



IAEA

60 Years

Atoms for Peace and Development

Updating SAMG

George Vayssier
NSC Netherlands

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george.vayssier@nsc-nl.com

Need to update SAMG

- NRC inspections after F-Daiichi revealed many gaps in plants' SAMG, examples:
 - Still working with rev. 0 of a generic product where rev. 1 already existed for many years
 - Not part of the procedure control mechanism at the plant
 - Not following up with design changes
- See reports Regions I – IV, May 2011

Need to update SAMG (cont'd)

- EU stress test report:
 - Only 5 countries had SAMG for all power states for all plants (B, SL, S, NL, CH; F for 900 MWe plants)
 - But not all SAMG had all required features
 - Most others had SAMG for power states
 - Some were still working
- See EU report <http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1412929078347&uri=CELEX:52012SC0287R%2801%29>

Reasons for update

- Changes in plant configuration
 - May also influence organisational changes around SAMG
- Revision of the background documentation for SAMG
- **Revision of generic product SAMG**
 - E.g. the new consolidated PWROG approach (implementation 2018)
 - Rev. 4 of the BWROG SAMG (release 2018)
- Industry operating experience
 - Exercises at (sister) plants
 - Peer review of exercises much useful !
 - Incidents, accidents
 - See e.g. pressure spike at F-2 during reflood – interrupted reflood
 - See lecture by Dr. Kawamura

Reasons for update (cont'd)

- Advances in safety research, examples:
 - Retention of small aerosols in filters
 - Hydrogen mitigation (PARs, etc.)
 - MCCI processes
 - Effect of overlying water to decelerate CCI, may increase time to basemat meltthrough
 - RPV failure mechanisms
 - At bottom / side / penetrations; time to failure
 - Better codes (e.g. MAAP5 now, ASTEC EU-code)
- Best done by vendor of generic product
 - Hence, large burden on NPP that developed its own SAMG
 - Not each NPP is able to follow all research
 - But do not forget: utilities are responsible for safety of their plant(s), not the SAMG vendor!

Sources for research work - 1

- **EU programmes**

- SAR-NET, now part of NUGENIA
 - Large network of countries coordinating their severe accident research work (focus in Europe), examples of work:
 - PASSAM containment filtered venting
 - IVMR in-vessel melt retention (EU Horizon 2020 – next slide)
 - see e.g. Newsletters in <http://www.sar-net.eu/sites/default/files>
- Book on severe accident research (overnext slide)

- **OECD / NEA / CSNI**

- Working group on analysis and management of accidents (WGAMA)
- Projects: e.g. RASPLAV, MASCA; SERENA; THAI, BIP, STEM
 - Behaviour of molten core in vessel; steam explosions; iodine source term
- Overviews in State-of-the-Art Reports (SOARs) – a next slide

IVMR work in SAR-NET (Fichot)

The 8th European Review Meeting on Severe Accident Research - ERMSAR-2017
Warsaw, Poland, 16-18 May 2017

