8 Emergency Operating Procedures (EOPs) and Severe Accident Management Guidelines (SAMGs) - Issue 06

Table of contents

8 Emergency Operating Procedures (EOPs) and Severe Accident Management Guidelines (SAMGs) - Issue 06 ................................................................................................... 1
8.1 Introduction ...................................................................................................................................... 1
8.2 Identified Problems .......................................................................................................................... 1
8.3 Solutions to Identified problems ...................................................................................................... 2
8.4 Deviation from State-of-the-Art and Significance ........................................................................... 3
  8.4.1 State-of-the-art .......................................................................................................................... 3
  8.4.2 Situation at NPP Temelin ............................................................................................................. 4
  8.4.3 Deviation from the state-of-the-art ............................................................................................. 4
8.5 Technical Arguments ....................................................................................................................... 4
  8.5.1 Defense in Depth ......................................................................................................................... 4
  8.5.2 Timelines and safety culture enhancement ................................................................................ 5
  8.5.3 Collateral requirements ............................................................................................................. 6
  8.5.4 Involvement of the licensing authority ....................................................................................... 6
8.6 References .......................................................................................................................................... 7
8.7 Appendix: Severe Accident Management Guidelines purpose .......................................................... 8

8.1 Introduction

Symptom-oriented emergency operating procedures (SEOPs) are designed to guide and support the operating personnel in accident prevention. Severe accident management guidelines (SAMGs) extend the SEOP concept into mitigation and/or limitation of accident consequences such as core melting.

The implementation of SAMGs or equivalent procedures as a prerequisite for adequate Defence in Depth provisions in case of accident is the state-of-the-art in Member States of the European Union.

8.2 Identified Problems

SAMGs are of special importance in the case of the Temelin prototype plant and have been recognised a necessity by CEZ. However, SAMGs have not yet been developed and implemented in the Temelin Defence in Depth Concept.

SAMGs have also to be taken into account when developing EOPs in order to achieve consistency for appropriate decision making and subsequent actions. Transitions between the EOPs and SAMGs must be defined. Careful harmonisation and integration of SAMGs into EOPs should therefore precede the verification and validation process needed for proper implementation and possible use of both. In view of the delay in supplying and implementing SAMGs, the symptom based EOPs as prepared and validated for Temelin Unit 1 must be considered tentative at this stage of development.

Given the risk implication to Austria, its population and environment, when one of the Levels of Defense - here Level 4, the last on-site, the containment - is challenged in a severe accident, the implemented EOPs and SAMGs measures are of paramount importance.
It should be recalled that in all accident comparable conditions, when SAMGs are applied the Defense in Depth layers Level 1 up to Level 3 are at the verge of failure or have failed already. The SAMGs should provide for maintaining Level 4 of the Defense in Depth as an ultimate resort before large releases of radioactive material into the environment takes place.

Furthermore, for accidents with containment failure or bypass, since the Defense in Depth layers Level 1 up to Level 4 have failed already, SAMGs are part of Level 5 in that they are supposed to provide for actions to limit or reduce otherwise large releases of radioactive material into the environment to the minimum achievable under severe accident conditions and therefore support emergency management and offsite emergency response.

For these reasons the SAMGs must be available to the operator and the emergency support staff to be able to prevent, to mitigate and if necessary to limit severe accidents while following ALARA requirements in the best way achievable.

Emergency management and response depends strongly on the proper use of the lead time available for intervention. International Emergency Exercises (like INEX) have provided the participating organizations with an appropriate picture of the information flow and flow delays to be expected.

To the extent necessary to ensure optimal management strategies, the emergency management of possibly affected countries should also be informed of the actions foreseen in the SAMGs. Should the need arise, additional explanations by the Operator could be asked and given to prevent misunderstandings and misinterpretations resulting from inappropriate use of the information given.

