MUSA – WP4 Second Intermediate Reporting 09/04/2021

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GENERAL INFORMATION

- **Organization: University of Pisa**
- **Contact person(s)/author(s): Sandro Paci, Michela Angelucci**
- **Severe accident code and version: MELCOR 2.2 v. 18019**
- **Uncertainty Tool and version: Dakota through SNAP env.**
- **Computing environment (hardware):**
  - Operative systems: Windows 10 Pro / Windows Server 2019 Datacenter
  - RAM: 16 GB / 64 GB
  - CPU characteristics: i9-10885H CPU / Xeon Gold 5218

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DESCRIPTION OF THE REFERENCE CASE

- **Description of the reference case**
  - SNL Nodalization with few changes:
    - Core power – MUSA spec.
    - Tmelt (UO2-INT and ZRO2-INT)
    - COR_CR activated
    - Deposition Surfaces in containment
    - RN1 Default v2.*
    - MACCS features

Reference: mainly "*MELCOR Best Practices as Applied in the State-of-the-Art Reactor Consequence Analyses (SOARCA) Project*"

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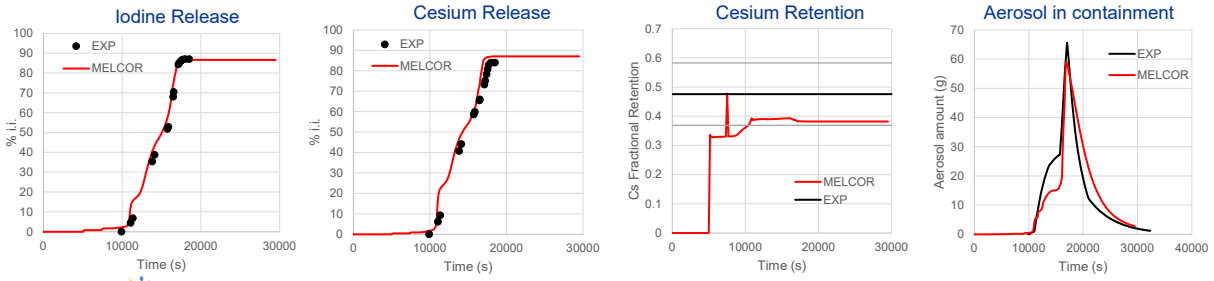
DESCRIPTION OF THE REFERENCE CASE

Table : List of FOMs selected by the Partner for the WP4 FPT1 exercise

e.g.	PARAMETER
1	Release of iodine from top of the bundle [% of i.i.]
2	Release of Caesium from top of the bundle [% of i.i.]
3	Caesium retention in the circuit [% of Cs released from the core]
4	Aerosol amount in the containment's atmosphere [g]
5	Total gaseous iodine amount in the containment's atmosphere [g]
6	Total iodine aerosols amount in the containment's atmosphere [g]
7	Total deposited/adsorbed iodine amount in the containment [g]

Figures: Plot of the FOMs



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DEVELOPMENT OF THE SA CODE AND UT COUPLING (AND STATUS)

- As underlined in ENEA presentation, currently the "replacement samples" option is not available when using the SNAP/GUI. Therefore, if one calculation fails, it prevents Uncertainty Analysis finalization:
  - o New Python Directed job-stream feature has been added in SNAP

MELCOR and DAKOTA coupling through SNAP: PYTHON DIRECTED STREAM

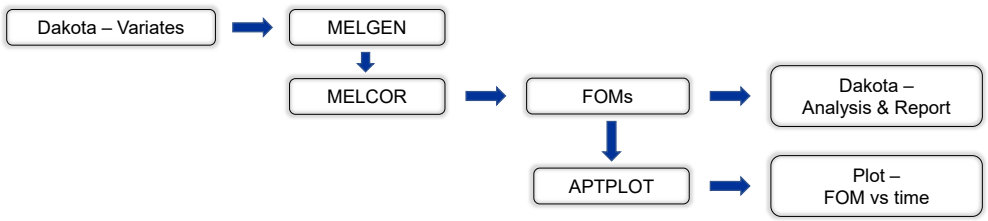

Figure: Sketch of the severe accident code and uncertainty tool calculation scheme

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DEVELOPMENT OF THE SA CODE AND UT COUPLING (AND STATUS)

