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End User Group requests

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Summary

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D1.5 – End User Group Requests

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Summary

The present Deliverable D1.5 is a synthesis of the MUSA End Users Group input given in the kick-off meeting, which took place in 10-12 of July 2019, and in a survey, which circulated in March 2020. The main points addressed concern:

- Enhancement of outcomes value
- Relevance of potential outcomes.
- Sequence selection in WP5
- Exploitation of results.
- Communication and dissemination.
- Shortcomings of MUSA outcomes.

Content

1 Introduction

The Management and Uncertainties of Severe Accident (MUSA) project was launched under the frame of EC H2020 on June 1st, 2019. According to the project structure, the Executive Board (ExB) of the project (i.e., the project coordinator and the WP (Work Package) leaders, supported by the PMO) will work in collaboration with the End User Group (EUG), which consists of eight representatives of national and international organizations. Table I shows the specific composition of EUG. Their main purpose is to enhance as much as possible the use of MUSA outcomes in the nuclear community, particularly the one involved in nuclear safety assessments. In order to articulate the feedback from EUG, in addition to attending General Assembly (GA) annual meetings, specific surveys might be circulated to collect their views on specific matters related to the project.

Organisation name	Acronym	Type
Tokyo Electric Power Company Holdings, Inc	TEPCO	Utility
Korean Institute of Nuclear Safety	KINS	Research
National Atomic Energy Agency	PAA	Nuclear Regulation
UJV group	UJV	Research
European Nuclear Education Network	ENEN	Education Network
AscóVandellós NPPs association	ANAV	NPP Operator
Emergency Preparedness & Response	EP&R	TSO
R P Safety Consulting Ltd.	RPSC	SAM community

Table 1: Composition of MUSA End-User Group

The present document (Deliverable D1.5) is a synthesis of the EUG input given in the kick-off meeting, which took place in 10-12 of July 2019, and in a survey, which circulated in March 2020. The main points addressed concern:

- Enhancement of outcomes value
- Relevance of potential outcomes.
- Sequence selection in WP5
- Exploitation of results.

- Communication and dissemination.
- Shortcomings of MUSA outcomes.

2 Enhancement of outcome value

MUSA is focused on predicting the source term (fission product releases to the environment). Nonetheless, the uncertainties affecting ST are often not directly related to "fission product" inputs to the predictive models (for example, thermal hydraulic behavior and creep rupture can have a huge effect). It should be ensured that when identifying sources of uncertainty, all sources are considered, not just those directly affecting specific behavior of fission products. It would be relevant to gain any knowledge on the impact of actions to manage the scenario, for example: consequences of injecting water in reactor, cavity or containments, right timing (in case this is so) for venting containments through a FCVS. Additionally, if shutdown scenarios were addressed, they would give good insights into an area where technical bases for management are not so robust, as in reactor operation mode.

A concise report – in a "digestive" form – could be written and handed to utilities, vendors, research center, universities TSOs and regulatory bodies – briefly all entities using computational codes to simulate SAs. In addition, a practical "handbook" with best-practices for uncertainty quantification (i.e., a structured guidance) could be envisaged, which would be available to a broader scientific public. It is of utmost relevance that a sound discussion of advantages/disadvantages of the methodologies applied is reported and, as a result, one or several procedures are eventually recommended.

The best use of previously related projects, like SOARCA and the OECD/BSAF, would be very beneficial to strengthen and streamline the orientation of MUSA. Additionally, a peer review of MUSA outcomes by experts involved in those projects is highly recommended.