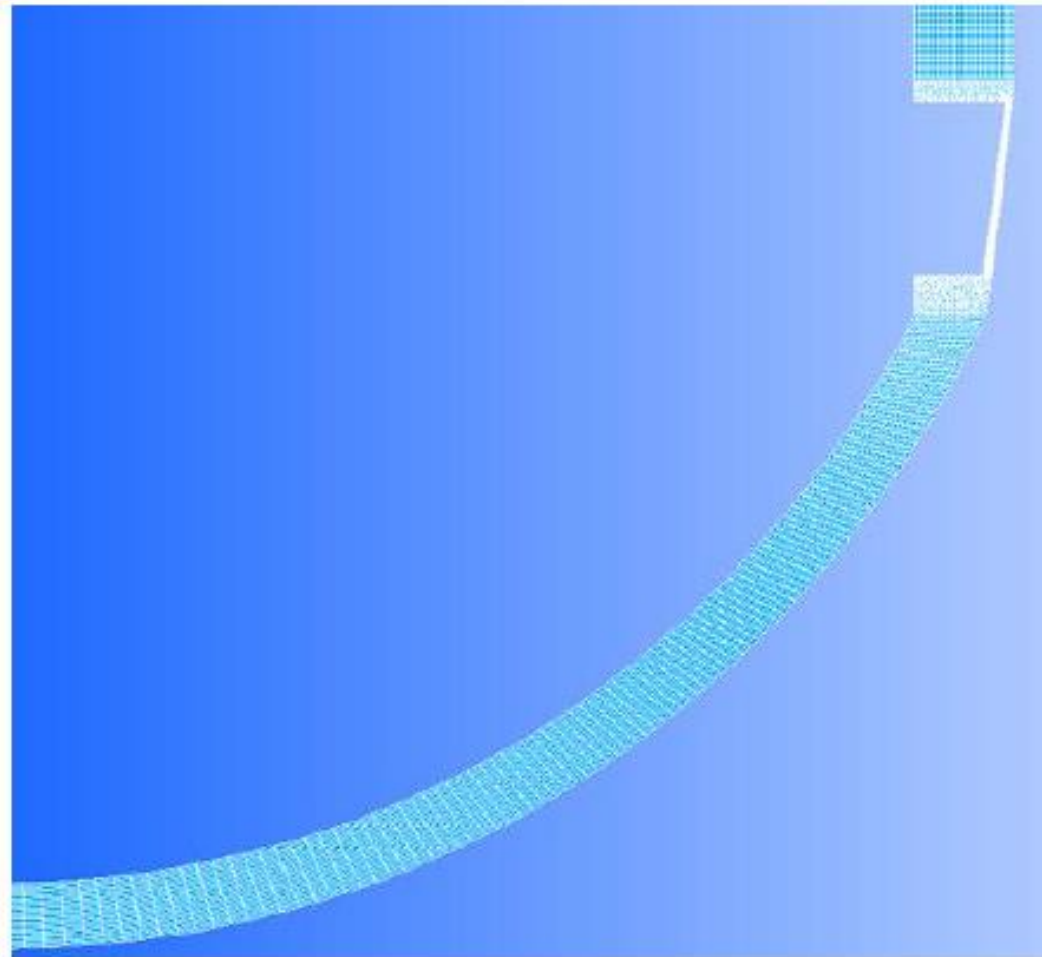
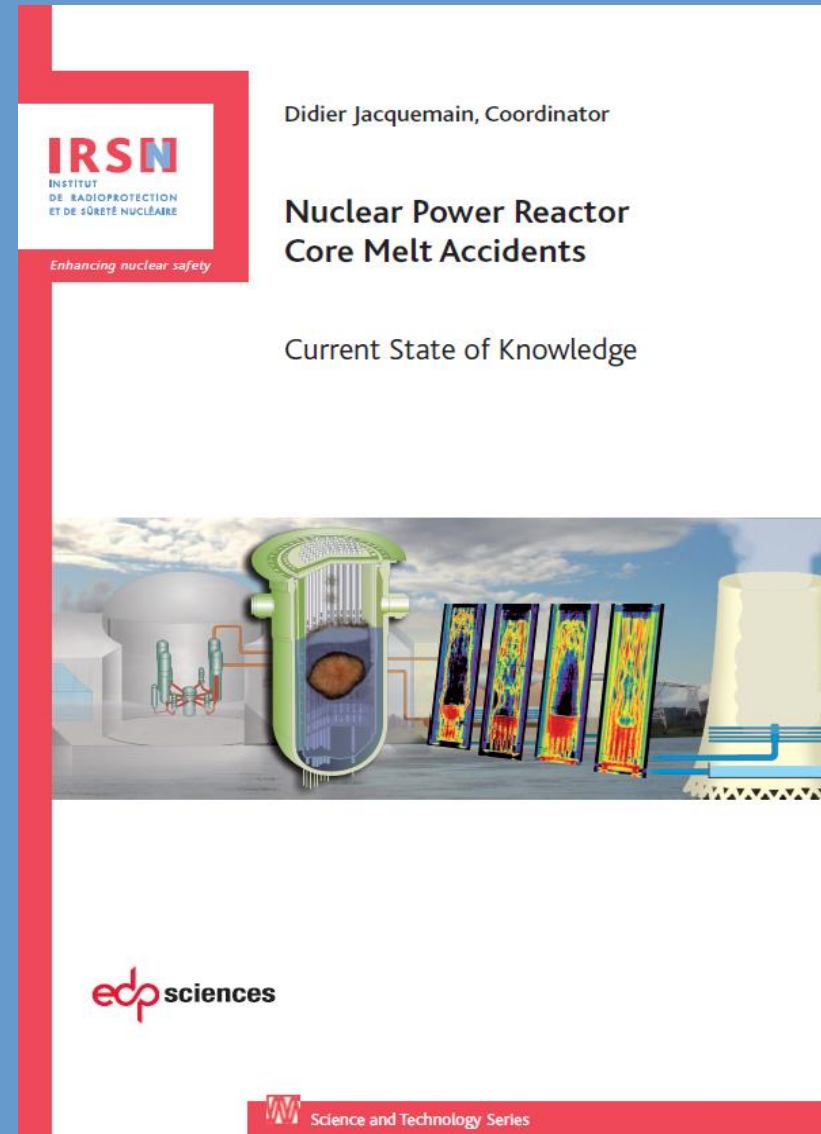
