IAEA Workshop on the Development of Severe Accident Management Guidelines Using the IAEA's SAMG Development Toolkit

Lecture 12

Practical examples of SAMG from BWR-OG

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Practical examples of SAMG from BWR-OG

Laguna Verde NPP

- BWR/5 Mark II containment
  - 810 MWe after EPU
  - UHS Gulf of Mexico
  - GE design, Ebasco A&E
  - Utility: CFE State owned
- Regulatory framework
  - Country of origin "licensable"
    - After local regulatory endorsement
  - Follow international best practices
    - Expose to WANO, OSART evaluation

Laguna Verde NPP

- EOPs based on BWROG EPGs
  - since commercial operation
  - last updated 2016,
    - Rev. 3 + post-Fukushima approved EPG changes

- Implementing BWROG SAGs
  - development included generic changes as they were approved
    - significant EPC post-Fukushima activity from NRC orders
  - training to be completed by mid 2018

- Attending BWR-EPC
  - regularly since December 2012

BWROG EPG/SAG scope

- Any mechanistically possible scenario
    - No cutoff for low-probability scenarios
    - Not limited to or focused on dominant PRA sequences

    – Still, plants may consider:
        - "Stylized scenarios" for regulatory compliance
        - Training in dominant PRA scenarios to assure credited actions are covered

BWROG EPG/SAG approach

- "Symptomatic" means
  - A set of critical process variables
  - Action levels for each variable
  - Control each variable independently
    - "Overrides" to coordinate two or more variables
- This allows
  - Flowcharted procedures
  - No initiator diagnosis: Same procedure for all
    - "Contingencies" to cover certain degraded conditions

BWR vs. PWR
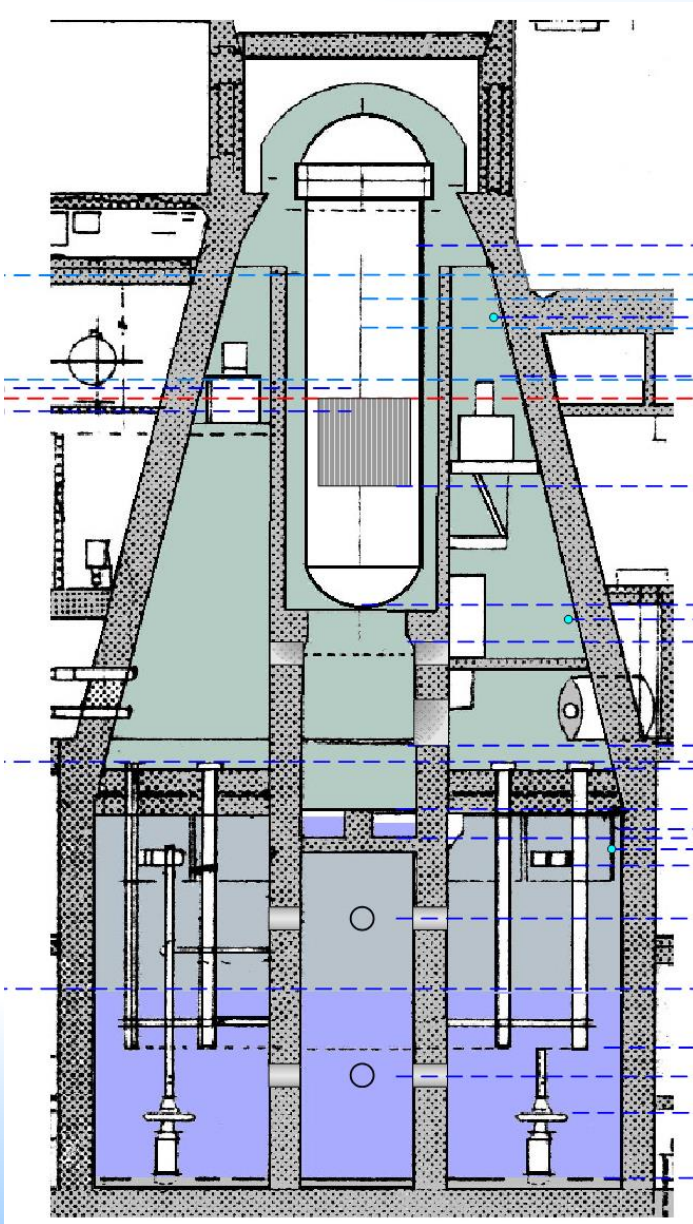
Fundamental differences BWR vs. PWR

