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Harmonisation of Level 2 PSA Issues: Feasibility study based on hydrogen combustion, consequences of RPV failure, iodine behaviour and molten core concrete interaction

ML Ang[1], B Chaumont[2], E Grindon[1], H Loffler[3], C Spengler[3]

1) AMEC NNC, Knutsford (GB)
2) IRSN, Fonteney-aux-Roses (FR)
3) GRS, Köln (DE)

Summary

In the ERMSAR-05 seminar, activities on the comparison of SARNET partners' methods for Level 2 PSA and the uncertainty assessment were summarised. Following this a more detailed comparison of the treatment of four complex phenomenological issues was conducted to examine the feasibility of achieving some degree of harmonisation in the evaluation of these issues in a Level 2 PSA. The issues selected were: hydrogen combustion, consequences of vessel failure, iodine chemistry and molten core concrete interaction (MCCI).

This paper provides a summary of this comparison exercise and discusses the approach adopted, summarises the comparison of partners' methods, including uncertainty assessment, and presents some recommendations concerning future harmonisation initiatives.

A. INTRODUCTION

In the first phase of SARNET Work Packages 5.1 and 5.2, an understanding was reached regarding the SARNET partners' choices of methodology in their Level 2 PSAs, including the assessment of uncertainties [1]. This detailed comparison has been supplemented by a separate task examining the feasibility and need for the harmonisation of Level 2 practises in EC member states. From these evaluation studies, there is a clear consensus that Level 2 PSA is regarded as having reached an acceptable level of maturity and a general approach has been consistently applied in the PSAs conducted in EC member states. However, given the different national requirements placed on Level 2 PSA, there are appreciable differences in how Level 2 PSAs are conducted in practice in terms of their scope and content. Also, for the detailed evaluation of severe accident phenomena, there is a clear recognition that an agreed and consistent prescription for how analyses should be performed and, in particular, on how uncertainty is accounted for is still lacking.

Following a review of partners' practises and the outcome of recent international workshops, a way forward to achieve greater harmonisation in Level 2 PSA methods may proceed in the following way:

1) Identify the most important issues to be addressed,
2) For each issue, assess how decomposition into key sub-issues can be achieved, given the current knowledge base,
3) For the selected issues, a pragmatic methodology may include the following aspects:

Compile and review what has been done so far and based on this:

- Describe them in a qualitative way addressing the key physical and chemical features,
- Identify what may be regarded as good practice from the review,

- Derive general recommendations and, if possible, quantitative values on how to deal with the problem in a Level 2 PSA,
- Identify how generic, or plant-type specific or plant specific the guidance is,
- Agree on common areas where further research/development activities need to be performed.

An activity was instigated within SARNET to examine the feasibility and applicability of the above framework for achieving harmonisation based on four specific issues: hydrogen combustion, consequences of reactor pressure vessel (RPV) failure, iodine behaviour and MCCI. The overall approach to this study, using the above framework, is as follows:

Step 1: Develop a questionnaire identifying the key issues for partners' consultation.
Step 2: Responses from partners regarding their approaches, methods and rationales for the quantification in their Level 2 PSAs.
Step 3: Collate and extract recommendations/conclusions.
Step 4: Review of summary by partners.

The results of this activity are presented in 4 separate topic reports with the results of Step 3 summarised in a spreadsheet and the partners' individual responses from Step 2 included as appendices in each topic report. Some of the sub-issues identified as important for the consultation are listed in Table I to Table III at the end of this paper. The main emphasis of this study is to identify what is seen as good practice, given the current understanding of the phenomena, in order to achieve a consistent evaluation of particular phenomena in a Level 2 PSA. The comparison of the partners' methods for the different sub-issues led in each case to a set of general recommendations based on the following criteria:

- Seen as good practice and consistent with Level 2 PSA practices (e.g. retained by several partners and/or referenced in well recognized documents such as CSNI state of the art reports),
- Suggest method options when there is no clear endorsement of a single method.

These preliminary findings should provide an input to any future harmonisation initiative, including any development of guidelines. This paper provides a brief summary of the results and findings from this activity.