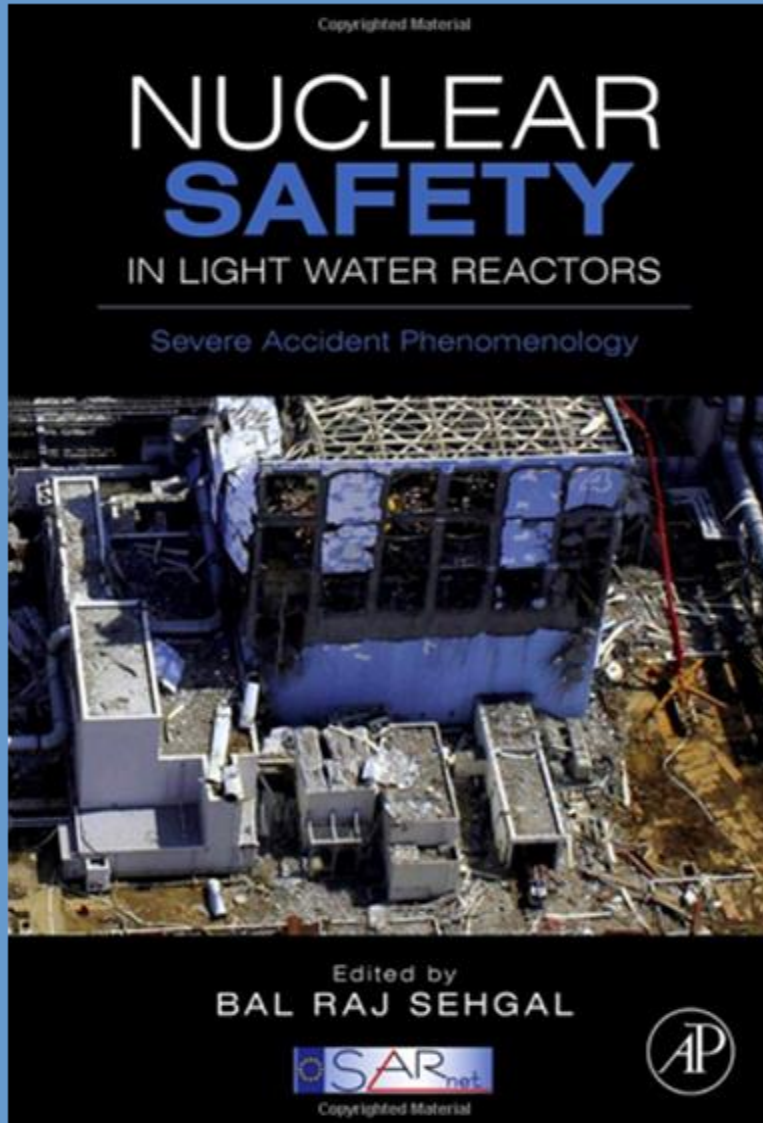


