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IAEA SAFETY STANDARDS SERIES

Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants

Step 10
Second Internal Review of Draft Publication

Reviewed in NSOC (Shaw/Asfaw/Nikolaki)

DRAFT SAFETY GUIDE No. DS 497A

Revision of Safety Guide NS-G-2.2

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1. INTRODUCTION

BACKGROUND

1.1. Requirements for the operation of nuclear power plants are established in IAEA Safety Standards Series No. SSR-2/2 (Rev. 1), Safety of Nuclear Power Plants: Commissioning and Operation [1], while requirements for the design of nuclear power plants are established in IAEA Safety Standards Series No SSR-2/1 (Rev. 1), Safety of Nuclear Power Plants: Design [2].

1.2. This Safety Guide provides specific recommendations on the development and use of operational limits and conditions (OLCs)[1] and associated operating procedures for nuclear power plants.

1.3. This Safety Guide was developed in parallel with six other Safety Guides on the operation of nuclear power plants, as follows:

- IAEA Safety Standards Series No. DS497B, Modifications to Nuclear Power Plants [3];
- IAEA Safety Standards Series No. DS497C, The Operating Organization for Nuclear Power Plants [4];
- IAEA Safety Standards Series No. DS497D, Core Management and Fuel Handling for Nuclear Power Plants [5];
- IAEA Safety Standards Series No. DS497E, Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants [6];
- IAEA Safety Standards Series No. DS497F, Recruitment, Qualification and Training of Personnel for Nuclear Power Plants [7];
- IAEA Safety Standards Series No. DS497G, Conduct of Operations at Nuclear Power Plants [8].

1.4. The terms used in this Safety Guide are to be understood as defined and explained in the IAEA Safety Glossary [9].

~~1.4.~~1.5. This Safety Guide supersedes IAEA Safety Standards Series No. NS-G-2.2, Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants[2].

OBJECTIVE

[1] In some States, the term 'technical specifications' is used instead of the term 'operational limits and conditions'.

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-2.2, IAEA, Vienna (2000).

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~~1.5.~~1.6. The purpose of this Safety Guide is to provide recommendations on the development, content and implementation of OLCs and operating procedures for nuclear power plants, to meet Requirements 6 and 16 of SSR-2/2 (Rev. 1) [1], respectively. Recommendations are also provided on the development of emergency operating procedures and severe accident management guidelines to meet Requirement 19 of SSR-2/2 (Rev. 1) [2], and on OLCs and operating procedures to prepare for decommissioning to meet Requirement 33 of SSR-2/2 (Rev. 1) [1].

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~~1.6.~~1.7. The recommendations provided in this Safety Guide are aimed primarily at operating organizations of nuclear power plants and regulatory bodies.

SCOPE

~~1.7.~~1.8. It is expected that this Safety Guide will be used primarily for land based stationary nuclear power plants with water cooled reactors designed for electricity generation or for other production applications (such as district heating or desalination).

~~1.8.~~1.9. This Safety Guide covers the concept of OLCs, their content as applicable to nuclear power plants, and the responsibilities of the operating organization for their establishment, modification, compliance and documentation. Operating procedures (including emergency operating procedures and severe accident management guidelines) to support the implementation of the OLCs and to ensure their observance are also within the scope of this Safety Guide.

~~1.9.~~1.10. Procedures for maintenance, surveillance, in-service inspection, radiation protection and other safety related activities in connection with the safe operation of nuclear power plants, and procedures for emergency preparedness and response, are outside the scope of this Safety Guide.

STRUCTURE

~~1.10.~~1.11. Recommendations relat~~ed~~ing to the concept and development of OLCs are provided in Section 2. Sections 3–6 provide recommendations on safety limits, limits on safety system settings, limits and conditions for normal operation, and surveillance requirements for OLCs. Sections 7 and 8 provide recommendations on the development of operating procedures and guidelines. Section 9 provides recommendations on how to ensure compliance with OLCs and operating procedures, including on the need to retain records of such compliance. Appendix I presents a sample list of the items for which ~~limits and conditions~~OLCs are generally established and Appendix II gives outlines for the development of operational procedures. The Annex contains an example to illustrate the interrelationship between a safety limit, a safety system setting and a~~n~~ ~~operational~~ limit for normal operation.

