would be a much better example of "professional" judgment. Storm representative dew point selection actually is very straightforward. The bigger assumption is whether that storm representative dew point actually represents the moisture producing the rainfall and whether it can be maximized and still produce the same storm dynamics.

cool-season is hyphenated in one sentence then not hyphenated in the next

On page 2.1, 2nd paragraph, it is noted that the USACE Black Book includes storm through 1972 (Hurricane Agnes). Consider updating the 1969 to 1972. It is also noted that the Bureau of Reclamation has a similar, extensive storm database that covers much of the western US from the Rocky Mountains westward and should be utilized. These storm data were utilized in HMR 49, 55A, 57, and 59. Also, it may be worth noting that AWA has utilized SPAS to update the old storm databases with storms analyzed through 2020 and added hundreds of storms to the overall database which have been used in SSPMP development in NRC studies and throughout the US.

In Section 2.1, 2nd paragraph, last sentence, change "review" to "reviewed".

In Section 2.1, 3rd paragraph, 2nd sentence, recommend augmenting the storm search domain description to include "regional hydrometeorological and **topographic** characteristics"

The discussion on the latitudinal constraint should reference HMR 57, page 69 note as that is where this originates from

in regards to the discussion/description of all-seasonal and cool-season, reword this to say. In regions where the greatest rainfall occurs without snow on the ground, are applied as rainfall only. However, the all-season can also occur in regions where the greatest rainfalls accumulate with an antecedent/concurrent snowpack. Examples would be the West Coast of the United States (e.g. Sierra Nevada and Cascade Ranges). In regions where the all-season rainfall is greater than the rainfall that could occur with an antecedent/concurrent significant snow pack, a separate cool-season PMP is developed to apply as a rain-on-snow event. In these situations the cool-season rainfall will produce lower rainfall depths, but the additional concurrent snowmelt combined with the cool-season PMP rainfall may produce a total runoff amount greater than the rain only all-season PMP runoff. Example locations would be large basins in the Upper Midwest and New England regions."

Add HMR 48 in parenthesis as an example cool-season PMP estimates for limited cases

Note that in Figure 2-1, some storm locations are not plotted (e.g. Rattlesnake, ID Nov 1909). For completeness, USBR storms should be plotted, as they will fill in much of the western US. Also, consider plotting SPAS storm locations. In addition , consider adding HMR 55A, 57, and 59 storm locations to fill in the western US

Recommend that SPAS be discussed in Section 3.1, 2nd paragraph. Also, use of climatological base maps (e.g. PRISM) and remote sensing output provides another advancement/improvement to develop DADs

On page 3-2, 1st paragraph, If this is referring to SPAS, this is not accurate. The most intense portion of the storm (and any SPAS storm) is NEVER excluded. If this referring to separating the storm into 2 (or more) DAD zones, they each contain the most extreme rainfall but do not combine them into one center because that is not meteorologically accurate. The HMRs also separated numerous storms into individual DAD zones (e.g. HMR 55A, 57 and 59).

The last sentence of the 1st paragraph, page 3.2 does not appear to be justified by the preceding discussion. Recommend revising the last sentence to just state: ". . . decomposition of multicenter storm events should be accompanied by substantive justifications. One incorrect example (1972 Hurricane Agnes) does not invalidate the process. It would be helpful for this discussion to detail the reasoning for separating storms into distinct DAD zones. The reasons for this are related to storm timing, storm interactions with topography, or a combination of both as they occur within an overall larger storm domain. It should also be noted that USACE Black Book storms and storms in HMR 55A, 57, and 59 utilized separate/multiple DAD zones.

In Section 3.2, 3rd bullet, the HMR conversion ratios are severely outdated and produced using a lack of data. Suggest noting that significant recent work has been completed to investigate actual storm accumulation patterns at sub hourly intervals to develop site-specific, storm specific ratios. Consider utilizing the updated information available from the numerous storm analyses that include actual sub-hourly data

Suggest replacing "is generally discouraged" and replace with "requires substantial justification".. The process is meteorologically valid as long as it is properly justified.

This sentence should be re-worded to more clearly state the intent, which I think is, if a given location has adequate storm data, there is no need to transposition in more storms than necessary.

Recommend including a discussion on the use of sea surface temperatures as a surrogate for dewpoint. This was utilized in many SSPMP submissions and is also described in HMRs 57 and 59.

In Section 5.1.2, 2nd paragraph, note that HMR 51 used 12-hr persisting, but HMRS 55A, 57, and 59 used 3-hr as well. In additional, all AWA PMP studies have utilized 3-, 6-, 12-, and/or 24-hr climatologies. This is because those data sets are now available (they weren't for HMR 51) and they better represent the intent of the process.

In Section 5.1.4, 1st paragraph, 1st sentence, recommend referencing the WMO Manual for PMP and the precipitable water table contained in that document as it provides a more complete table.

remove extra space after 71- F

In Section 5.1.4, 1st paragraph, last sentence, clarify by adding to the end of the sentence: "since 3 dimensional PW datasets do not exist for older storms and therefore would produce an inconsistent data set between old and new storms for PW estimation and storm maximization calculations."

In Section 5.1.4, 2nd paragraph, last sentence, it is noted that this critical assumption has been evaluated for individual storms and through numerical modeling. The assumption is true in some cases but not in others. References (Chen and Bradley 2007; Mahney et al., 2013; Mahoney 2016, etc.).

