GUIDELINES FOR REGULATORY REVIEW OF EOPs AND SAMGs FOR RESEARCH REACTORS

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1. INTRODUCTION

1.1. Background

The need for establishing a regulatory guidance for the review of the Emergency Operating Procedures (EOPs) and Severe Accident Management Guidelines (SAMGs) developed by the licensee resulted from the recommendations and suggestions of the IRRS mission conducted by IAEA in 2011 at CNCAN, Romanian regulatory body, as well as from the self-assessment process of CNCAN and the conclusions of “stress tests” programme, conducted at the request of the European Council for all the nuclear power plants in Europe.

This activity has the objective to ensure that CNCAN develops the necessary tool to assess and review the licensee’s procedures and guides supporting the response to emergency situations and severe accidents, based on the current international standards and on the best practice of other nuclear safety authorities with similar responsibilities and experience exchange in this area of regulatory assessment.

The guidelines for regulatory review of EOPs and SAMGs developed for nuclear power plants have been used as a basis for the development of a simpler guideline, for the regulatory review of EOPs and SAMGs for research reactors.

1.2. Purpose and scope of the guidelines

This document provides guidelines for a regulatory review of the licensee’s development and implementation of on-site accident management programme for both the preventive and the mitigatory domains, for a research reactor. The review evaluates compliance of the accident management programme with the regulatory requirements and / or applicable international standards, the comprehensiveness of the technical basis, strategies and measures and of procedures and guidance.

The review can be scheduled during either the development or the implementation process of the accident management programme. The aim may be the review of an existing set of procedures and guidance to identify deficiencies and issue recommendations for a successful completion of the programme, or for providing recommendations for the improvement of the guidance as a part of a periodic safety review process.

These review guidelines provided in this report identify the key issues for the review of main aspects of accident management programme development and implementation for a research reactor. Also questions are suggested that the review team should ask during the reviews and inspections. However, this guide and the associated checklists do not replace a preparation and planning for a review, especially in the context of specific research reactor facility.

1.4. Definitions and acronyms

This section provides key relevant, to accident management, acronyms and definitions. The acronyms and definitions below are primary based on the IAEA glossary terms. Also some definitions and acronyms specific to Romania are included.

accident. Any unintended event, including operating errors, equipment failures or other mishaps, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.

accident conditions. Deviations from normal operation more severe than anticipated operational occurrences, including design basis accidents and design extension conditions without and with extensive core damage (severe accidets). Examples of such deviations include a major fuel failure or a loss of coolant accident (LOCA).

AM - accident management. The taking of a set of actions during the evolution of an accident: (a) to prevent the escalation of the event into a severe accident; (b) to mitigate the consequences of a severe accident; (c) to achieve a long term safe stable state.

AOO - anticipated operational occurrence. An operational process deviating from normal operation which is expected to occur at least once during the operating lifetime of a facility but which, in view of appropriate design provisions, does not cause any significant damage to items important to safety nor lead to accident conditions. Examples of anticipated operational occurrences are loss of normal electrical power and faults such as a turbine trip, malfunction of individual items of a normally running nuclear installation, failure to function of individual items of control equipment, loss of power to the MCP. Some States and organizations use the term abnormal operation (for contrast with normal operation) for this concept.

DB - design basis. The range of conditions and events taken explicitly into account in the design of a facility, according to established criteria, such that the facility can withstand them without exceeding authorized limits by the planned operation of safety systems. Used as a noun, with the definition above. Also often used as an adjective, applied to specific categories of conditions or events to mean ‘included in the design basis’ as, for example, in design basis accident, design basis external events, design basis earthquake, etc.

DBA - design basis accident. Accident conditions against which a nuclear installation is designed according to established design criteria, and for which the damage to the fuel and the release of radioactive material are kept within authorized limits.

EOP – Emergency Operating Procedure. Nuclear installation specific procedures containing instructions for operating staff to implement preventive measures for managing accidents. Emergency operating procedures typically contain all preventive measures for both design basis accidents and beyond design basis accidents up to the point of core damage.

initiating event. An identified event that leads to anticipated operational occurrences or accident conditions and challenges safety functions.

normal operation. Operation within specified operational limits and conditions. For a nuclear installation, this includes startup, power operation, shutting down, shutdown, maintenance, testing and refuelling.

operational limits and conditions. A set of rules setting forth parameter limits, the functional capability and the performance levels of equipment and personnel approved by the safety authorities for safe operation of an authorized facility.

operational States. States defined under normal operation and anticipated operational occurrences. Some States and organizations use the term operating conditions (for contrast with accident conditions) for this concept.

postulated initiating event. An event identified during design as capable of leading to anticipated operational occurrences or accident conditions. The primary causes of postulated initiating events may be credible equipment failures and operator errors (both within and external to the facility), human induced or natural events.