Commented [AKE2]: To use same language as SSR-2/2 (Rev. 1), para 4.10

2. THE CONCEPT OF OPERATIONAL LIMITS AND CONDITIONS AND THEIR DEVELOPMENT

THE CONCEPT OF OPERATIONAL LIMITS AND CONDITIONS

2.1. ~~The Agency's Specific Safety Requirements for Commissioning and Operation Ref.[1]~~ Paragraph 4.6 of SSR-2/2 (Rev. 1) [1] states~~: that~~

> "The plant shall be operated within the operational limits and conditions to prevent situations arising that could lead to anticipated operational occurrences or accident conditions, and to mitigate the consequences of such events if they do occur. ~~OLCs~~The operational limits and conditions shall be developed ~~to~~ for ensuring~~e~~ that the plant~~s~~ is being~~are~~ operated in accordance with design assumptions and intent, as well as in accordance with its licensing conditions."

~~In order to achieve this requirement, the plant safety analysis report should be developed in such a manner as to identify clearly the OLCs that must be met to prevent situations from arising which might lead to accident conditions or to mitigate the consequences of accidents if they do occur.~~ The OLCs should be defined in such a way that the independence of the levels of defence in depth and their adequate reliability is ensured. ~~See principle 8 in Ref. Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1 [16].~~

2.2. ~~From Requirement 6~~Paragraph 4.9 of ~~of Ref.~~SSR-2/2 (Rev. 1) [1] states:

> "The operational limits and conditions shall include requirements for normal operation, including shutdown and outage stages, and shall cover actions to be taken and limitations to be observed by the operating personnel."

~~These operational states~~Modes of ~~N~~normal operation ~~should~~ include start~~ing~~ up, power operation, shutting down, shutdown, maintenance, testing and refuelling. The OLCs should ~~also~~ define operational requirements to ensure that items important to safety ~~systems and safety features~~ perform their functions in all operational states, in design basis accidents ~~(DBAs)~~ and in design extension conditions ~~(DECs)~~ for which they are necessary. This ~~covers~~ includes permanently installed, portable and mobile equipment used for accident management (including for severe accident management) ~~permanently installed, portable and mobile, in their standby conditions~~.

2.3. The technical aspects of the OLCs should ~~cover~~ address the limitations to be observed, as well as the operational requirement~~s~~ that structures, systems and components important to ~~the~~ safety ~~of the nuclear power plantperform~~ are able to perform their intended functions as ~~assumed~~ described in the ~~plant~~ safety analysis report for the plant.

~~2.1.~~ Safe operation depends upon personnel as well as on equipment and procedures; therefore, OLCs should ~~therefore~~ also ~~cover~~ include the actions to be taken and

Commented [SP3]: We always try to help the reader by identifying the actual paragraph(s) – this has been applied throughout the draft

Commented [SP4]: This requirement from SSR-2/2 (Rev. 1) is paraphrased in the text below using the word 'must', which is not appropriate here – we need instead to use a direct quote. This approach has also been applied throughout the draft.

Commented [SP5]: OK to have the full quote?

Commented [SP6]: We do not generally refer back to individual principles in SF-1. Reference to the requirements of SSR-2/2 (Rev. 1) is sufficient here.

Commented [SP7]: OK? The quote refers to 'normal operation', not 'operational states' (i.e. which include AOO).

Commented [AKE8R7]: I think it would be nice to introduce the phrase 'modes of normal operation' here, so it's clear what you mean when you use it later.

Keep 'operational states' to mean those plant states that are not accident conditions

Commented [SP9]: SSR-2/2 (Rev. 1) uses 'startup'.

Commented [SP10]: OK? Terms should be in accordance with the definitions in the Glossary under 'Plant Equipment'.

Commented [SP11]: All abbreviations that occur just a few times have been written in full.

Commented [SP12]: OK to delete? I don't think we need this text.

Commented [SP13]: I know this is in the original SG – but the meaning is unclear. Limitations in what? Observed by whom? Please reword.

limitations to be observed by operating personnel.

~~2.2.~~2.4. With regard to operating personnel, the OLCs should include requirements for surveillance and corrective~~,~~ or complementary actions~~,~~ that are necessary to supplement the functioning of equipment involved in maintaining these ~~established~~ OLCs. Some OLCs ~~may~~ might involve a combinations~~s~~ of automatic functions and actions by personnel.