### 8.3 Solutions to Identified problems

- Remaining EOPs and the complementing SAMGs, as well as the transition rules should be implemented and updated for NPP Temelin as the results of the analyses of severe accidents involving containment failure (see Chapter 7) become available.
- The EOPs and SAMGs should be made available to Austria to the extent necessary to optimise emergency planning in case of beyond design base accident scenarios with potential crucial consequences to Austria, its population and environment.

**Timeline:** Neither for Temelin Unit 1 nor Unit 2 would the state-of-the-art relevant in Member States of the European Union permit operation or even fuel loading before resolution of this issue. All the necessary analyses and related measures could be completed within one year.
8.4 Deviation from State-of-the-Art and Significance

Category: high safety significance/large or moderate deviation
Levels of Defence in Depth are considerably diminished.
(The high safety significance is because SAMGs are a relevant support to Defence in Depth (DiD) and provide the potential to reduce severe accident consequences.)

8.4.1 State-of-the-art

There is only a very limited number of NPPs that was taken into operation during the last decade or after the 1996 SAMG voluntary program in the USA became effective. It is therefore obvious that a derived European practice must rely on requirements formulated during this time rather than practical examples of licensing practice.

Extensive information generated internationally regarding the initiation and propagation of severe accidents has permitted the characterisation of residual risks and the identification of plant upgrades that have a potential for significantly reducing such risks. Of particular importance are the development of a set of accident scenarios and their occurrence frequencies, the mode and timing of containment failure relative to reactor vessel failure, the projected consequences and the emergency response measures. This has led the US NRC to launch a plan to address severe accidents for operating nuclear power reactors in 1985.

In 1991 the recommendations of the IAEA Conference on "The Safety of Nuclear Power: Strategy for the Future" identified the need for accident management and core damage mitigation (see Issue 1 Topic 5: 'Fundamental Principles for the Safe Use of Nuclear Power; The Safety Objectives and their Application for Accident Prevention and Mitigation: Limiting the consequences of severe accidents').

Symptom-oriented EOPs were adopted throughout the EU following the 1979 Three Mile Island accident and the 1986 Chernobyl Unit 4 accident. Severe accident management guidelines (SAMGs) extend the EOP concept from accident prevention into accident consequences mitigation. EOPs and SAMGs must consequently allow for co-ordinated sequences of actions, particularly when entered and exited.

A distinguished group of senior regulators of 23 member states of the IAEA (including the Czech Republic) took an unprecedented strong position advocating SAMGs introduction in 1996 when stating in the conclusions of their discussions /Ref. 8/: “There was unanimity on the need for the operating organisation to have emergency plans and the requirement for their acceptance or approval by the regulator. A general view was taken that the issue of severe accident management was an important development which warranted the operating organisation paying special attention to measures to prevent severe accidents and also to consider the way events should be controlled following the occurrence of a severe accident.”

In Europe SAMGs were introduced in Belgium, The Netherlands, Spain, Slovenia, Switzerland and Finland. Germany, France, Sweden and the U.K. have taken diverse approaches in adopting accident management concepts, some of them already in the early 1980’s. Work is still going on in a number of countries in Europe such as in Hungary, Bulgaria, Slovakia, Czech Republic, Lithuania, Ukraine, Armenia, Russia.
It is standard Westinghouse practice for all of its NPPs to implement both symptom-oriented EOPs and SAMGs. The Westinghouse Owners Group (WOG) has supported the original development. Practically all operators of PWRs, among them several utilities operating WWER-1000 reactors have prepared the documents, procedures, flow charts, plant status trees as required, on the basis of then-available information. Updated and optimised procedures and guidelines were and are being prepared for the operators as additional information becomes available.

SAMGs together with INSAG-10 Defense in Depth - Level 5 provisions establish appropriate information links and the transition to the off-site emergency management operations vital to a comprehensive ALARA concept implementation. This information is of vital interest to all those involved in Accident Management as well as in Emergency Preparedness within the Czech Republic and abroad.