Figure 1: View of the ablated vessel profile selected for the benchmark

Sources for research work - 2

- **National programs Europe** (examples: MIRE: source term, effect of filters, France; QUENCH: reflood, Germany; METCOR: in-vessel, Russia)
- **US research projects**
 - Nat'l labs, EPRI, DOE, NRC
 - E.g. MACE, MELCOR-code (Sandia)
 - Compendium in EPRI Technical Basis Report
 - DOE investigates effect of SAMG actions (BWRs)
- Other countries, e.g. **Korea (KAERI), Japan (JAEA, JANSI)**

EU and IRSN books on severe accident research





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OECD report on filtered venting

Nuclear Safety
NEA/CSNI/R(2014)7
July 2014
www.oecd-nea.org

Status Report on Filtered Containment Venting

Committee on the Safety
of Nuclear Installations

(Sub)Tasks in SAR-NET (partly)

Task 2 coordinator J.P van Dorselaere (IRSN)

- TA 2.1 In-vessel Corium/Debris Coolability, led by Alex Miassoedov (KIT)
- TA 2.2 Ex-vessel Corium Interactions and Coolability, led by Pascal Piluso (CEA)
- TA 2.3 Containment Behaviour, including H₂-explosion Risk, led by Ivo Kljenak (JSI)
- TA 2.4 Source Term, led by Luis Herranz (CIEMAT)
- TA 2.5 Severe accidents linkage with environmental impact and emergency management, led by François Bréchignac (IRSN)
- TA 2.6 SA Scenarios, led by Felice De Rosa (ENEA)

Interface research - applications

- Research groups (may) have ‘users group’
 - Consists of people working in engineering
 - E.g. Areva, Westinghouse
 - But these are not responsible for safety, utilities are...
- Unfortunately, area for improvement:
 - Prime mentality in research is: filling gaps in our knowledge
 - Prime mentality in SAMG developers: SAMG is engineering, not science
 - Example (heard..): “SAMG is just adding water”

Conclusions

- SAMG should be a living tool
 - Following plant modifications
 - Following operating experience
 - Including feedback from exercises/drills
 - Following changes in generic SAMG
 - Many changes due to F-accident
 - Following safety research
 - Note: but first of all: complete development of SAMG!
- Make SAMG part of maintenance of procedures and guidelines
 - Including the training
- Periodic review is helpful (may even be required), define action plan with time frame

Experience With RAMP and Other SAMG Review Missions

George Vayssier, NSC Netherlands,
george.vayssier@nsc-nl.com

Ivica Bašić, APoS, Croatia
basic.ivica@kr.t-com.hr

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Nature of SAMG Reviews

- Various IAEA RAMP missions (RAMP = Review of Accident Management Program)
 - Krsko, Slovenia (2001); Ignalina, Lithuania (2007)
- Various bilateral SAMG review missions /courses, with NPPs, NPP Owners Group, regulators
 - NPP Switzerland (2007, 2012); PWROG SAMG (2013), BWROG SAMG (2015/6); CNSC Canada (2013), SSM Sweden (2015/6) - both of these are regulators
- Publications
 - EOP-SAMG (2012), PWROG SAMG (2014), EDMG (‘B5b’, 2014)

Working Method for Reviews

- IAEA Safety Guide NS-G-2.15, SRS 32 (under revision)
- IAEA SVS 9 (RAMP missions – was under revision)
 - Very large compilation of questions
- In-depth review of generic or plant specific SAMG
- Interview of plant staff
- Observation of SAMG exercise
- NSC-NL Review staff: SAMG developers, SAMG implementers, retired PSA experts
 - e.g. from Westinghouse, NextEra Energy, Krsko Slovenia

Subjects of the Review -1/2

- Definition of overall AMP and its compliance with the national requirements;
- Quality and extent of accident analysis to support the AMP;
- Assessment of plant vulnerabilities and capabilities;
- Development of severe accident management strategies;
- Evaluation of plant equipment and instrumentation;

Subjects of the Review -2/2

- Development of AM procedures and guidelines;
- Verification and validation of the procedures and guidelines;
- Integration of AMP and NPP Emergency Plan;
- Staffing and qualification;
- Training needs and performance; and
- AMP revisions.