SA - severe accident. Accident conditions involving significant core degradation.

safety function. A specific purpose that must be accomplished for safety.

scenario. A postulated or assumed set of conditions and/or events. Most commonly used in analysis or assessment to represent possible future conditions and/or events to be modeled, such as possible accidents at a nuclear facility, or the possible future evolution of a repository and its surroundings. A scenario may represent the conditions at a single point in time or a single event, or a time history of conditions and/or events.

SAMG – Severe Accident Management Guideline

symptom based procedure/guideline. Procedure or guideline containing actions which are taken depending on the values of directly measurable parameters. A symptom is a measurable parameter that is available to the operator in the control room.

SSC – Systems Structures and Components

2. APPLICABLE REQUIREMENTS AND STANDARDS

2.1 National requirements

One of the aims of the regulatory review of EOPs and SAMGs for a research reactor is to verify compliance with the applicable national nuclear safety requirements. The national regulations may include only general requirements related to operating procedures and to the emergency planning and response. Nevertheless, general requirements such as these are still sufficient as a legal basis for verifying and enforcing compliance in the area of EOPs and SAMGs, although this process would be more straightforward with specific requirements.

It should be noted that, in general, the requirements on accident management for research reactors are significantly less detailed than those for nuclear power plants, following a graded approach based on risk information.

2.2 International standards and guides relevant for regulatory review of EOPs and SAMGs for research reactors

The requirements in international documents relevant to the review of accident management programmes for research reactors include:

IAEA Safety Standards Series NS-R-4 - Safety of Research Reactor: Safety Requirements:

− Para. 7.51: *Operating procedures shall be developed for all safety related operations that may be conducted over the entire lifetime of the facility, including (a) ~ (o) .... (g: the reactor operator’s response to AOO, DBA, and, to the extent feasible, to BDBAs, h: emergencies)*

− Para. 7.72: *Emergency plans shall be prepared for a research reactor facility to cover all activities planned to be carried out in an emergency. Emergency procedures shall be prepared by the operating organization, in accordance with the requirements of the regulatory body, and in co-operation, where necessary, with the appropriate governmental and local authorities or other bodies, to ensure the effective co-ordination of all site services and of external aid in an emergency*.

− Para. 7.74: *The emergency plan shall be implemented by means of emergency procedures in* *the form of documents and instructions detailing the implementation actions and the arrangements required to mitigate the consequences of the emergency. The emergency plan and procedures shall be reviewed at specified periods and shall be amended as necessary to ensure that lessons learned are incorporated*.

IAEA Safety Standards Series NS-G-4.4 Operational Limits and Conditions and Operating Procedures for Research Reactor

− Para. 5.53: *Emergency procedures should be prepared, and they should be a component of the emergency plan. Their development should be based on the evaluation and analysis of all aspects of possible emergencies. The procedures should specify the methods and duties of intervention staff and the emergency actions that are necessary to mitigate the possible consequences of the emergency. They should refer to the emergency facilities and emergency equipment*.

3. ACCIDENT MANAGEMENT CONCEPTS

3.1 Concept of accident management: Emergency Operating Procedures and Severe Accident Management Guidelines

Defence in depth (DiD) concept is fundamental to the safety of nuclear installations. It consists of a hierarchical deployment of different levels of equipment and procedures in order to maintain the effectiveness of physical barriers placed between radioactive materials and workers, the public or the environment, in normal operation, anticipated operational occurrences and in accident conditions at the nuclear installation.

This concept is applied to all safety related activities, whether organizational, behavioural or design related. This is to ensure that all safety related activities are subject to independent layers of provisions, so that if a failure were to occur, it would be detected and compensated for or corrected by appropriate measures. Application of the concept of defence in depth throughout design and operation provides protection against anticipated operational occurrences and accidents, including those resulting from equipment failure or human induced events within the nuclear installation, and against consequences of events that originate outside the facility.