B. HYDROGEN COMBUSTION

B.1 Evaluation approach

The evaluation of the hydrogen combustion issue was performed by 11 partners under a number of headings, given in Table I, and it examined the partners' approaches on a number of specific issues. They included:

a. General issues defining hydrogen combustion threats to be considered, e.g. phases of accidents, sources of hydrogen production.
b. Distribution of hydrogen within the containment.
c. Ignition conditions, including ignition and flammability limits, ignition sources and locations.
d. Combustion regimes, including the codes/models used for analysis.

e. Ways in which the events are considered in the Accident progression Event Tree (APET).
f. Influence of other APET events on this issue, e.g. effect of spray operation and core reflooding, direct containment heating and filtered containment venting.
g. Ways of uncertainty treatment.
h. Consequences of hydrogen combustion.

B.2 Preliminary Findings

The recommendations include the following:

(1) In and ex-vessel phases should be considered when considering the hydrogen risk in a Level 2 PSA.
(2) All sources of hydrogen generation in severe accident codes should be considered. Main sources are: cladding oxidation, melt oxidation, in-vessel melt coolant interaction, during melt dispersion (direct containment heating and ex-vessel melt coolant interaction), corium oxidation and concrete decomposition (including steel for concrete reinforcement) during MCCI.
(3) Multiple burns are possible during the different phases on the accident. They should be considered in conjunction with ignition conditions.
(4) In case of an early containment bypass, the impact of analysing the hydrogen distribution and combustion is very limited and, if done, may be simplified.
(5) The analysis of mixing mechanisms (condensation, spray and ventilation) and the effect of specific devices (such as rupture disks, flaps) to assess concentration heterogeneity is recommended. Compartments (or rooms) or groups of compartments (or rooms) with the less favorable geometry should be identified and characterised.
(6) The use of categories of hydrogen concentrations alone, as criteria to determine combustion regimes, should be avoided.
(7) Steam inerting (or the use of any specific inerting devices) should be considered.
(8) Severe accident codes such as MELCOR, MAAP or ASTEC (or lumped parameters codes for containment thermal hydraulics) are acceptable codes for supporting studies to assess hydrogen distribution, as the validation basis is regarded as adequate.
(9) Less detailed nodalisation of the containment is generally used when performing hydrogen distribution calculations in support to Level 2 PSA. This may lead to a non conservative assumption about the combustion regime when using concentration criteria and compensation by adapted peaking factors should be considered.
(10) Analysis of recombiner efficiency, using specific models in severe accident codes models or use of simplified validated models, is essential.
(11) Flammability limits (except for specific high temperature or pressure ignition sources) should be based on the Shapiro diagram. Simplifications may nevertheless be used but the conservatism introduced must be recognised.
(12) It is advisable, given the current level of knowledge, to exclude in the derivation of a probability of ignition to include an analysis of the energy necessary for ignition for identified sources of energy (e.g. sparks, hot spots).
(13) Different sources of ignition should be considered to include random sources and continuous sources of ignition. Ignition probability is currently derived using expert judgement.
(14) For large dry and open containment, the ignition location may not be considered as a key parameter for eventual systematic combustion calculations.

(15) The ignition time may be considered as the worst physically possible time for simplified assessment or as part of the assessment of uncertainties.

(16) The different regimes of combustion should be considered, including possibility of deflagration and transition to detonation (DDT).

(17) For low or intermediate hydrogen concentrations (corresponding to rather low flame speed), the combustion is not complete. For those concentrations, it seems reasonable to assess the peak pressure due to combustion on the base of adiabatic isochoric complete combustion (AICC) peak pressure using a corrective factor to take into account combustion incompleteness.

(18) In cases where there is no risk of DDT, demonstrated by the use of sigma criteria, the peak pressure may be assessed on the basis of the AICC peak pressure.

(19) In the case of detailed calculations, a detailed nodalisation of the containment is necessary to correctly assess the flame speed.

In addition, some conclusions on the approaches to derivation of probabilities for APET quantification and the identification of key issues for uncertainty treatment have been included in the topic report (but not included in this paper). It must be pointed out that the proposals for specific recommendations on the hydrogen combustion issue have been possible due to a reasonably well established state of the art on the majority of the identified sub-issues. Some other issues, requiring further consideration, include ignition in the presence of mixtures containing both hydrogen and carbon monoxide.