2.5. Paragraph 4.10 of SSR-2/2 (Rev. 1) [1] states:

"The ~~OLCs at the power plant~~operational limits and conditions sh~~ould~~all include the following~~ items~~:

(a) Safety limits;
(b) Limiting settings for safety system~~s settings~~;
(c) Limits and conditions for normal operation;
(d) Surveillance and testing requirements;
(e) Action statements for deviations from normal operation."

In addition, ~~OLCs should include objectives for~~ ~~all or some of~~ the most significant OLCs should include objectives ~~in order to~~ that justify their applicability, as well as ~~a~~ the bas~~e~~is for the~~ir~~ derivation of these objectives. These ~~items~~ objectives and bases should be included in the documentation on OLCs to increase the awareness ~~on the part~~ of plant personnel of the importance of applying~~ication~~ and observing~~ance of~~ OLCs.

~~2.3.~~2.6. ~~It should be understood that~~ OLCs should form a logical system in which the elements listed in para. 2~~3~~.5 are closely interrelated and in which the safety limits constitute the ultimate boundary of the safe conditions. An example explaining such an interrelationship is given in the Annex. The OLCs should be readily accessible to control room personnel; ~~. For this~~ they should be easily identified and preferably be in a single document for control room use. Control room ~~operators~~ personnel ~~should~~ are required to be ~~highly knowledgeable~~thoroughly familiar with ~~of~~ the OLCs and their technical basis: see para. 4.11 of SSR-2/2 (Rev. 1) [1].

~~2.4.~~2.7. ~~Should~~ If a situation arises in which, for any reason, operating personnel do not understand the operational state of the plant or cannot ascertain ~~that the power plant~~whether it is being operated within OLCs~~operating limits~~, or if the plant behaves in an unpredicted way, measures should be taken without delay to bring the plant to a safer state.

DEVELOPMENT OF OPERATIONAL LIMITS AND CONDITIONS

2.8. Paragraph 4.7 of SSR-2/2 (Rev. 1) [1] states that "operational limits and conditions shall reflect the provisions made in the final design as described in the safety analys~~e~~is report." The OLCs should be based on a safety analysis of the individual plant and its environment. ~~in accordance with the provisions made in the final design as~~

Commented [SP14]: What does this mean? Please clarify.

Commented [SP15]: This is a requirement, not a recommendation. It is very important that we maintain thid distinction. Requirements sated as recommendations have been corrected throughout the draft.

Commented [PS16]: All the other items in this list are covered in specific subsections. However, this is the only mention of "Action statements…" in the text. Is this deliberate?

Commented [SP17]: Too vague.

Commented [SP18]: I know that this is here in the original SG – but it is not clear how this fits within the subheading of "The concept of OLCs". Either an introductory sentence is needed – or more this para. elsewhere?

Commented [SP19]: OK?

Commented [SP20]: What does this mean? Para 7.9 refers to returning the plant to a "safe state" – is there a reason for this difference?

Commented [AKE21R20]: maybe because it is not after an AOO or accident, rather after 'unpredicted' behavior?

Commented [SP22]: This requirement was paraphrased below.

~~described in the safety analyses report Ref.[1].~~ The use of ~~the~~ deterministic safety analysis should be complemented by probabilistic safety analysis, as appropriate. The OLCs should be determined with due account taken of the uncertainties in the process of safety analysis. The safety analysis report and OLCs should be reviewed and amended where necessary on the basis of the results of commissioning testing (see para. 6.4 of SSR-2/2 (Rev. 1) [1]). ~~The~~

~~2.5.~~2.9. A written justification should be provided for each of the OLCs, and this should ~~be substantiated by means of a written indication of~~include the reason for ~~its~~ the adoption of each OLC and any relevant background information. These justifications should be readily available~~ when necessary~~, for example in the main control room and in the technical support centre at the site.

~~2.6.~~2.10. The initial OLCs should normally be developed in co-operation with the plant designers well before commencement of operation to ensure that adequate time is available for an independent assessment commissioned by ~~a safety expert of~~ the operating organization.