The accident conditions considered in accident management include scenarios with a very low probability of occurrence, but which may lead to significant consequences resulting from degradation of the nuclear fuel.

Accident management is the taking of a set of actions during the evolution of accident conditions with the objective of: preventing progression into a severe accident, mitigating the consequences of a severe accident, and achieving a long-term safe stable state.

The accident management programme should address all modes of operation and external hazards (extreme weather conditions, earthquakes, external fires and floods, man-made hazards such as explosive and toxic gas clouds, oil-spills, etc.) relevant for the site considered, taking into account some possible dependencies between events. It should also consider that external hazards could result in significant damage to the infrastructure on-site or off-site. Accident management programme should be developed and maintained consistent with the nuclear installation design and its current configuration.

3.2 Graded approach

Given the different types and sizes of research reactors and the associated utilization programmes, a graded approach should be applied to the accident management programme and to its regulatory review, commensurate with the potential hazard of the reactor facility.

Aspects of the accident management programme and of the related regulatory review which may be subjected to grading include the scope, extent and details of the analysis, and the required human and logistical resources, which may be significantly less for low power research reactors than for high power research reactors.

Factors affecting the application of a graded approach are those related to the risk and the potential hazard, including, for example:

- The reactor power;
- The fission product inventory and the radiological source term;
- The amount and enrichment of fissile material;
- Fuel design;
- Inherent safety features of the design;
- The presence of high pressure or high energy piping (experimental loops);
- The quality of the means of confinement (containment and ventilation systems);
- The presence of experimental facilities and experimental devices, and the reactor utilization programme;
- The stage of the lifetime of the reactor facility, ageing of the reactor, and upgrades and modifications;
- Any other special hazard (e.g. hydrogen, chemical and fire hazards);
- Siting (regional characteristics);
- The structural concept (above or below ground);
- The proximity of the reactor facility to populated areas.

Grading may be applied to the scope and level of detail of review of design basis events and the assessment of the beyond design basis events of the reactor facility. Certain accident scenarios may not apply or may need only limited analysis in low power research reactors compared with high power research reactors. For example, the analysis and management of a loss of coolant accident may vary significantly depending on the power and design of the reactor.

The graded approach may be also applicable to the selection of site related design basis events (and beyond design basis events) to the extent that the examination of events may show that some of them pose a minimal hazard to the reactor facility on a particular site.

A graded approach may also be used in the application of the safety requirements related to the levels of the defence in depth, in the sense that level 5, and sometimes level 4 of the defence in depth concept, may be met by the inherent safety characteristics of the reactor instead of through engineered safety features of the design. If the research reactor is designed without confinement or containment, for example, this needs to be justified on the basis that, under accident conditions, there is no potential for release of radioactive material from the facility that may result in unacceptable off-site consequences.

Grading may be applicable to the emergency arrangements to be established based on the potential hazard associated with the research reactor facility. Grading may also be applied to the number and types of escape routes, based on the layout and size of the reactor facility. It may also be applied to the necessary emergency equipment, and to the scope and frequency of the emergency drills and exercises. A graded approach can be also applied to the organizational aspects, including human and logistical and financial resources.

Application of the graded approach should be based on the potential hazard of the research reactor facility, and should take into account the existence of other nuclear installations on the site, including those facilities associated with the research reactor.

3.3. Development of EOPs and SAMGs

A structured top down approach should be used by the licensee to develop the accident management guidance. This approach should begin with the objectives and strategies followed by measures to implement the strategies and finally result in procedures and guidelines, and should cover both the preventive and the mitigatory domains.

Multiple strategies should be developed to achieve the accident management objectives, which include:

- Preventing severe fuel damage by termination of accident progression, or, delaying the time at which significant fuel degradation happens;
- Terminating the progress of fuel damage once it has started as far as it does not preclude the following objectives;
- Maintaining the integrity of reactor coolant (pressure) boundary to prevent melt through progression;
- Maintaining the integrity of the reactor containment building or of any other confinement of fuel and preventing containment by-pass;
- Mitigating releases of radioactive material from any location of fuel outside the reactor building/containment; and
- Achieving a long-term safe stable state.

From the strategies, suitable and effective measures for accident management should be derived, corresponding to available hardware provisions. Such measures may include modifications to the nuclear installation, where these are deemed important for managing accident conditions including severe accidents. Personnel actions initiated either in the control room or local actions in the installation could be an important part of these measures. During an accident such measures would include use of systems and equipment still available, recovery of failed equipment and use of portable and mobile equipment stored on-site or off-site.