– Boiling is part of its nature
  - Originally designed to be depressurized, fast
– Simpler reactor control:
  - Only one container to take care
– More complex containment control
    – Except for inerted atmosphere
  - Two compartments
    – each with its own variables
    – plus secondary containment
  - Large heat sink inside
  - Fission product scrubbing for containment venting

BWROG EPG/SAG approach

- Critical process variables (examples)
  - Reactor Control: Level, Pressure, Power
    - No temperature needed, should always be $T_{SAT}(P_{RX})$
  - Containment Control: Level, Pressure, Temperature
    - For each compartment, initially subcooled
  - Typically, one entry condition for each variable

- EOP action levels, lead to:
  - Attempt normal and preferred systems first
  - Use less desirable actions and systems
  - Or else
    - Take rector to lowest energy state
    - Maintain containment within limits

Transfer to SAMG

- Preferred path
  - Reaching the last reactor level control step w/o success
    - With some judgment allowance
- Alternate path (catch all)
  - "Core damage is occurring" override
    - First of several S/A determinations
    - Note: No core exit thermocouples in BWRs

➔ Once entering SAMG
  - Discontinue all EOPs
  - Enter all SAMGs

Transfer to SAMG

- Laguna Verde SAMG placement rules
  - Interim ERO will enter SAMGs
    - Probably little else to do w/o full ERO support
    - Needed for timely S/A anticipatory actions
      - Local actions in reactor building
  - TSC takes command and control
    - TSC evaluators ready to recommend SAMG actions
    - Turnover to Emergency Director completed

LV SAMG structure

- Two flow charts
  – Reactor control
  – Containment control

- Two "dynamic" strategies
    • Reactor injection control
    • Containment hydrogen control

  – Flowchart insert for selected strategy

S/A Reactor Control

S/A Containment Control

Reactor Injection Control

- Will always want water in the reactor
  - Questions are
    - How much
    - Which injection point
    - Can I use it for something else

- Reactor injection → Central role
  - Specify injection objective and priorities
  - Control others consistently
    - Likely want to spray containment (inerted)
    - Always want to minimize release
    - Always need to watch for spent fuel pool
  - → Answers depend on S/A progression stage

Reactor Injection Control

- Flowchart insert (sample, out of 5)

Reactor Injection Control

- Example:
  ## SAWA/SAWM strategy NRC Order 13-109
    - Vessel breached, no UHS

  – Objectives:
    – quench core debris
    – preserve WW vent path, until reliable UHS (7 days)

  – Too much water
    - Exceed vent capacity
    - Disable wetwell vent path

  – Too little water
    - Allow CCI
    - Compromise SP scrubbing

  – . . .

Reactor Injection Control

- Example:
  ## SAWA/SAWM strategy NRC Order 13-109
  - Vessel breached, no UHS

  – . . .

  – Coordination
  - Containment sprays: internal and external sources
  - Containment venting: pump capacity and containment challenge
  - Spent fuel pool makeup

  – How to choose?
  ➔ Tech Support Guidelines (TSG)

  – Are we succeeding?
  ➔ Tech Support Guidelines (TSG)

Final remarks

- Full benefit from EPG/SAG
  - Only through committee participation
  - Reading Bases is not enough

  – Example: A need to deviate from EPG/SAG
    - Bring to BWROG-EPC for discussion (S/A program reqd.)
    - Possible outcomes:
      – Issue was resolved years ago
        » may be warranted or not
      – New issue applies to other plants too
        » will be resolved, eliminating the deviation
      – Plant specific issue
        » provides justification to deviate

BWROG EPG/SAG

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End of Lecture 12
Practical examples of SAMG from BWR-OG