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Current Activities with the MELCOR Code in CSN

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- Background
- Licensing activities with MELCOR: PAR's and FCVS
- BSAF activities
- Expanding the number of Spanish MELCOR users

3 Background

- CSN has been using MELCOR for NPPs safety analyses since the end of 90s
- Main plant application activities:
    - Independent evaluation of PSA-2 analyses
    - Studies on local hydrogen accumulations
    - Feasibility of external vessel cooling for some Spanish NPPs

4 Background: technical agreements with Ciemat

- Presently, CSN use of MELCOR heavily based on Ciemat by technical agreements
- First Agreement (2009 - 2013) required
  - Enhance the ability to use SA codes (MELCOR)
  - Improve MELCOR phenomenological models
  - Accomplish for plant specific applications

5 Background: technical agreements with Ciemat

- Very positive results from this first agreement:
  - Very active participation in Sandia Fuel Project (2009-2013)
    - Wide use of MELCOR for BWR and PWR experiments
  - ARTIST-2 project, development of the ARI3SG model for FP retention close the break point
  - A SGTR sequence for a Spanish PWR was successfully run with MELCOR 1.8.6 to find out the efficiency of ARI3SG

6 Technical agreements with Ciemat

- Second Agreement (2014-2017) requires:
  - To provide technical support to CSN in licensing activities
  - To improve the expertise in the use of severe accidents codes, especially MELCOR
  - To obtain a comprehensive knowledge about Fukushima accidents

LICENSING ACTIVITIES

SUPPORTED BY MELCOR

8 Licensing activities. Overview

- MELCOR widely used as technical support tool for licensing activities in these two safety issues:
    - Installation of PARs in W_PWR
    - Installation of Filtered Containment Venting (FCVS)
- Ciemat performs the calculations under specifications of CSN

9 PARs implementation

- Implementation scheduled by 2016 and 2017
- A typical 3-loops W_PWR with large dry containment modeled with MELCOR
- SOARCA recommendations for modeling considered
- Four scenarios analyzed:
  - SBLOCA-3. 2” break in the cold leg, Fans on, dry cavity
  - SBLOCA-4. 2” break in the cold leg, Sprays on, wet cavity
  - SBO
  - LBLOCA. Hot leg break, AFW off, IS off, Sprays on, Fans on, dry cavity. Calculations in progress

10 PARs implementation

- Main safety insights:
  - Number of PARs needed to prevent flammable gas combustion
  - Impact of spray activation in SBO:
    - Spray activation time
    - Spray Operational conditions: flow rate, etc.
  - Concrete composition

11 PARs implementation

- Main safety insights (cont.):
  - Effect of water in the cavity
  - RPV reflooding
  - Sensitivity to in-vessel oxidation
  - Impact of number of containment nodes in the modelling

12 Licensing activities. FCVS implementation

- Implementation scheduled by 2016 and 2017
- TH and Source term calculations planned
- Plant modelling based on the analyses for PARs
- Scenarios analyzed:
  - SBO
  - SBLOCA-4: 2” break, sprays on, wet cavity. Calculations in progress

13 FCVS implementation

- Preliminary calculations provide insights in the TH area:
  - P and T evolution in containment
  - Pressure loss in pipes
  - Effect of different vent opening and close pressure
  - Mass and energy removed from the containment
  - Impact of the presence of water in the cavity
- Source term calculations are planned for the near future

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BSAF 1 & 2

Benchmark on Severe Accident Fukushima

15 BSAF 1 & 2. Overview

- CSN has been participating in BSAF with technical support from Ciemat since the onset of the project
- MELCOR code extensively used for modeling Units 1 to 3 in BSAF-1
- BSAF-2 participation focused on Unit 1 only, including radiological impact
- MELCOR and MACCS are being used in BSAF-2

BSAF 1. Main lessons learned

- Severe accident analyses insights:
  - Main sources of uncertainties:
    - Plant description
    - Modelling of phenomena
    - Boundary conditions

BSAF 1. Main lessons learned

- Severe accident analyses insights (cont.):
- Safety systems performance:
  - Potential for rather unpredictable deviations from nominal conditions
  - Performance modelling under off-nominal conditions might result essential
- RPV and/or primary containment leaking and combustible gases release/transport highly uncertain
- Suitable meshing of wetwell is important: thermal stratification cannot be ruled out in the scenario
- Lack of data recorded resulted in very different sets of sensible approximations and hypothesis matching the scenario

BSAF 1. Main lessons learned

- MELCOR modelling:
  - MELCOR best practices guidelines by SOARCA were followed as far as possible
  - Flow paths with 2 phase flow: drift flux model provided good results
  - Suitable use of MELCOR capabilities for cavity modelling and melt spreading
  - The time step can affect notably MELCOR results
  - MELCOR results carefully scrutinized to ensure consistency

BSAF-2. Outline of MELCOR challenges

- BSAF-2 provides new challenges for MELCOR modelling:
  - Expand the time encompassed by the calculations: up to 21 days
  - Activation of the RN package
    - 17 RN classes
    - Iodine pool model: not activated
    - Pool Scrubbing based on SPARC 90

BSAF-2. Outline of MELCOR challenges

- BSAF-2 new challenges (cont.)
  - Biological shield in drywell modelled
  - Modelling of the reactor building
  - Combustible gases generation and transport
  - 2 cavities and corium spreading considered
  - New water injection models and new failures considered

More Spanish MELCOR users

New Spanish users of the MELCOR code

- The number of Spanish users of MELCOR is increasing
- Both, Spanish universities and private companies are becoming new MELCOR users
- Based on the policy followed in CAMP project, CSN is planning to sign technical agreements with new Spanish MELCOR users
- Main goal: to obtain additional MELCOR calculations
- Two technical agreements has just been signed

Thank you for your attention!!