Appropriate guidance should be developed by the licensee for the preventive domain of accident management in form of Emergency Operating Procedures (EOPs) and Severe Accident Management Guidelines (SAMGs) for the mitigative domain.

In the preventive domain, the guidance should consist of descriptive steps, as the nuclear installation status is known from the available instrumentation and the consequences of actions can be predetermined by appropriate analysis. The EOPs are of prescriptive nature and should cover both design basis accidents and design extension conditions, but are typically limited to actions taken prior to fuel damage.

In the mitigatory domain, large uncertainties may exist both in the reactor status, availability of the systems and in the timing and outcome of actions. Consequently, the guidance for the mitigatory domain should not be prescriptive in nature but rather should include a range of potential mitigatory actions and should allow for additional evaluation and alternative actions.

Accident management guidance, including guidance for management of severe accidents, should be developed for all physically identifiable challenge mechanisms for which the development of accident management guidance is practicable in order to minimize the impact of severe accident on public health and safety.

When developing guidance on accident management, consideration should be given to the full design capabilities of the installation, using safety and non-safety systems and including possible modifications and the use of mobile equipment. Care should be taken if the possible use of some systems beyond their originally intended function and anticipated operating conditions and possibly outside their design basis is foreseen in the guidance on accident management. Specific consideration should also be given to maintaining conditions needed for continued operation of equipment ultimately necessary to prevent large or early radioactive releases.

Accident management guidance should assist the personnel to prioritize, monitor, and execute actions in the working conditions that may exist during accidents including those resulting from external hazards which are more severe than external natural events.

A verification and validation processes should assess the technical accuracy and adequacy of the instructions, and the ability of personnel to follow and implement them. The teams responsible for execution of accident management strategies should be adequately staffed and qualified.

3.4. Integration with emergency management

Accident management should be an integral part of the overall emergency arrangements at a nuclear installation.

For the accident management, the operating organization should have a decision-making authority that should be clearly defined and established at an appropriate level, commensurate with the complexity of the task and the potential consequences of decisions taken. The roles assigned to the members of the on-site emergency response organization may be different in the preventive and mitigatory domains, and, where this is the case, transitions of responsibility and authority should be clearly defined.

In the preventive domain, the control room supervisor (or a dedicated safety engineer or other designated staff with the necessary qualifications) should be able to fulfill this responsibility.

In the mitigatory domain, decisions should be made by a person having a broader perspective of accident management activities and understanding comprehensive implications of the decisions.

Major decisions which could have significant adverse effects on public safety or the environment should be made with the full knowledge of the person entrusted with legal responsibility for the nuclear installation, where reasonably practicable.

The accident management guidance (EOPs and SAMGs) should be compatible with the assignment of responsibilities and should be consistent with the other functions considered in the overall emergency response arrangements.

A technical support centre (with a specialized team or group of teams) should be available to provide technical support by performing evaluations and recommending recovery actions to a decision making authority, both in the preventive and mitigatory domains. The technical support centre should have the capability, based on their knowledge of the nuclear installation status to recommend mitigatory actions as deemed most appropriate for the situation. This should be done only after evaluating potential negative consequences. If the technical support centre is composed of multiple teams, the role of each team should be specified.

Appropriate levels of training should be provided to members of the on-site emergency response organization; the training should be commensurate with their responsibilities in the preventive and mitigatory domains as well as support the transition between domains. For example, severe accident sequence development, procedures and guidelines in use at the time of the transition from the preventive to the mitigative domain, emergency response teams or actions performed for recovering unavailable systems the emergency response team that deals with coping with the consequences of extreme events should be trained to lead under extreme conditions and demonstrate their leadership abilities during exercises or drills.

4. REVIEW OF THE ACCIDENT MANAGEMENT PROGRAMMES

4.1 Objectives and scope of the review

This section identifies the principal objectives of a regulatory review of an accident management programme development and implementation. Normally, the function of the regulator is to ensure that the accident management programme provides the nuclear installation operators with reasonable, prudent and effective procedures and guidance. In performing the review, the regulator will address various aspects of the accident management development and implementation. These reviews might include the technical bases documents, verification, validation and training programmes.