8.4.2 Situation at NPP Temelin

Symptom-oriented EOPs are being implemented at Temelin Unit 1, but SAMGs have not been implemented yet. Thus, Defence in Depth cannot be considered adequate when compared to the extent required in Nuclear Power Plants in Member States of the European Union.

The Technical Support Centre is equipped and manned to provide support to the operator in case of a Severe Accident. It is supposed to make extensive use of the SAMGs. The training and experience of the personnel are helpful and necessary prerequisites for Severe Accident Management, but they cannot replace the SAMGs.

8.4.3 Deviation from the state-of-the-art

The delay in preparation and implementation of SAMGs and of their integration with the implemented EOPs beyond the start-up of the plant is a deviation from the state-of-the-art in Member States of the European Union.

It is understood that SAMGs for Temelin are being developed at this time. The view taken by the OSART mission, that the operator is in the right way of having all this tools - not "completely" but – "well" implemented must be seen against this background.

8.5 Technical Arguments

8.5.1 Defense in Depth

"Defence in Depth In Nuclear Safety", INSAG-10, issued in 1996 by the IAEA, Chapter Defence in Depth (DID) - 'Level 4: Control of severe conditions including prevention of accident progression and mitigation of the consequences of a severe accident', paragraph 45, states the following:
“...Essential objectives of accident management are:

1. to monitor the main characteristics of plant status;
2. to control core subcriticality;
3. to restore the heat removal from the core and maintain long term core cooling;
4. to protect the integrity of the containment by ensuring heat removal and preventing dangerous loads on the containment in the event of severe core damage or further accident progression;
5. to regain control of the plant if possible and, if degradation cannot be stopped, delaying further plant deterioration and implementing on-site and off-site emergency response....”

The Defence in Depth (DID) objectives 4 and 5 and partially even 3 have not been met adequately yet for this composite NPP.

The support to the Control Room as well as the knowledge basis at the Technical Support Centre (TSC) rely on the accident analyses results for the efficient accomplishment of the actions required to provide for, or even re-establish, a sufficient level of Defence in Depth. Conclusions to be drawn for SAM from this knowledge are left entirely for the emergency management staff requiring sufficient lead time before any action is taken (see the Appendix for the full appreciation of the preparatory work SAMGs can save). SAMGs are adopted to reduce significantly the lead time requirements.

It is understood that DID Level 5 of INSAG-10: "Mitigation of the radiological consequences of significant external releases" also requires the establishing of SAMGs. From the above, the following conclusion can be drawn: Defence in Depth - a crucial element to the ALARA concept - is not implemented to the extent attained in most European Nuclear Power Plants.

8.5.2 Timelines and safety culture enhancement

The delay of the introduction of SAMGs at the Temelin NPP is surprising for a number of reasons:

- Undisputedly, the need for the introduction of SAMGs has been clear since the time of the decision to finalise the plant;
- WWER-1000 Temelín NPP is a prototype reactor for which extensive design and accident analyses were required. Therefore a well established understanding of accident sequences in the DBA and the BDBA ranges should and could have been created;
- The results from the PSAs conducted have indicated the special need for SAMGs, especially with regard to severe accident sequences involving containment bypass and failure
- The WWERs owners group has no working program for WWER-1000 Temelín units;
- The decision basis actually available for the TSC (Technical Support Centre) personnel has not been validated, nor was the implementation subject to an independent audit; BDBAs are to be treated on a case by case basis.
- The original designer developed his own line of SAM policy. Results from this work are not known to have contributed to Temelín’s SAM policy.
All these facts should have led the operator to devote considerable effort to the SAMGs development. However the development to date was limited to the implementation of EOPs and to the further analyses of severe accident occurrences and phenomena, all of which are prerequisites, but do not substitute fully developed SAMGs. These factors together are usually taken as symptoms for considerable limitations regarding the type of safety culture required for the operation of NPPs.