C. CONSEQUENCES OF RPV FAILURE

C.1 Evaluation Approach

The evaluation of this issue followed a similar approach and was performed by 8 partners under a number of headings, summarised in Table II, including:

a. Conditions of RPV failure (including size and location of vessel breach, conditions of corium discharge to reactor cavity).
b. Vessel rocketing.
c. High Pressure Melt Ejection (HPME) and Direct Containment Heating (DCH).
d. Ex-vessel steam explosion.
e. Specific design features, e.g. cavity door (or door seal) failure.
f. Event tree organisation.
g. Principles of event tree modelling.
h. Uncertainties considered and methods for assessment.

C.2 Preliminary Findings

The comparison of the partners’ methods for the different sub-issues led to a set of general recommendations:

(1) The present state of knowledge does not allow an accurate prediction of the failure size of the reactor vessel. Small size and large size breaches (including circumferential vessel bottom rupture) should be considered.

(2) Central, lateral and circumferential ruptures of the vessel lower head should be considered.

(3) The corium composition and physical state at vessel rupture should be deduced from severe accident code calculations for the different Plant Damage States (PDS).
(4) Vessel lifting at vessel failure, at high or intermediate pressure and for a centrally located hole (due to gases driving forces and reactor pit pressurization), should be assessed. This can be assessed using a simplified modelling approach.
(5) Vessel rocketing consequences on containment structures should be investigated. This may involve using simple models or expert judgment.
(6) For some plant designs, cavity door and door seal failure due to debris heat-up (direct contact, radiative and convective effects) may lead to containment by-pass and should be assessed.
(7) Geometrical details of the cavity and of the connections between the cavity and other compartments are essential to determine the carryover and the trapping fraction of corium entrainment in HPME scenarios and a detailed examination of the design is necessary.
(8) Retention of debris in the different compartments should be assessed. This may involve using simple models or expert judgment and be supplemented by relevant experimental results.
(9) The assessment of particle size from melt fragmentation and the subsequent particle oxidation may also involve using simple models, supported by experimental results.
(10) The modelling approach for the assessment HPME and DCH should be checked against relevant experimental results, based on geometrical features as representative as possible to the reactor design.
(11) Combined effects of DCH and hydrogen combustion should be considered.
(12) Peak pressure analysed for the cavity and/or for the containment should be compared with the cavity and/or containment fragility curves.
(13) In the case of melt ejection outside the reactor cavity, the corium mass available for MCCI should be reduced accordingly.
(14) Given the present state of knowledge (i.e. no coupled calculations considering all the immediate consequences of reactor vessel failure), the different potential consequences of the melt discharge to the reactor cavity may be assessed separately as successive events in the event tree (vessel rocketing, melt dispersal and direct containment heating, cavity failure, ex-vessel steam explosion, containment failure). Care must be taken regarding the dependencies between the different phenomena in the assessment of available corium mass and energy.

In addition, some conclusions have also been included on the approaches to derivation of probabilities for APET quantification and the identification of key issues for uncertainty treatment in the topic report.

D. IODINE BEHAVIOUR

D.1 Evaluation approach

The understanding and modelling of the complex chemical reactions improved considerably in the 1990s and a summary of these developments is presented in [2] and an OECD CSNI report is expected soon [3]. However, the fundamental processes are still regarded as not fully understood and current modelling within Level 2 PSAs is regarded as incomplete and, for some sequences, entailing a high level of uncertainty. The questionnaire identified the key issues and sought to identify the partners' approaches in dealing with some of the sub-issues. At this point it is not useful to present findings on specific sub-issues, as has been done for hydrogen combustion and RPV failure, and a broader view is taken.

D.2 Preliminary Findings

The following is a summary of the current approaches from the 10 organisations responding to the questionnaire:

1. Some partners currently do not address chemistry effects. In some instances this is because there is no requirement for source term information. In some cases qualitative rather than quantitative arguments have been used to justify that volatile iodine forms (inorganic and organic) have a relatively small impact on the overall PSA. However, this may also be attributed to the complexity of the issue and the proprietary nature of the approaches that have been developed, i.e. there is no obvious “off-the-shelf” methodology to adopt.
2. Several partners use global modifying factors based on interpretations of available chemistry data. These modifying factors are applied to the results from integral code analysis. These factors may be defined as an attempt at describing best-estimate behaviour or they may be defined with a bounding or conservative bias. The uncertainties are generally addressed by making reasonably bounding assumptions and/or performing sensitivity studies.
3. The use of stand alone iodine code as an integral part of the PSA is not generally seen as a practical way ahead and simplified models have being developed by several partners. It is not clear whether these models are intended to be fully integrated into PSA methods or used as supporting justification / sensitivity analysis.
4. Where simple or explicit iodine chemistry models are adopted, it is difficult to draw any general conclusions about their completeness and verification without additional information on the analyses, which may be proprietary. However, no one organisation seeks to address all the phenomenological issues. Typically, some boundary conditions are assumed and only a few issues are addressed; however, the subset of issues addressed varies depending on the primary focus of the safety arguments.