The general objective of the review of the accident management programme is to determine whether the specific goals of the accident management can be achieved:

- Termination of the progression of an accident as early as possible;
- Prevention of the accident evolving to severe consequences;
- Maintain the integrity of fission product barriers including containment/reactor building and spent fuel storage;
- Minimize the release of radioactive materials into the environment;
- Achieving a long-term safe stable state of the reactor core or spent fuel storage.

Further, the review of the accident management programme shall determine whether the development and implementation of the programme addressed the following key issues:

- Mechanisms that can challenge critical safety functions or boundaries to fission product release are identified;

- Nuclear installation vulnerabilities are identified, considering the challenging mechanisms;
- The capabilities of the nuclear installation under challenges to critical safety functions and fission product barriers are identified, including capabilities to mitigate such challenges, both in terms of available equipment and personnel;
- Suitable accident management strategies and measures are developed, including the use of fixed and onsite and offsite portable equipment to cope with the vulnerabilities identified;
- Procedures and guidelines to execute the strategies and measures are developed, considering the actual configuration of the nuclear installation, documented, validated and available;
- The staff is trained in conduct of accident management activities;
- The integration of accident management and emergency preparedness arrangements is tested, including the availability of technical support and the communication interfaces.

The review shall identify whether the accident management programme documentation, including procedures and guidelines, contain as a minimum the following elements:

- Objectives and strategies of the accident management;
- Technical basis for the accident management programme; use of safety analyses and operating experience;
- Validation reports for the accident management procedures and guidelines;
- Responsibilities of the operating personnel for the response to transients and accidents;
- Training programme for the operating personnel, to understand and apply EOPs and SAMGs;
- Reports from emergency response exercises in which accident management has been tested.

For each accident management procedure and / or guidelines, the following information should be specified:

- initiation criteria / entry conditions;
- automatic and manual actions;
- measures and indications used to confirm the success of the accident response measures / assessment and monitoring of the installation response;
- monitoring of safety relevant parameters that give a direct indication of the integrity of the physical barriers against uncontrolled releases of radioactivity;
- the time window within which the actions are to be applied (if relevant);
- the equipment and resources (e.g. AC and DC power, water) required;
- consideration of required personnel resources;

- consideration of habitability for local action;
- cautions and limitations;
- potential negative consequences of the actions (if the case);
- transition criteria and exit/termination condition;
- consideration of long-term accident management strategies;
- reference to local actions sheets, if relevant (field instructions).

4.2 Preparation and performance of the regulatory review

The regulatory review will comprise of documentation review, inspections and interviews. The staff participating in the review should have a good understanding of the design and operation of the nuclear installation, including the safety analyses and the operating practices and related procedures. Since the accident management is multi-disciplinary by nature it is important that a proper team is assembled that can cover a variety of technical disciplines including: deterministic safety analyses, probabilistic safety analysis, structural and electrical engineering, human factors, radiological protection, training expertise, etc..

The review will start with the review of relevant documentation, which includes:

- safety analysis reports, with deterministic transient and accident analysis and with probabilistic safety assessments (where available);
- operating limits and conditions; normal operating procedures; alarm response procedures;
- licensee's description of the accident management programme / actions to be taken in response to transients and accidents;
- the procedures and guidelines for response to transients and accidents (these include abnormal operating procedures and / or EOPs and SAMGs if available; the procedures and guidelines should cover also transients and accidents initiated by external events – e.g. earthquakes, floods, etc.);
- documents describing the technical basis for the accident management programme, procedures and guidelines; normally such documents would make reference to safety analyses and operating experience;
- an analysis of the staffing needs for implementing accident management;
- reports proving that the accident management procedures and guidelines have been validated (through safety analyses, exercises or through other means);
- records of emergency exercises that tested also accident management;
- records of training of operating staff in accident management; records of examination of the operating staff , as part of their qualification and authorization process;
- quality assurance applied in the development and implementation of the accident management programme.

After the review of documentation, the regulator should plan the inspections at the nuclear installation and the interviews with the licensee's staff.

