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#### Wetwell Modeling Nodalization Study and SNAP Post Processing Jesse Phillips

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## Outline



- BWR Mk I Wetwell
  - Evaluate modeling practices
    - Single CV representation
    - Multiple CV representation (16 CVs)
      - Modified version investigated
    - Near/Far Field (2 CV representation)
      - Two flow path natural circulation flow
- SNAP Post Processing
  - Example videos
  - Using Python scripts for post processing calculations

## **Investigating Modeling Practices**



- Purpose
  - Single wetwell volume representations do not determine local saturation conditions well for station blackout accidents
    - How does this impact pressurization response, fission product scrubbing, results... ?
    - Initial investigation of potential modeling avenues compared to available test data
- Relevance
  - Fukushima unit 1 energy removal was almost entirely dependent on the lowest setpoint SRV actuations
    - The result: isolated heating of the suppression pool
      - With power available, operators will cycle SRV operations to promote more uniform suppression pool heat up.
  - Fukushima unit 2 underwent nearly 60 hours of RCIC only operation
  - Fukushima unit 3 underwent 36 hours of RCIC operation and SRV cycling
    - Provides more data to investigate the containment pressure response

#### **BWR Mark I Containment**





## Single Control Volume Model



- Single CV representation is a typical modeling practice for severe accident analyses
  - Attempts to capture curvature (though not relevant for this analysis)
- SPARC90 model activated
  - Steam/Pool interaction
  - RN removal if present
- Losses of SRV line ignored



## Single CV MELCOR Comparison





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## **16 CV Model Depiction**



- Inertial and friction length – wetwell torus segment lengths
- Flow area internal cross-sectional area (torus minor diameter)



#### 16 CV Results





#### 16 CV Results







#### Results

- A single flowpath connecting two CVs supports only unidirectional pool water transport
  - Does not permit natural circulation determination of any kind
- Difficult to determine appropriate losses between pool segments
- No enhanced circulation by plume
- Instability enforced circulation observed
- No point comparing these results with data

## 16 CV Modified Model Depiction

- Inertial and friction length – set to a "small" length (0.01m)
  - Reduces multiphase shear effects, permits higher fluid acceleration





#### **16 CV Modified Results**





#### **16 CV Modified Results**





## **Comparison With Data**





## Two CV Model (WIP)



- This configuration should permit a "more" straight forward model for enforcing appropriate mixing
  - Attempts to capture near field and far field effects
  - 2x multiplier on FL area (to account for both sides and remove numerical error (round-off) instability oscillations)
- SPARC90
  - No attempt to place stacked cells due to SPARC pool height consideration



#### **Near-Far Field Results**





# N/F Modified



- Two flowpath definition to permit MELCOR the opportunity to determine buoyancy driven natural circulation
  - Same reduced lengths as mentioned prior
  - Radius/2 used to determine
     WW bottom flow area
     (note: Pool level is below the midpoint of the wetwell and no CCF coupling was applied)
     Top FL Region
     Top FL Region
     Bottom Flow

## N/F Modified Results





## N/F Modified Comparison





## N/F Modified Results



- Need to explore dependency on selected flow area
- The increased complexity of two offset flowpaths makes the model more difficult to understand
  - Early over-prediction (under mixing)
  - Later under-prediction (over mixing)
- Appears to produce improvements in the overall predictions with little added modeling effort
- Will likely over predict subcooling and a later containment pressurization breakaway due to local saturation conditions
- May demonstrate issues at saturation due to the rapid level swell when voiding begins to occur

## **Questions and Comments**



Before Moving on to a quick SNAP Tutorial on Python Post Processing

Ref: Cook D.H., "Pressure Suppression Pool Thermal Mixing", NUREG/CR-3471, ORNL/TM-8906, 1984

## **SNAP Post Processing**



- SNAP animations
  - Can utilize raw plot file data or Python Script generated data
- Creating a Python Script in the SNAP animation model
  - Select "Python Data Source" in the navigation tree (see next slide)
  - Click the Edit icon, a red E, next to "Initialization Source"
  - Create desired new "Virtual Channel Names" by clicking on the Add button. The new VCNs will be available as plot element (in place of the "Data Sources" identified in the plot files
    - Specify the source (example is provided)
    - If you wish, specify an initial value (example is provided)
  - Click the Edit icon next to "Transient Source"
    - Create your transient python script
  - Connect new VCN to animation element

## Python Data Source



#### Navigation Tree



## Define Source and Create Channels Editing Initialization Source

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Add Virtual Data Channels

Created Virtual Data Channels 🔨

Define Source ("Master" is named "Data Sources" See Nav. Tree

Initialize Virtual Data Channels

ľ	O Initialization Source		×
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	env_I2_rat		
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## Python Script Calculations Editing Transient Source



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env_Xe_rat		
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#Env Cs		
<pre>value1 = S0("RN1-TOTMAS-2_2") # Class 2 radioactive mass</pre>		for use in
value2 = S0("CFVALU_9000") # CF calculating mass released to environment		
value4 = S0("RN1-TOTMAS-2_16") # Class 16 radioactive mass		animation
value6 = S0("RN1-TOTMAS-2 17") # Class 17 radioactive mase		animation
value5 = (value1 + (0.5116 * value4) + (0.7348 + value6)) # Decompose Classes	into Radioactive Cs Ma	ass Only
if (abs(value2) < 1.0e-7):		-
setChannel("env Cs rat", value2) # if Cs in environment is small return sm	all value	
value3 - (value2/value5) # Fraction of release material in environment		
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## Linking Animation Element with Python Virtual Channel



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## Linking Animation Element with Python Virtual Channel

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#### Questions