2.11. Paragraph 4.12 of SSR-2/2 (Rev. 1) states:

> "The operating organization shall ensure that an appropriate surveillance programme is established and implemented to ensure compliance with the operational limits and conditions, and that its results are evaluated, recorded and retained."

Each OLC should have associated surveillance requirements that support the operating personnel in ensuring compliance with the OLC.

~~2.7.~~2.12. ~~It is also essential that the~~ OLCs should be meaningful to ~~the~~ responsible operating personnel, and should be defined by directly measurable (or directly identifiable) values of parameters. Where directly ~~identifiable~~ measurable values cannot be used, the relationship ~~of~~ between a limiting parameter and the reactor power (or another measurable parameter) should be indicated by tables, diagrams or computing techniques, as appropriate. The ~~limit or condition~~OLC should be stated in such a way that it is clear whether or not a breach has ~~or has not~~ occurred.~~ in any situation.~~

~~2.8.~~2.13. Clear presentation and avoidance of ambiguity are important contributors to the reliab~~le~~ility ~~in the~~ use of OLCs:~~, and~~ therefore, advice on human factors should be sought at an early stage in the development of the documentation in which the OLCs will be presented to the operating personnel. The meaning of terms should be explained to help prevent misinterpretation.

~~2.9.~~2.14. Where modifications to the OLCs become necessary, the same approach as that described in para~~graph~~s. 2~~3~~.8–2~~3~~.12 should be followed. All plant modifications should be reviewed to determine whether they necessitate modifications to the OLCs.

Commented [SP23]: Strange phrase. The justification **is** the reason for adoption. Hence the rewording.

Commented [SP24]: Not clear how this would be determined. OK to delete?

Commented [SP25]: By whom? Please specify.

Commented [SP26]: The original text referred to adequate time for assessment and approval by the Regulatory Body – which made more sense. There seems to be a much weaker argument now – basically saying that the operating organization should give itself enough time – is that what is intended?

I think that assessment and approval of OLCs by the RB (if so required by the RB) is an important requirement – are you happy to not mention this at all? I could be considered misleading.

Commented [SP27]: We do not normally refer to individuals such as "safety expert". Also, it would help to indicate what you mean by "independent assessment" i.e. when it is paid for by the operating organization.

I suggest that this whole para needs rewording for clarity.

Commented [SP28]: It is helpful to first introduce the requirement, i.e. before adding a recommendation. OK?

Commented [SP29]: This type of phrase is normally redundant – and we generally delete.

Commented [SP30]: Yes?

Any modification to the OLCs should be subject to assessment and approval by the operating organization following the established procedures at the plant. The revised OLCs ~~may~~might also need to be approved by the regulatory body in accordance with para. 4.15 of SSR-2/2 (Rev. 1) [1]. ~~More information can be found~~Recommendations on plant modifications are provided in ~~Ref. Modifications to Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-2.3~~ DS497B [38].

~~2.10.~~2.15. When it is necessary to modify OLCs on a temporary basis, for example to perform physics tests on a new core, ~~particular care should be taken to~~it should be ensured that the effects of the change are fully analysed, and that the modified state, although temporary, ~~necessitates~~ involves at least the same level of assessment and approval of the OLCs as a permanent modification. When a permanent approach is available as a reasonable alternative, this should be preferred to a temporary modification of an OLC.

2.16. Paragraph 4.8 of SSR-2/2 (Rev. 1) [1] states:

> "The operational limits and conditions shall be reviewed and revised as necessary in consideration of experience, developments in technology and approaches to safety, and changes in the plant."

Periodic review of OLCs should be undertaken to ensure that they remain applicable for their intended purpose. ~~, and, where necessary, the~~ OLCs should be modified, ~~in the light of operating experience, technological development, approaches to safety and changes in the plant,~~ for example, to reflect the replacement of equipment, environmental effects on equipment, and ageing. This periodic review should be ~~carried out~~performed even if the plant has not been modified.

~~2.11.~~2.17. ~~C~~Consideration should be given to the application of probabilistic safety assessment ~~(PSA) applications~~ in the optimization of OLCs. This ~~application relates to the use of~~involves a risk informed approach, using insights from ~~PSA~~probabilistic safety assessment~~,~~ and ~~operational~~ operating experience to optimize allowed outage times, surveillance test intervals and test strategies. Further ~~information is available~~recommendations are provided in IAEA Safety Standards Series No. SSG-3, ~~Ref.~~ Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants~~, IAEA Safety Standards Series No. SSG-3~~ [9].