3 Relevance of potential outcomes

The EUG, as well as the AB, was given a short-list potential outcomes to rank from 1 (top-high) to 5 (bottom-low): enhancement/adaptation of UaSA methodologies to SA analysis; systematic application of UQ to SA analysis; characterization of input deck uncertainties; insights into Source Term uncertainties (uncertainty bands & governing factors); identification of remaining issues worth further investigation. As a result of the ranking received (5 respect to 8 EUG members), the order from most to less important has been settled to be:

	EUG1	EUG2	EUG3	EUG34	EUG5	Avg
Insights into ST uncertainties	1	3	1	4	1	2.0
Characterization of input deck uncertainties	4	4	2	2	5	3.4
Systematic application of UQ to SA analysis	3	1	3	1	2	2.0
Enhancement/adaptation of UaSA methodologies	2	2	5	3	4	3.2
Identification of remaining ST issues	5	5	4	5	3	4.4

Table 2: Ranking of potential outcomes by EUG members

- The feedback from EUG members provide clear insights into which MUSA outcomes they value most. There are two out of 5 outcomes set that they consider of higher relevance. They are closely related with practical application of the MUSA results, as it should be expected given the nature of EUG members: systematic application of UQ and insights into ST uncertainties.
- There is a mid-relevance group which is related with intermediate and necessary steps when doing a BEPU analysis: enhancement/adaptation of UaSA methodologies and characterization of input deck uncertainties.

- The less relevant outcome from people who are supposed to use the MUSA results is the identification of ST issues worth further investigating. This insight fits with the composition of the EUG, as said above; further investigation is not what their activities are focused on.

Despite the consistency of the conclusions drawn from Table 2, the credit to be given should always consider the small size of the survey sample.

4 Sequence selection in WP5

In selecting accident sequences, consideration of external event / common cause situations, and careful consideration of the impact and timing of mitigative human actions following core damage (per SAMG), is highly recommended. Beyond any doubt, picking "risk-dominant" sequences is considered essential. From the probabilistic point of view, the clearly dominant sequence is an SBO. Though, in order not to be too much unrealistic (as it could be seen during the Fukushima accident sequence, where some mitigative measures could be taken anyway), it is proposed not to consider a completely unmitigated scenario. For instance, late core flooding could be undertaken, or ex-vessel corium flooding could be considered. LOCA and SGTR scenarios might also be of interest, but given that SA mitigation is symptom-based what is really important is to address sequences with ex-vessel phases in which a water injection into cavity and Filtered opening impacts can be explored.

In WP6, related to UQ and Innovative Management of SFP Accidents, the low decay heat stored and the considerable inventory of coolant suggests considering sequences with no fuel damage and with particular emphasis on SAMGs to prevent accident progression. Among the sequences of most interest in countries like South Korea for PWR reactors are loss of cooling (LOCA) and loss of pool inventory (LOPI), both in normal operation and during refueling.

5 Exploitation of results

Given the extensive use of EPRI/PWROG guidance on SA management in NPPs, the collaboration of EPRI in the project gives a good chance for MUSA results exploitation.

The MUSA results will be very useful for safety analysts, particularly when dealing with Severe Accident Management (SAM). For this reason a "best-practice" handbook dealing with application of UaSA methodologies is highly recommended; inclusion of concrete examples (PWRs, BWRs, VVERs plants; LOCA, SBO, SGTR sequences) of how to run a SA analysis and how to quantify uncertainties would be very practical. Standard input decks for different codes and plants would be certainly helpful for end-users.

Insights from MUSA would be very helpful for reviewing AM programs and, potentially, in developing and optimizing SAM strategies, particularly on aspects concerning human actions on existing, recovered or dedicated equipment. In this regard, functional requirements for mitigation systems (such as filtered vents, hydrogen control, etc.) might be developed based on both best estimate and the associated uncertainties. Some MUSA results might be included in "internal regulations" that could help in discussions with NPP designers in countries with a developing nuclear programme.

In addition, it is considered that the MUSA adopted methodologies might have the potential to guide BEPU application in severe accident analysis.