The inspections should include the following (on a sampling basis):

- Verification of the process of updating the accident management procedures / EOPs and SAMGs to reflect permanent and temporary modifications to the nuclear installation (configuration management) and to other relevant procedures;
- Verification of the feasibility of various actions that have to be taken outside the control room (including equipment tagging, accessibility, etc.);
- Verification of operators' knowledge of the accident management procedures and guidelines (this can be done by asking questions about the general strategy for responding to transients and accidents, about the entry conditions and the identification of the correct procedures, about the basis for certain actions in the procedures, about the parameters that need to be monitored, etc.)
- Observation of one or more emergency response exercises in which accident management is also tested;
- Verification of systems and equipment (SSCs) credited in accident management (visual inspection where possible; checking of records of environmental and seismic qualification, testing, maintenance, inspections);
- Verification of records from training activities and from emergency exercises;

The results of the documents review, findings from interviews of licensee staff and from inspections / walk-downs have to be documented and analyzed. The findings will be presented to the licensee, their comments will be addressed and a final review report will be prepared and issued, as for any other area of regulatory review.

The review questions in the following chapter may be used to ensure that the review covers all the relevant aspects of the development and implementation of an accident management programme.

5. REVIEW QUESTIONS ON EOPs AND SAMGs

5.1 Review Questions on EOPs

The following questions can be used in the review of the EOPs for a research reactor.

#	Question	Y	N	N / A	Comments / Details
	General questions				
1	Has the licensee implemented an accident management programme?				
2	Has the licensee documented the (technical) basis for its accident management programme?				
3	Does the accident management programme of the licensee include procedures for responding to transients and accidents?				
4	Does the licensee have procedures for responding to events such as:				
	- loss of reactivity control?				

	- loss of coolant?				
	- loss of external power supply?				
	- loss of coolant circulation?				
	- internal fires?				
	- seismic events?				
	- flooding?				
	- other events analyzed in the safety analysis report?				
	- events that are specific to particular experiments?				
	- events that exceed the design basis of the reactor? (BDBA)				
5	Does the licensee have written guidance on the elaboration, verification, validation and implementation of accident management procedures?				
6	Has the licensee involve its own staff, in a multi-disciplinary team, in the elaboration, verification, validation and implementation of accident management procedures? (in some cases, the procedures have been taken from the designer / vendor of the nuclear installation and adapted for the respective facility with little involvement of the licensee's staff)				
7	Are there indications that the accident management procedures have been revised to reflect modifications (permanent or temporary) to the nuclear installation? Check whether the revision number and date are clearly identified, together with a history of revisions and reasons for the revisions.				
	Questions on the technical aspects of the procedures				
8	Are the entry conditions in procedures clearly specified?				
9	Do the procedures (or each procedure, in case of event-based approach) provide a means to check off that the following were observed or performed? a. Symptoms b. Automatic actions c. Immediate operator actions				
10	Do the immediate operator actions avoid referencing operators to other procedures for instructions?				
11	Do the procedures contain provisions for coordinating the activities of others? For example, is there a checklist for a coordinator to record that an action has been completed?				
12	Are the steps that must be performed in a fixed sequence clearly distinguishable from steps that do not have to be performed in a				

	fixed sequence?				
13	Are the procedures user-friendly? (for example, procedures for responding to transients and accidents should not be overly descriptive and include a lot of text; they should preferably be in the form of flow-charts)				
14	Does each instructional step direct only one action?				
15	Does each instructional step meet the following criteria? a. The action to be taken is specifically identified (open, turn, shut). b. Limitations are expressed quantitatively, c. Equipment and parts are identified clearly and unambiguously.				
16	If a step contains three or more objects of an action, are they listed rather than imbedded in the sentence? For example, if an operator is directed to close three or more valves, they should be listed rather than strung out in a sentence.				
17	Do the alignment instructions in the procedure meet all of the following criteria? a. Each item requiring alignment is individually specified (It is not acceptable to refer personnel to previous steps.) b. Each item is identified with a unique number or nomenclature. c. The position in which the item is to be placed is specified. d. The position in which the item is placed is verified.				
18	If explanations/cautions are applicable to the performance of specific steps or series of steps, are they placed immediately ahead of the step(s) to which they apply?				
19	Are explanations/cautions separate and easily distinguishable in appearance from instructional steps? For example, are they enclosed in boxes, typed in bold face letters, headed with the word CAUTION, NOTE, etc.?				
20	Can the text of a explanation/caution be read without interruption by intervening steps or page turning?				
21	Do explanations/cautions avoid the use of action statements? (Statements directing personnel to perform actions must not be imbedded in explanations/cautions. Explanations/cautions should be expressed in the passive voice.)				
22	Are explanations/cautions provided to inform personnel when displays are based on secondary sensing modes? For example, is a caution provided when a light indicates only that a circuit is energized rather than the position of the valve?				

