PWROG

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PWROG Severe Accident Activities

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March 15, 2018

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 Conservatisms 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 CO_2 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 CO_2 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

Conservatisms 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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