There is a general reluctance within the chemistry community to make explicit recommendations for use in plant analyses supporting PSAs. It can also be seen that stand alone iodine chemistry models have not been widely adopted for PSA applications and this is not confined to the experience of the SARTNET partners. It can also be argued that even if such models were readily available, there remains considerable uncertainty in the thermal-hydraulic parameters needed to drive these chemistry models, particularly in the longer timeframe where the uncertainties in the accident progression phenomena further increase.

It is clear that the PSA community recognises the importance of iodine chemistry effects and also that the understanding of the phenomena may be incomplete. This is evident in the current comparison of partner’s approaches. In the short term, it would be useful to document the development status, validation and verification of any chemistry models currently being used for PSA applications. In particular, it should be noted what modelling priorities have been set, what simplifying assumptions are made in setting the initial conditions and what has not been included in the model. Generally, it is seen as important to develop a set of guidelines that the PSA community could adopt to minimise the potential for divergent approaches. Elements that could be considered in developing such guidance include:

(1) Formally establish the set of conditions necessary to justify chemistry effects as of only secondary importance in a Level 2 PSA framework. Given the available knowledge base, certain combinations of containment integrity, pH control and silver scavenging could potentially be identified as conditions sufficient to inhibit significant volatile iodine formation. The best approach for sequences where such conditions can not be met remains uncertain. However, the following elements are suggested:

(2) Establish a framework identifying key influences for the development of a general simple modifying factor approach, e.g. reasonably enveloping assumptions on containment iodine speciation. It is recognised that these key influences may be different for different reactor designs, e.g. not all designs have silver in the control rod matrix.

(3) Understand the limitations of iodine models currently used to support PSA studies, e.g. MELCOR 1.8.5, MAAP4 (with EDF iodine chemistry sub-routine) and simple stand alone models. In particular what simplifying assumptions are made in the initial conditions, what boundary conditions are assumed and, perhaps most importantly, which issues are not addressed in the models.

(4) Evaluate the above to ensure the approaches are not divergent. Perform benchmark analyses and sensitivity studies / uncertainty analyses to understand the implications of adopting iodine chemistry models. It is recognised that chemistry effects would potentially have the greatest impact on late phase source terms, e.g. due to containment venting where the different iodine species will undergo differential filtration. In this regime there are already considerable uncertainties in the integrated plant analysis codes.

Whatever elements are considered, it is essential that any guideline development has significant input from the iodine chemistry community.

E. MOLTEN CORE CONCRETE INTERACTION (MCCI)

E.1 Evaluation Approach

The evaluation of this issue was based on responses by 8 organisations under a number of headings, summarised in Table III. In these the accident sequences were analysed using the integral codes MAAP (4 organisations) and MELCOR (3 organisations). One organisation made use of ESCADRE-ASTEC. When the integral codes' models for MCCI are invoked, the initial conditions and also the boundary conditions depend on:

- the plant / plant type investigated,
- the accident sequence until the start of MCCI, calculated by the models of the integral codes.

Thus, any harmonisation effort depends on some portability of methods and is in general quite difficult. The evaluation of MCCI was performed under a number of headings and examined partners' approaches on a number of specific issues. They included:

a. Differences resulting from different assumptions on boundary and initial conditions:
   - Quenching of the melt by initial water in the cavity,
   - Detailed boundary conditions of integral code,
   - High pressure melt dispersion from the cavity.

b. Differences resulting from model differences in the codes used:
   - Heat fluxes to the concrete/erosion velocity,
   - 2D erosion behaviour and pool configuration,
   - Pool temperature,
   - Water addition on top of the melt.

c. Differences resulting from different assessment of the codes and their uncertainties.

d. Differences resulting from different assessment of experimental work.

e. Differences resulting from different nodalisation and quantification methods in event tree.

For the last three issues, the evaluation examined the partners' approaches to the quantification in the APET nodes on three specific issues:

- Basemat melt-through,
- Effect of water on corium coolability,
- Plant specific vulnerabilities.