24	Do the procedures specify that the safety relevant parameters which have to be monitored by the operators?				
25	Do the safety relevant parameters monitored in accident management include: - reactor power; - reactor coolant inventory; - reactor coolant temperature; - reactor coolant pressure (if relevant); - radioactivity in the reactor coolant; - radioactivity in the reactor building; - radioactivity on the reactor site				
26	Is the monitoring of safety relevant parameters available in case of all credible accident scenarios?				
27	Are instrument readings, control values, and other limits used to guide operator actions expressed in quantitative terms when possible?				
28	Are quantitative limits expressed as ranges rather than single values?				
29	Are limits compatible with those stated in the safety analyses and technical basis documents?				
30	Are contingency instructions easy to understand? For example, if three or more conditions are associated with an action, they should be listed separately from and ahead of the action statement.				
31	If calculations are required, is space provided in the procedure to perform the computations and to record the results?				
32	Do graphs, charts, tables, and figures meet all of the following criteria? a. They are compatible with the procedure. b. They are legible and readable under expected conditions of use. c. Values can be extracted or interpolated easily and with required accuracy, e.g., nonlinear scales are not used. d. Units of scale and measurement are readily available and usable to the operator. e. Titles are descriptive of contents and use.				
33	If the procedure specifies an action that must be performed at a later time or repeated at periodic intervals, does it provide a means to assist the operator in performing the step(s) within the required time				

	frame? For example, if an action must be repeated every 15 minutes, are there spaces for the operator to record the times at which the action must be performed?				
	Questions on staffing analysis for accident management				
34	Has the licensee analyzed and documented the minimum staffing required on shift at all times to adequately respond to all transients and accident situations?				
35	Does the shift staffing composition include a shift supervisor, a control room operator and sufficient equipment operators and maintainers? How it has been determined?				
	Questions of the verification and validation of accident management procedures				
36	Has the licensee performed a technical verification of the emergency operating procedures? How?				
37	Has the licensee performed the validation of the emergency operating procedures? How?				
38	Are there records of the verification and validation of the EOPs?				
	Questions for which verification will be performed during inspections (verification should be done for each procedure)				
39	Are equipment numbers and/or nomenclature used in the procedure the same as those which are displayed on the equipment?				
40	Are the units of measurement used in the procedure the same as those displayed on instruments?				
41	Are the emergency operating procedures readily identifiable and easily accessible?				
42	Does the procedure identify all major symptoms or combinations of symptoms associated with the emergency? (Determine whether the operator can describe major symptoms or combinations not identified by the procedure.				
43	Does the procedure specify automatic actions associated with the emergency adequately? (Determine whether the operator can describe automatic actions not identified by the procedure.)				
44	Does the procedure specify all critical actions required to respond to the emergency? (Observe whether the operator performs critical actions not specified by the procedure.)				
45	If the procedure contains sequence-critical actions, is the sequence specified by the procedure correct? Observe whether the operator				

	performs sequence-critical actions in the sequence specified.)				
46	Does the procedure allow enough time to perform time-critical actions? (Observe whether the operator can perform time-critical actions in the time allowed, i.e., by equipment response, distances involved, etc.)				
47	Does the procedure identify equipment adequately? (Determine whether the operator can readily identify all equipment and items referred to in the procedure.)				
48	Are references to equipment in the procedure identical to the labels displayed on the equipment?				
49	Are the units of measurement used in the procedure the same as those displayed on instruments?				
50	Does the procedure identify the location of each item of equipment adequately? (Observe whether the operator can locate switches, gages, etc. in a timely manner.)				
	Questions on consideration of factors affecting accident management				
51	Can the actions specified in the procedures be implemented in the conditions expected? (e.g. temperatures, radiation dose-rates and other conditions expected in case of worst-case scenarios)				
52	Will power supply be available as needed for accident management?				
53	Can the actions specified in the procedures be performed as expected in case of loss of communication?				
54	Can the actions specified in the procedures be performed as expected in case of loss of illumination / lighting? What equipment is provided for such situations?				
55	Are the radiological protection cautions and measures specified for the accident management procedures?				
56	Is is clearly specified in the licensee's documents who has the authority and responsibility for the accident management and emergency response actions? - for implementing EOPs; - for monitoring the state of the nuclear installation; - for making notifications to the authorities.				
	Questions about training, qualification and emergency exercises				
57	Are the operators and other shift staff members trained and qualified in the application of EOPs? (check the records and the staff's knowledge)				
58	Are the accident management procedures exercised as part of the				

	emergency response exercises?				
59	Are there records of actions taken to improve accident management based on lessons learned from training and from emergency exercises?				
	Questions about opportunities for improvement				
60	Has the licensee performed or received: - self-assessment - benchmark with other licensees - audits - independent external reviews of its accident management arrangements?				