Major Findings of Exercises-1/4

- Lack of understanding of the generic SAMG, despite training by vendor
 - Mixing up of EOPs and SAMG
- No defined technology transfer from vendor to plant
 - Working from various other sources (non-proprietary)
- No adequate technical basis for plant specific SAMG
 - Vague reference to EPRI Technical Basis Report
 - Optimistic results of PSA (low calculated H2 risk)
- Use of generic SAMG w/o proper transfer to the plant specific characteristics
 - Risky for the sequence and severity of FP boundary challenges

Major Findings of Exercises–2/4

- Components relied upon might not withstand environmental conditions
 - Planned strategies might not work
- Impact of environment on instrument readings was not considered
 - Large deviations may occur
- Conditions in rooms for local actions may be harsh
 - Manual actions difficult
- Very limited number of scenarios analysed
 - Sometimes even 1 or 2

Major Findings of Exercises-3/4

- ‘Light’ severe accidents used in exercise
 - Team not confronted with complex scenarios and possibly severe consequences
 - Exercise limited to few hours, not overnight, no shift changes
- No understanding of needed time windows for SAMG actions
 - Notably relevant if portable equipment must be hooked on
- No discussion of possible adverse effect of planned actions
- No estimate of possible source term to inform authorities

Major Findings of Exercises – 4/4

- Rooms for ERO and TSC not protected against radiation
 - Rooms had to be left in case of releases!
- No independent power source for ERO and TSC
 - Laptops used would soon run out of power in SBO
- Functions in ERO not described, no dedicated training
- People did not stick to their own functions, executed other people's functions...



Major Findings of Generic Reviews – 1/2

- Focus on RPV injection rather than on FP boundary protection (FP = fission product)
 - But we are in a severe accident just because of a lack of injection/cooling of the RPV !
- Absence of detailed guidance on the system level
 - Only text-book like explanation of what a severe accident is
- Potential negative consequences not quantified
 - Leaves the TSC with guesses
- “Severe accident insights not needed, following predetermined plant parameters is sufficient”
 - This approach is dangerous and fails totally when deviations from default guidance are necessary
- Difficult/impossible questions in the logic diagrams
 - Example: Has it been determined that the RPV has failed?



Recognition of Vessel Meltthrough? statement from WOG SAMG

- With regards to the issue of diagnosing the occurrence of certain severe accident phenomena, the WOG SAMG is based on the inability to diagnose with certainty the occurrence of reactor vessel failure and core concrete interactions for all possible severe accident scenarios
- There was no combination of plant indications upon which such a diagnosis could be made with certainty.
- Therefore the guidance was developed in such a way that the user would also share in the uncertainty in the diagnosis and act accordingly.



Major Findings of Generic Reviews–2/2

- No guidance for the time between entry in SAMG is necessary and assembling of and first recommendation by the TSC
 - Only one approach has defined guidance
- Mixing up of priorities of RPV injection and FP boundary protection
 - These two go *in parallel*, not in sequence !
- No defined guidance to establish a dedicated ultimate heat sink
 - Only one approach has...
- Containment venting independent from EP measures, leak rates (unfiltered) – do this earlier /later than p_{design}
- No attention to large quantities of contaminated run-off water
 - Brought forward by Bob Lutz (retired Westinghouse)

Overall lessons

- Developing SAMG and handling a severe accident are ***extremely complex*** tasks
- To set up plant specific SAMG is a ***major task***, which requires *commitment, budget, time*
 - It is not some side line activity!
- Use some generic SAMG product ***critically***, not the vendor but YOU are responsible!
- Peer review is an ***essential*** element of the SAMG development and implementation
 - Additional help (IAEA, other) may be useful

Conclusions

- Various reviews have been carried out, both on plant drills/exercises and generic SAMG
- Basis were IAEA NS-G-2.15 and SVS-9
- Besides many good points, also many differences/ shortcoming have been found
- Role of peer review is *essential* for a robust SAMG program