E.2 Preliminary Findings

From this evaluation, it is recommended that any harmonisation for the issue of MCCI in PSA studies should focus on generic plant characteristics and phenomena and should aim at a common knowledge base to be applied in the studies. Several points are identified for which attempts on harmonisation seem worthwhile:

(1) The key information for PSA quantification from the MCCI analysis is the time dependant erosion rate. From this information the time of basemat melt-through and the gas release rates contributing to containment pressurisation are deduced. The uncertainty for estimating the erosion depth after ~ 2 days of MCCI taking place in a nuclear power plant is approximately 50 %. Harmonisation may consider any consensus that this uncertainty indeed reflects the state of the art. Similarly, there is a high uncertainty concerning the axial/radial heat flux distribution in homogeneous/stratified conditions and should be given further consideration.

(2) It is recommended to check and improve the MCCI models concerning the 2D erosion behaviour based on qualified experiments performed most recently or in the near future. The validated models should assess their specific uncertainties by a code benchmark for a generic rector calculation.

(3) These uncertainties (erosion velocities, 2D heat flux distribution) should be taken into account for the quantification of probabilities in event tree nodes determining erosion or penetration of concrete. The potential of the models for converging on similar erosion rates in the late phase, which slow down for later times, could be investigated in a code benchmark for a plant calculation case with 'infinite' basemat thickness.

(4) The impact of water (either initial water in the cavity or water injected on the top of the corium pool) is still not sufficiently resolved in the current evaluation approaches. Deterministic models seem unready for direct application in PSA studies and current evaluation is mostly based on expert knowledge or argued qualitatively. Harmonisation on this point is recommended, but may be difficult to achieve.

(5) Boundary and initial conditions for MCCI are generally provided by the integral code results, from the previous phases of the accident. Large effects were attributed to the mass of the melt and the level of decay power at the beginning of MCCI. For evaluations on uncertainty it is important to check if uncertainties having a large impact

on the mass of melt and the start time for MCCI/initial decay power are adequately represented in the integral code runs.

(6) HPME from the cavity to produce DCH is typically taken into account by the 'standard' models for DCH in the integral codes. If there is much dispersion from the cavity, the likelihood for coolability of the melt retained in the cavity will be improved. This, however, increases the threat to the containment integrity by DCH. Based on recent research on DCH the models for estimating melt dispersion from the cavity entail a high degree of uncertainty. Harmonisation consideration should similarly apply to HPME as the threats of DCH/MCCI challenge to different containment boundaries are closely linked. A consensus is needed of how to deal with corium dispersion from the cavity in case of high (but below operating) primary system pressures, e. g. by consideration of plant-specific cut-off pressures or bounding cases of 10 %/100 % of melt retained in the cavity.

(7) The impact of pool temperature on fission product release may have to be examined. In the models the uncertainty range for the pool temperature, which is up to now not regarded as a relevant parameter for APET consideration but important from source term standpoint, is about 500 K.

(8) Plant specific issues cannot be subject to harmonisation. But there should be a consensus that plant specific vulnerabilities, in or near the reactor cavity, have to be identified and evaluated.

F. CONCLUSIONS

The subject of harmonisation of Level 2 PSA practices is a difficult and challenging subject and this is clearly reflected by the conclusions of the recent post FISA symposium workshop on harmonisation of Level 2 PSA in Europe [4]. Within the SARNET project, a feasibility study was conducted to examine how this aspiration of harmonisation may be progressed. The main emphasis in this study is to identify what is seen as good practice, given the current understanding of the phenomena, in order to achieve a consistent evaluation of a particular phenomenon in a Level 2 PSA. A framework has been established to provide a consistent basis for the preparation of a questionnaire for partners' consultation. The evaluation of the partners' responses on the four issues was, however, performed differently. Nonetheless, this preliminary study succeeded in the identification of good practice and in providing some recommendations for harmonisation activities. This approach should provide a template and input for any future EC initiatives on this harmonisation issues. A number of limitations have been identified from the current study and these should be considered further in future studies:

(1) Harmonisation of detailed treatment of individual issues may be hindered due to information accessibility and usage (e.g. use of different severe accident codes, data sources, etc.). Consensus for some severe accident issues has been established in a number of recent international studies (e.g. OECD).

(2) Development of guidance on uncertainty analysis would be desirable, and should incorporate a certain amount of flexibility. Full harmonisation on methods may not be necessary as these methods have their own technical merits.