5.2 Review Questions on SAMGs

The following questions can be used for regulatory review of SAMGs where these have been developed (based on the assumption that a severe accident for the respective nuclear installation is credible). If SAMGs are not necessary or relevant for a research reactor, this section of the regulatory review guidelines will not be needed.

#	Question	Y	N	N / A	Comments / Details
1	Has the licensee implemented SAMGs?				
2	Has the licensee documented the (technical) basis for the SAMG?				
3	Has the licensee specified the criteria that would indicate the onset of a severe accident?				
4	Were specific analyses performed for identification of the symptoms (i.e., parameters and their values) by which the personnel may determine the reactor core condition and state of protective barriers?				
5	Were challenges to fission product boundaries in different reactor states identified through analyses?				
6	Was the timing of such challenges evaluated through analyses in order to improve the potential for successful human intervention?				
7	Have the systems and material resources that may be used for SAM purposes been identified through analyses?				
8	Have the SAM actions been verified by analyses to be effective in countering challenges to protective barriers?				
9	Were important event sequences that may lead to severe accidents identified by using a combination of probabilistic methods,				

	deterministic methods and sound engineering judgement?				
10	Were these event sequences reviewed against a set of criteria aimed at determining which severe accidents shall be addressed in the design of accident management programmes?				
11	Have been potential design changes or procedural changes evaluated that could either reduce the likelihood of these selected events, or mitigate their consequences should these selected events occur, and implementation of those if reasonably practicable?				
12	Has been consideration given of the full design capabilities of the nuclear installation, including the possible use of some systems (i.e. safety and non-safety systems) beyond their originally intended function and anticipated operational states, and the use of additional temporary systems, to return the reactor to a controlled state and/or to mitigate the consequences of a severe accident (provided that it can be shown that the systems are able to function in the environmental conditions to be expected)?				
13	Are the system availability or unavailability assumptions justified and documented in the definition of accident sequences selected for deterministic accident analysis?				
14	Do the SAMGs include organizational structure of the severe accident management program within the facility, with identification of the roles and responsibilities of all program participants, including operating staff and emergency response and support groups?				
15	Are the parameters that define the transition from EOPs to SAM procedures selected and justified?				
16	Are the key parameters to diagnose the state of various reactor and nuclear installation systems throughout the progression of the accident selected and included in the procedures?				
17	Are the actions to be taken to counter challenges to the reactor and nuclear installation systems clearly defined and described in the SAMGs?				
18	Indicators that can be used to judge the success of the implemented actions are included in the SAMGs?				
19	Is there a communication protocol to be followed during implementation of SAMGs?				
20	Is there a technical support group available to support the implementation of the SAMGs?				
21	Were the guidelines or procedures developed for all groups participating in accident management such as control room operators, technical support group, and decision makers in accordance with their respective roles?				

22	Are the instructions to implementers clear and unambiguous, using consistent language and specific terms in accordance with established rules (preferably in a writer's guide)?				
23	Is the text and supplementary diagrams in the guidelines and procedures easy to read?				
24	Do the SAMGs cover common-cause events, potential damage to the fuel in spent fuel pools, releases of radioactive materials and hydrogen, and run-off of contaminated water to the environment?				
25	Has it been verified that access to equipment will be possible for local actions required by the guidelines?				
26	Have the long-term implications or concerns of implementing the strategies been considered?				
27	Has the licensee performed the assessment of availability and capability of the systems credited to perform the different strategies?				
28	Has the licensee analyzed and documented the staffing required to perform the SAMGs?				
29	Has the licensee performed a technical verification of the SAMGs? How?				
30	Has the licensee performed the validation of the SAMGs? How?				
31	Are there records of the verification and validation of the EOPs?				
32	Are the SAMGs readily identifiable and easily accessible?				
33	Are the operators, other shift staff members and technical support group members trained and qualified in the application of SAMGs? (check the records and the staff's knowledge)				
34	Are the SAMGs exercised as part of the emergency response exercises?				

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