APPENDIX

FERC Risk Informed Decision Making (RIDM) - Regulations, Guidelines and Manuals

FEMA Federal Guidelines for Dam Safety

FEMA Testing and Reporting on Spillway Gate Operations, Annual Spillway Gate Operation Certificate. [Note: FEMA requires annual or regular testing of Spillway gates. It defines Auxiliary and Emergency Spillways, but does not directly address testing them.]

FEMA Glossary Federal Guidelines for Emergency Action Planning for Dams III-3

> "Probable Maximum Flood (PMF): Flood that may be expected from the **most severe combination of critical meteorological and hydrologic conditions that is reasonably possible** in the drainage basin under study."

Will authorities interpret "Probable Maximum Flood (PMF)" (or upgrade practice) to explicitly include the full climate persistence of Hurst-Kolmogorov dynamics, the "Pineapple Express" with sequential atmospheric rivers, and triple threat "perfect storms" from concurrent cyclones stopped by weather fronts and thunderstorms?

In "Table D-1: Sample Guidance for Determining Emergency Level" p D-1 FEMA only once mentions "auxiliary spillway" and then only for a "non-failure" situation of:

"Reservoir water surface elevation **at auxiliary spillway crest** or spillway is **flowing with no active erosion"**. However, the Oroville Dam auxiliary ("emergency") spillway apparently reached the condition of: "Spillway flowing with an advancing headcut that is threatening the control
section" leading to "Imminent Failure". Why had the Oroville auxiliary ("emergency") spillway not been tested before under safe conditions?

FEMA (64) **Federal Guidelines for Dam Safety**: Emergency Action Planning for Dams. FEMA 64/July 2013. bit.ly/2lmgbKf

FEMA (P-94) (2015) guidelines on "Selecting and Accommodating Inflow Design Floods" for Dam Safety addresses: "2.3.7. Potential Impacts of Climate Change on Estimates of Probable Maximum Precipitation" (p20-21). FEMA 94 observes:

> "The climate models are consistent in showing increases of 10 percent every few decades that would correspond to 10 percent increases in PMP. . . . While research is occurring in this domain, no generally accepted methodology currently exists to evaluate the effect of climate change on flood frequencies or extreme precipitation depths. Until such methodologies are identified, **extreme precipitation should be evaluated in a conservative yet realistic manner**. In addition, **flood frequency and PMP estimates should be updated frequently as additional information becomes available such as after the occurrence of a very large precipitation event** or when new advances on climate modeling become available (CDA, 2007). **All such new modeling/methods should be thoroughly documented and justified**."

Yet remarkably, FEMA (94) makes no mention of California's seven megafloods in the last 1800 years nor of sequential "atmospheric rivers". Nor does it mention either of "Hurst", "Kolmogorov", nor "Persistence", nor of the extensive work by D. Koutsoyiannis on such hydrological statistics. Has FEMA really incorporated the full range of natural climate persistence, including California's megafloods with ~270 year return?