(3) Severe accident code analysis is a significant and integral part of a Level 2 PSA. For their correct use, it is necessary to have an appreciation of the application limits these codes have, and where code limitations are relevant for the overall PSA.

(4) Expert judgment is needed, but transparency is essential in this context. A prescription on how expert judgment should be used and how limitations are accounted for is currently lacking.

References

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[3] Clement B. et al, ‘Status paper on iodine chemistry’, draft OECD CSNI report.

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Table I Headings for questionnaire responses on Hydrogen Combustion

Generalities	Phases of accident considered	
	Sources of hydrogen	
	Multiple burns	
	Combined effect of CO and H2	
	Hydrogen by pass	
Distribution inside the containment	Zone definition	
	Mixing mechanisms	
	Concentration categories	
	Inerting efficiency	
	Codes/models used for supporting studies	
	Nodalisation used	
	Recombiners efficiency modelling	
Ignition conditions	Flammability limits	
	Energy for ignition	
	Sources of ignition	Igniters
		Electrical sources
		Hot spots
		Recombiners
		Other ignition sources
	Location of ignition	
	Ignition time	
Combustion	Regimes considered	Diffusion burn
		Deflagration (local/global)
		Criteria for flame acceleration
		Transition to detonation
		Criteria for DDT
		Geometrical classes
		Direct detonation
	Completeness of the combustion	
	Codes/models for supporting studies	
	Nodalisation used	
	Local/global loads assessment	
APET events	Spray operating	
	Core reflooding	
	DCH	

APET models	Probabilistic code used
	Principles of APET model for distribution
	Principles of APET model for combustion
Uncertainties considered	Sources of uncertainties (aleatory or epistemic)
	Uncertain parameters
	Distribution functions
Improvements suggested	

Table II Headings for questionnaire responses on consequences of RPV failure

RPV failure	Size of the vessel breach
	Location of vessel breach
	Mass, form (melt, debris), composition (homogeneous, stratified) of corium release to the cavity
Vessel rocketing	Modelling approach
	Hypothesis for loops rupture
	Consequences considered
Cavity door or door sealed failure (VVER design)	Door failure due to debris jet impingement or large molten pool impact
	Failure due to debris heat up during MCCI
	Consequences investigated
Water presence in the cavity	Water level
	Water temperature
	Debris quenching at RPV failure
HPME and DCH	Corium release to the cavity
	Effect of steam discharge
	Corium fragmentation modelling
	Corium oxidation at RPV failure
	Corium trapping and repartition in different containment zones
	Sections obstruction by debris, by isolation material
	Pit failure
	Containment failure
	Containment failure due to pressure wave
	Cumulative effect of DCH and hydrogen burning
	Other consequences considered
Ex vessel steam explosion	Corium release to the cavity
	Premixing phase modelling
	Explosion phase modelling
	Time, location of explosion
	Corium oxidation at RPV failure
	Cavity failure
	Vessel lift
	Containment failure
APET events organisation	
Principles of APET event modelling	
Uncertainties considered	
Method used to assess uncertainties	

Table III Headings for questionnaire responses on MCCI

Plant considered	type

	specific characteristics		
Code used	name/version		
	code validation status		
Sequential phenomena considered	melt release from RPV	corium dispersion from cavity	consideration
			represented by event tree node
			based on code / expert judgement
			main parameters
	melt quenching by initial water pool	steam explosion	consideration
			represented by event tree node
			based on code / expert judgement
			main parameters
		steam spikes	consideration
			represented by event tree node
			based on code / expert judgement
			main parameters
		porous debris bed coolability	consideration
			represented by event tree node
			based on code / expert judgement
			main parameters
	MCCI	water injection to the top of the melt	consideration
			represented by event tree node
			based on code / expert judgement
		containment failure by melt through	consideration
			typical timeframes considered
			represented by event tree node
			based on code / expert judgement
		contribution to overpressurisation failure of the containment	consideration
			represented by event tree node
			based on code / expert judgement
		main input parameters	initial water mass
			melt mass
			melt composition
			melt temperature
			time of RPV failure/decay power
			RPV pressure
			cavity pressure
			RPV failure mode
			concrete composition
			heat flux distribution
			concrete properties
			mass of water pool on top of the melt
			pool configuration
Uncertainties	in event tree		
	in deterministic code		
Possible future improvements			