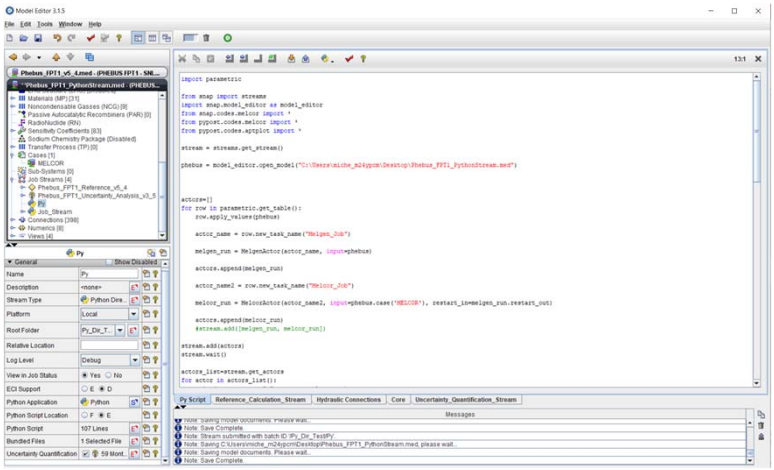

Figure: Sketch of the severe accident code and uncertainty tool calculation scheme

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DESCRIPTION OF INPUT UNCERTAINTY PARAMETERS AND UNCERTAINTY METHODOLOGY

		Reference values	Range of Variation	PDF Type	Note*
1	**CHI** – Aerosol dynamic shape factor	1.0	Min=1.0 Max=5.0	Beta	*As from WP2
2	**GAMMA** – Aerosol agglomeration shape factor	1.0	Min=1.0 Max=5.0	Beta	*As from WP2
3	**FSLIP** – Particle slip coefficient	1.257	Min=1.2 Max=1.3	Beta	*As from WP2
4	**STICK** – Particle sticking coefficient	1.0	Min=0.5 Max=1.0	Beta	*As from WP2
5	**TURBDS** – Turbulence dissipation rate	0.001	Min=0.00075 Max=0.00125	Uniform	*As from WP2
6	**TKGOP** – Ratio of the thermal conductivity of the gas over that for the particle	0.05	Min=0.006 Max=0.06	Log-uniform	*As from WP2
7	**FTHERM** – Thermal accommodation coefficient	2.25	Min=2.0 Max=2.5	Uniform	*As from WP2
8	**DELDIF** – Diffusion boundary layer thickness	1.0e-5	Min=0.000005 Max=0.0002	Uniform	*As from WP2

Table: Partner input uncertainty parameters and PDF

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DESCRIPTION OF INPUT UNCERTAINTY PARAMETERS AND UNCERTAINTY METHODOLOGY

	Partner Choice
Uncertainty Methodology used	probabilistic method to propagate input uncertainty
Method used to define the required number of samples	Wilks formula
Sampling method	Monte Carlo Sampling
Probability and confidence level selected	95%, 95%
Statistical analysis of the FOMs	min value, max value, mean, median standard deviation, cumulative distribution function (CDF), probability density function (PDF)
Sensitivity coefficients to characterize the correlation between the input uncertainty parameters and the FOM	Pearson, Spearman

Table : Partner uncertainty methodology (brief description in a tabular form)

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DEVELOPMENT OF UNCERTAINTY ANALYSIS - FIRST RESULTS

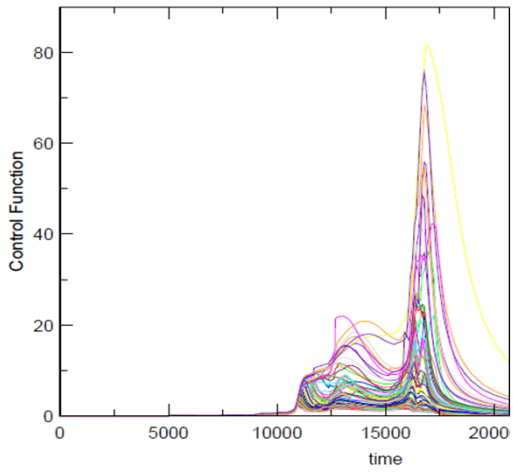

Figure:
Aerosol amount in the containment (g)

First results

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ISSUES TO BE REPORTED

- SNAP (Dakota Uncertainty Plugin - GUI):

  Problems in handling failed MELCOR calculations →

  → ExtractionData & Uncertainty steps fail

- SNAP (Python Directed Stream):
  - script phase seems not user friendly
  - "replacement samples" option: additional samplings created, but failed calculations not re-run
  - stream manager failures when adding jobs to the stream
  - "generate_report" fails

- No problems when running MELCOR/SNAP/DAKOTA in our 32-core virtual machine

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CONCLUSIONS

- Status of the activity:
  - Input Deck check & improvement: DONE
  - Reference case: DONE
  - SA/UT coupling: IN PROGRESS
  - First UA: IN PROGRESS
- Delay if any:
  - Currently no delay related to COVID
- Challenges:
  - Coupling phase not straight-forward
  - Choice of Parameters: few data available – human error
- Additional remarks:
  - Need of clarifications on the implementation of "replacement samples" in the SNAP environment

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