6 Enhancement of communication and dissemination

Participation in well-respected fora, conferences and workshops (such as ERMSAR, ICONE, NUTHOS, etc.; but also SA codes users' clubs meetings such as ASTEC, MELCOR, MAAP, COCOSYS, SCDAP-SIM, ATHLET-CD, etc.) sharing MUSA insights as much as feasible. As stated above, a concise handbook/report for downloading from an open web site would be very beneficial for the safety analyst community, particularly when dealing with SAMs. If confidentiality affects some key findings from MUSA, a procedure to set Non-Disclosure Agreements (NDA) with potential end users of MUSA results is highly recommended.

Inclusion of industry organizations into the dissemination plan, as already considered to some extent in the MUSA strategy, would increase both acceptance and “usability” of the results.

7 Shortcomings of MUSA results

A latent risk of MUSA outcomes is that uncertainties in SA analysis are so large that SA analyses are left out discussions with NPP vendors.

A potential shortcoming could be not advertising the outcomes enough, especially at international topical meetings (which is still the place where the SA analysis community meets regularly). Another one might be presenting the MUSA results in a so intricate way, which makes it hard to derive any practical application; thus, it is encouraged that major conclusions are stated in the clearest way possible.

In sight of the still broad uncertainties shown in projects like OECD/BSAF projects despite the safety code evolution in the last 25 years, a question could be raised in the MUSA framework: “are the uncertainty quantification methodology used for DBA analyses also applicable to SA phenomena? Would the MUSA results be applicable to changes in regulation or improvement in nuclear plant safety? These both questions become even more important when aspects like AM are considered in WP5 and WP6”. Keeping these questions in mind might be important along the MUSA project to orient actions and decisions.

8 Final remarks

The discussion presented in the sections above is of utmost significance in MUSA. MUSA is a research project with a very practical and innovative approach of SA analysis. In nuclear safety it should be mandatory to bridge the gap between research and application and bring both sides as close as possible. This was the intention of setting up the EUG body in MUSA and it is the reason why this report will be the basis for key discussions and decisions to be assumed at the right time along MUSA. Among the messages received, some are worth highlighting:

- Concise and clear reporting of MUSA results and methods (“best-practice guides”) should be in MUSA DNA from the start, so that MUSA findings can get properly spread as much as feasible.
- Implications of uncertainties in AM actions and vice versa, is of utmost interest for SAM and might strongly impact some already recommended practices, if suitably supported.
- Practical application of MUSA should be given the maximum priority; finding new ST issues to investigate should in no case be the target of the project, but a complementary outcome that might help to shape up future ST research.
- There exist general consensus that SBO sequences are accident scenarios worth nucleating MUSA partners focus; spread the focus on several scenarios might not be efficient for this phase of application of BEPU in SA analysis.
- Having MUSA partners who has got a close collaboration with PWROG and BWROG might be the best tool to exploit MUSA results, if worthy. This being said, the presence of MUSA project, either as a joint venture or as an individual entity, in open conferences and scientific articles should be pursued.

Annexe

List of Acronym:

AM Accident Management

BEPU Best Estimate Plus Uncertainty

BWR Boiling Water Reactor

BWROG Boiling Water Reactor Owner Group

DBA Design Basis Accident

DNA DeoxyriboNucleid Acid

EUG End Users Group

ExB Executive Board

FCVS Filtered Containment Venting System

GA General Assembly

LOCA Loss of cooling

LOPI Loss of pool inventory

MUSA Management and Uncertainties of Severe Accident

NDA Non Disclosure Agreement

NPP Nuclear Power Plant

PMO Program Management Office

PWR Pressurized Water Reactor

PWROG Pressurized Water Reactor Owner Group

SA Severe Accident

SAM SA Management

SAMG SAM Guideline

SBO Station Black Out

SFP Spent Fuel Pool

SGTR Steam Generator Tube Rupture

ST Source Term

TSO Technical Support Organization

UaSA Uncertainty and Sensitivity Analyses

UQ Uncertainty Quantification

VVER Vodo-Vodyanoi Energetichesky Reaktor (water-water power reactor)

WP Working Package