8.5.3 Collateral requirements

Availability of prerequisites — Severe accident studies and the Temelin PSA results are available and can be transformed into SAMGs in the short term. The results of the additional severe accident analyses in view of possible containment failure as described in the Cluster “Containment” (Chapter 7) can be integrated as they become available. Insights from PSA should be used to establish organisational and procedural measures for operators and Technical Support staff supposed to cope with evolving severe accidents.

Implementation — Verification and Validation will have to be performed using the Temelin full scope plant simulator. Documentation and Training material will have to be produced, training courses will have to be generated, trainers, plant staff and technical support staff will have to be trained. Additional computational support will have to be established and implemented at the TSC (Technical Support Center).

Maintenance — SAMGs as developed now will be limited to adaptation of accident sequences to current plant status. Updates will have to be made according to quality assurance (QA) and implementation procedures similar to those adopted for EOPs. Computational support, maintenance, quality assurance QA and implementation procedures for SAMGs are similar to those for EOPs as well.

Audits — Self-assessment as well as independent audits are to be foreseen for applications suitability, training efficiency and computing support validity. Status verification procedures are to be applied. A frequency of not less than once every two years appears to be adequate unless plant changes require a considerably higher frequency.

8.5.4 Involvement of the licensing authority

The usual involvement of the licensing authorities is not limited only to the Design Basis approach. It also includes the auditing of the safety related commitment of operating organisation, for example the introduction of PSAs on all levels, the implementation of SAMGs, etc.

Oversight by a regulatory body whose primary purpose is safety can stimulate complete and objective analyses as well as comprehensive improvements. The licensing body should evaluate the results of the overall severe accident program and document its own safety conclusions and recommendations.

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1 Severe accident studies referenced on the NRI report from March 2000 in response to the IAEA WWER-1000 safety issues report.
Comparable activities have not been identified to the extent required in the case of the SA precautions at the Temelin NPP.

8.6 References

4. IAEA-WWER-SC-171 (review of WWER-1000 issues resolution at Temelín).
5. IAEA-EBP-WWER-05 (WWER-1000 safety issues report).
8. Development of measures to assess safety of existing NPPs and the effectiveness of regulations and regulatory actions (including 'prescriptive' and 'performance based' approaches). Peer discussions on regulatory practices, IAEA Document PDRP-1, Vienna 1996
8.7 Appendix: Severe Accident Management Guidelines purpose

SAMGs provide a symptom based, structured guidance to plant staff responsible for stabilising and recovering the plant from a severe accident.

The SAMGs provide the comprehensive guidance necessary to:

- **Diagnose plant conditions** - a symptom based approach is employed using only measurable plant parameters;
- **Prioritise response** - symptom based parameters are prioritised based on the time available for response;
- **Assess equipment availability** - availability of equipment for response is determined (a key item in this part of the process is prioritising the recovery of equipment when it is not available);
- **Identify and assess negative impacts** - the negative impacts of implementing available equipment are identified next. This part of the process also includes the identification of additional actions that can mitigate the negative impacts;
- **Determine whether to implement available equipment** - based on a comparison of the negative impacts to the consequences of taking no action, the decision whether to implement a given strategy can be reached;
- **Determine whether implemented actions take effect** - after the strategy is implemented, it is necessary to know if the actions are effective and if the negative impacts are still acceptable;
- **Identify long term concerns for implemented strategies** - after the strategy is implemented, there may be additional long term actions required to maintain the strategy (e.g. refilling tanks).

SAMGs implementation might require changes to those EOPs that are supposed to serve for the transition between the preventive and mitigative phases of the accident management.

Such transitions from the EOPs to the SAMGs might occur in the case of:

- ATWS (Anticipated Transients without Scram) events
- Loss of core cooling
- Station blackout

The SAMGs are the tool for Technical Support Centre staff in co-operation with shift staff to stabilise and recover the plant from a severe accident. All means suitable to help this goal are of use.