3. SAFETY LIMITS

3.1. The concept of safety limits is based on the prevention of unacceptable releases of radioactive material~~s~~ from the plant through the application of limits imposed on the temperatures of fuel and fuel cladding, and on the coolant pressure, pressure boundary integrity and other operational characteristics influencing the release of radioactive material from the fuel. ~~Established s~~Safety limits are intended to protect the integrity

Commented [SP31]: The original SG referred to the Regulatory Body – and for completeness I think we need to mention this requirement here.
If you prefer, it could be placed in a footnote?

Commented [SP32]: This requirement has been paraphrased below – the direct quote is needed.

of certain physical barriers that guard against the uncontrolled release of radioactive material.

~~3.1.~~3.2. The safety limits should be established by means of a conservative approach to ensure that all the uncertainties associated with the~~of~~ safety analyses are taken into account. This implies that exceeding a single safety limit does not always lead to ~~the~~ unacceptable consequences~~ mentioned earlier~~. Nevertheless, if any safety limit is exceeded, the reactor should be shut down and normal power operation restored only after an appropriate evaluation has been performed and approval for restarting has been given in accordance with established plant procedures. Any allowed exception from the rule to shut down the reactor after a safety limit has~~ve~~ been exceeded should be included in the OLCs and justified in the safety analysis.

~~3.2.~~3.3. The safety limits ~~are~~ should be chosen with the objective of maintaining the integrity of the fuel cladding and the integrity of the pressure boundary of the reactor coolant system under all conditions, thus ensuring that there is no significant release of radioactive materials. ~~An essential factor in maintaining the integrity of the fuel cladding is adequate cooling of the fuel. In this regard, the pressure boundary of the reactor coolant system should be kept intact. This prevents any loss of coolant and resulting reduction in the effectiveness of cooling.~~

~~3.3.~~3.4. Although the integrity of the containment is important in limiting the radiological consequences of an accident, loss of containment integrity does not of itself lead to damage to the fuel cladding. ~~It~~ Consequently, the integrity of the containment is not ~~therefore~~ included in the safety limits, but should be included ~~under~~ in the limits and conditions for normal operation (see Section 6).

~~3.4.~~3.5. The temperatures of the fuel and fuel cladding should be limited to values that ensure that the design ~~intent~~ requirements with respect to the extent of failures of the fuel cladding ~~is~~ are achieved. The safety limits should usually be stated as the maximum acceptable ~~values~~ temperatures ~~which~~ that ensure the integrity of the fuel cladding, using~~with~~ a ~~the~~ conservative approach as described ~~sm mentioned in~~ para. 3.2. Safety ~~L~~limits for local heat transfer rates for the fuel cladding should be defined and established to ensure that local fuel temperatures and fuel cladding temperatures do not rise to levels at which cladding failure could occur.

~~3.5.~~3.6. Safety limits for the pressure and temperature of the reactor coolant system should be stated in relation to their design values.

4. LIMITING SETTINGS FOR SAFETY SYSTEMS ~~SETTINGS~~

4.1. ~~There will be s~~Safety system settings will be established in terms of~~for~~ a range of parameters. These ~~are the~~include the parameters ~~included~~ in terms of which safety

Commented [SP33]: We do not need to justify the recommendation. This is just supporting information – hence deleted.

Commented [SP34]: Yes?

Commented [PS35]: To match SSR-2/2 (Rev. 1) and para. 2.5.?

Commented [AKE36]: OK for changes in the first two sentences? It's not that the settings and limits are for the parameters; the settings and limts are for the systems and are set in terms of parameters, I think.

limits are established, as well as other parameters ~~,~~ (or combinations of parameters)~~,~~ ~~which~~ that could contribute to pressure or temperature transients. Exceeding some ~~such~~ safety system settings will cause the reactor to ~~be tripped~~automatically shut down ~~to suppress a transient~~. Exceeding other safety system settings will result in other automatic actions to prevent safety limits from being exceeded. ~~Some o~~Other safety system settings are provided to initiate the operation of engineered safety systems. ~~These Such~~Engineered safety systems limit the course of anticipated operational occurrences in such a way that either safety limits are not exceeded, or the consequences of postulated accidents are mitigated. The interrelationship~~connection~~ between safety system settings, safety limits and ~~operational~~ limits for normal operation is illustrated in the Annex.

