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PWROG Severe Accident Activities

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Purpose

- Status of PWROG SAMG and Severe Accident Studies
 - Enhanced PWROG SAMGs issued in 2016
 - PWROG SAMG Maintenance Program Established
 - SAMG Strategy MAAP5 analyses
 - SAMG Setpoint and Computational Aid Software
- Highest Priority Severe Accident Items of Interest for the PWROG
 - Reducing Conservatism in SAMG
 - Treatment of Combustible Gasses
 - Containment Vent Performance
 - Improved Venting Guidance
 - Containment Penetration Performance

PWROG Severe Accident Activities

PWROG SAMG

- The Enhanced PWROG SAMG was issued in February 2016
 - SRM-SECY-15-0065: Commission directed NRC staff to update ROP for SAMGs Implementation oversight
 - Used insights from ongoing US DOE led Fukushima forensics program
 - All utilities committed to upgrading to the PWROG SAMG within 2 refueling outages or 3 years, whichever is greater
 - Clock started in Feb. 2016
 - Consistent with NSIAC Letter (ML15335A442)
 - All utility commitment letters are listed in ML16032A029

PWROG SAMG Maintenance Program

- The PWROG SAMG Maintenance Program started in August 2016
 - Purpose: To receive, evaluate, categorize, and disposition SAMG feedback to support docketed NRC commitment of site implementation of SAMG
 - US DOE led Fukushima forensics program will provide insights for improvements including hydrogen generation, core melt progression, AFW Pump survivability
 - All members encouraged to provide feedback
 - Feedback can be suggested improvements, recommended technical changes, requests for more information, etc...
 - Core Group of Members to review feedback, prioritize responses, and endorse consensus responses

Enhanced SAMG Technical Bases

- PWROG-16005-P resolved several open items with respect to SAMG strategy technical bases
 - Combustible Gas Management
 - Minor modification to hydrogen assessment for Ice Condenser Containments
 - Containment Hydrogen Flammability calculations should remove the 10 psig containment pressure margin
 - Treatment of Core Concrete Interaction (CCI)
 - Estimates for moles of CO and CO₂ generated during CCI for 3 different concrete types
 - CO can be used as alternate means of CCI detection – recommend adding to Instrumentation Technical Support Guidance (TSG)
 - Guidance for Venting Containment
 - Setpoint to start vent preparation activities (5 psi less than the median 5% containment failure pressure)
 - Setpoint to open the containment vent (median 5% containment failure pressure)
 - A note or caution should be added to Main Control Room Guideline to work with other support organizations prior to venting containment
- Further research in these areas will greatly benefit the PWROG SAMG Strategies

SAMG Setpoint & CA Software

- Development of SAMG Engineering Calculation Utility Software (SECURE)
 - Software to automate calculation of SAMG setpoints and Computational Aids
 - Inclusion of an estimated steam inert containment pressure setpoint for ice condenser containments
 - Limited applicability – may not be possible for some plants
 - Dramatic Improvements to the Hydrogen CA (CA-3)
 - Use of generic CO and CO₂ estimates applied as a function of core thermal power and concrete type
 - Software coding to resolve non-converging solutions
 - Automatic shading of challenge regions

Potential Future Severe Accident Studies

Conservatism in SAMGs

- SAMGs are intended to be based on best-estimate analyses
 - Allows for a realistic prioritization of recovery actions and mitigation strategies
- Current guidance for containment venting contains some conservatism
 - Overly conservative containment venting criteria may result in large offsite releases earlier than is absolutely necessary
 - Containments without hardened vents may compromise their ability to reclose if operated
- If additional conservatisms were removed, venting may be less likely to be needed to manage combustible gasses (for example)
 - Delay venting as long as possible to minimize releases

Conservative Treatment of Combustible Gasses in SAMG

- Conservatisms in management of combustible gasses include:
 - Conservative treatment of CO in Burn Estimates
 - Complete data on the combustion characteristics of CO-H₂-H₂O-CO₂-air mixtures is relatively scant
 - Burn efficiency for lower hydrogen concentrations
 - SAMGs currently assume complete combustion
 - Conservative binning of expected Zr oxidation
 - Assumed 50% baseline, 75% if RCS injection is recovered, 100% if CCI is occurring

Containment Vent Performance

- Potential negative consequences of containment venting strategies for PWRs without hardened containment vents
 - Combustible gas ignition if steam condenses in vent path
 - Leakage of fission products or combustible gasses from the vent line
 - Failure of vent valve to close due to extreme conditions
- Additional studies that assess the ability of non-hardened vents to function during a severe accident are needed to increase confidence in venting strategies

Improved SAMG Venting Guidance

- Emergency Planning and Ultimate Decision Maker containment venting guidance
 - Tools or guidance to help optimize containment venting strategies
 - Timing
 - Nuclear decay, Fission product deposition, release energies, evacuation status
 - Duration
 - One large release (50% is the current recommendation)
 - Containment failure margin

Containment Penetration Performance

- SAMGs include treatment of fission products and combustible gasses that may have propagated into buildings adjacent to containment
 - This may complicate power restoration and which components can be restarted
- Performance of containment penetrations at elevated temperatures and pressures
 - Impact of ageing and in-service degradation
 - Likelihood of fission product leakage or combustible gas propagation
 - Impact of accident time

Conclusion

- The PWROG has developed SAMGs that are based on the current state of knowledge
 - US DOE led Fukushima forensics program
 - EPRI Technical Basis Report
 - PWROG SAMG Extended Technical Basis
 - PWROG-16005-P
- Containment venting and combustible gas management is an area where current strategies could be improved
 - Additional analysis
 - Experimental testing



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