Suggest referencing AWA studies (TVA TR for example) where the dew point climatologies were developed and updated

In Section 6.1.2, 2nd paragraph, 2nd sentence in regard to the statement that the ". . . limiting the IPMF to a value of 1.5 remains unclear", the 1.50 value is somewhat arbitrary but is likely overly conservative. The assumption is that significantly increasing the moisture to a given storm would alter the storm dynamics and therefore produce a storm that is no longer the same as observed from a storm dynamic/storm efficiency perspective. Modeling of storm adjustments with different levels of RH/moisture applied have shown that storms do change significantly with far less moisture variation. Instead, the issue is within the underlying assumption in the PMP process, that simply adding more moisture can produce the same storm with more rainfall and that the process of IPMF is valid.

In Section 6.1.2, 2nd paragraph, consider adding additional references like Chen and Bradey, Mahoney, etc.

In the discussion at the top of page 6-4, recommend adding the need to move a given storm 2 weeks towards the warm season during the maximization process. Reference can be made to HMR 51 discussion.

period missing after "SSPMP" and before "These"

In Section 7.1, 1st paragraph, last sentence, note the orographic transposition factor (OTF) is now called the Geographic Transposition Factor (GTF). All studies utilizing this process since 2018 refer to the GTF. Suggest a clarification note or stating "OTF/GTF".

In Section 7.1.2, 3rd sentence, it is noted that the OTF (GTF) is not for spatial pattern development as seemingly inferred. It is recommended that this sentence needs to be clarified to note that the OTF (GTF) is used to calculate the difference in recurrence interval depths at one location vs another with the assumption that these reflect the expected difference in precipitation that would occur between the observed storm location and the basin grid location. And that those differences are inherently captured in the precipitation frequency depths and therefore capture all the precipitation process that vary between the locations. This includes the effect of topography in-place and upwind of each location. The spatial component comes back into play when calculating the PMP depths and redistributing them by following the precipitation frequency spatial patterns or other spatial patterns over the basin.

In Section 7.1.2, 1st paragraph, 5th sentence, the statement that the OTF (GTF) is a "significant departure" from HMR approaches" should be clarified. The Storm Separation Method utilized in HMRs 55A, 57, and 59 applies the 24-hr 100-yr precipitation frequency in its calculations and the HMRs utilize precipitation frequency patterns as a recommended spatial pattern application. Terefore, the intent of the process and use of precipitaiton frequency estimates for PMP calculation and spatial distrubition is not a signficant depature.

In Section 7.1.2.4, 2nd bullet, consider adding a note that the storm type mixing is assumed to be addressed by use of the various durations (6 and 24-hr to represent given storm types. The assumption is that 100-yr recurrence intervals would be driven by local storms at the 6-hr duration and by tropical or general storms at the 24-hr duration.

In Section 7.1.2.4, 3rd bullet, suggest additional wording noting that, the use of PRISM and other climatological basemaps accounts for the spatial variations that occur in large area storms. These are applied in the regionalization of NOAA Atlas 14. The GTF process simply calculated the difference in precipitation frequency depths at the storm center location and each grid location. This ratio is then applied to the entire DAD matrix of values and therefore the rarity of the overall spatial variations associated with individual events is captured.

In Section 7.1.2.5, in regard to double counting of OTF and MTF, it is noted that several recent studies completed subsequent to the studies reviewed in this NUREG/KM have explicitly evaluated this aspect and demonstrated that the MTF is captured within the GTF process

On top of page 8-3, 2nd bullet, since the "10" storms threshold is arbitrary and would vary by location, basin size, storm type(s), etc., it is suggested that if at least 10 storms are not used, a detailed justification for a more limited number of storms should be included in the development of the SSPMP.

On Page 9-3, 2nd paragraph, recommend adding to the paragraph that the gridded PMP approach produces a default spatial pattern that closely follows precipitation frequency patterns thereby following the approaches recommended in HMRs 55A, 57, and 59.

In the Section 9.1.1 spatial distribution discussion, it is important to take into consideration the effects of topography on rainfall accumulation patterns. HMR 52 patterns are not meteorological possible in regions effected by terrain and should not be used in those regions. This was recognized by the author's of HMR 52 and noted in the stippled region discussions, TVA HMRs, and HMRs west of 105th meridian. Many recent studies have utilized storm specific patterns, controlling storm patterns, synthetic patterns, and Huff curve methods for 10th, 50th, and 90th percentiles.

On page 10-1, 3rd paragraph, 3rd sentence, the reference to "heavy precipitation events" is not specific to PMP, but to 10-, 25-, 50-, and 100-year level recurrence intervals. The term "heavy' should be explicitly defined as PMP is very different and will likely have very different outcomes versus other recurrence intervals and precipitation types.

General Comment on Chapter 10: Research regarding extreme precipitation varies significantly depending on the duration, recurrence interval, storm type, and geographic location. Several studies have shown that PMP level rainfall may not increase or even decrease depending on the combination of atmospheric dynamics, moisture inflow, and thermodynamic gradients that all combine to produce PMP type rainfalls. The simple assumption that warmer temperatures produce a higher holding capacity of moisture in the air does is correct, but does not mean that the most extreme rainfall events will increase in number of occurrence and/or amounts. It may mean that more rainfall accumulates overall or in more frequent lesser intensity events but that the atmospheric dynamics that must combine to produce the most extreme events are lessened. Precipitation projections in the suite of GCM and regional downscaled models is the most variable and unpredictable of all the parameters. Site-specific climate change evaluations and application of climate change projections completed by AWA have resulted in both increases and decreases in PMP estimates. In addition, it is also important to note the changing seasonality in relation to potential timing of occurrence of PMP type events, amount of snowpack accumulation, and timing of runoff and how each of those are combined may change.