4.2. ~~Established S~~Ssafety system settings should be established to ensure the automatic actuation of safety systems within parameter values assumed in the safety analysis report, despite the possible errors that could occur adjusting the nominal set point. Appropriate alarms should be provided to enable the operating personnel to initiate corrective actions before safety system settings are reached.

4.3. The following list contains ~~are~~ typical parameters, operational occurrences and protective system devices for which safety system settings ~~are necessary~~should be provided:~~.~~ ~~Note that the settings may be different in different operational states. For example, at a low operating temperature, the relief system for the reactor pressure vessel may necessitate lower pressure settings.~~

~~4.3.4.1.~~

- Neutron flux and distribution (startup, intermediate and operating power ranges);
- Rate of change of neutron flux;
- Axial power distribution factor;
- Power oscillation;
- Reactivity protection devices;
- Temperatures of fuel cladding, or fuel channel coolant;
- Temperature of reactor coolant;
- Rate of change of temperature of reactor coolant;
- Reactor core void content (~~BWR~~boiling water reactor);
- ~~Rate of change of temperature of reactor coolant;~~
- Pressure of the reactor coolant system (including cold overpressure settings);
- Water level in the reactor vessel~~,~~ or pressurizer (varying with plant state and differing with reactor type);
- Reactor coolant flow;
- Rate of change of reactor coolant flow;
- Recirculation flow (boiling water reactor~~BWR~~);

Commented [SP37]: Unclear – and I think redundant. Hence deleted.

Commented [AKE38]: I would like to clearly distinguish between 'operational limits' (which I think should only appear as within the generic term OLCs) and 'limits and conditions for normal operation' (i.e. bullet c) of SSR-2/2 (Rev. 1) para 4.10)

Commented [PS39]: This is unclear – can you please reword to make the meaning clearer.

Commented [SP40]: This list is not consistent with Appendix I – which is also a list of parameters, occurrences and devices for which OLCs are needed.

Can you please edit this list to match Appendix 1 (or vice versa)? Or at least provide an explanation for why they are different.

We nust try to be as consistent within the SG – if this cannot be done then delete either this list or Appendix I.

Commented [PS41]: OK? This is a recommendation – yes?

Commented [PS42]: Moved to after the list

- ~~Rate of change of reactor coolant flow;~~
- Rate of change of recirculation flow (boiling water reactor~~BWR~~);
- Tripping of primary coolant circulation pump, or tripping of recirculation pump (boiling water reactor~~BWR~~);
- Intermediate cooling and ultimate heat sink;
- Water levels in ~~the~~ steam generators;
- Inlet feed-water temperature for the steam generators (pressurized water reactor~~PWR~~);
- Outlet steam temperature for the steam generators;
- Steam flow and pressure;
- Feed-water flow and temperature (boiling water reactor~~BWR~~);
- ~~Settings provided to i~~Initiation of~~e~~ steam line isolation, turbine trip and feed-water isolation;
- Closure of isolation valve for the main steam line;
- Injection of emergency coolant;
- Containment pressure;
- ~~Settings provided to initiate s~~Startup of spray systems, cooling systems and isolation systems for the containment;
- Dry well pressure and ~~/~~temperature (boiling water reactor~~BWR~~);
- Wet well pressure, ~~/~~temperature and ~~/~~water level (boiling water reactor~~BWR~~);
- Control and injection systems for coolant poison;
- ~~Radioactivity l~~Levels of radioactive material in the primary circuit;
- ~~Radioactivity l~~Levels of radioactive material in the steam line;
- ~~Radioactivity l~~Levels of radioactive material ~~and levels of atmospheric contamination~~ in the reactor building;
- ~~Radioactivity l~~Levels of radioactive material in exhaust air and the waste water outlet;
- Loss of normal electrical power supply;
- Loss of emergency power supply;
- Steam g~~G~~enerator tube leakage monitoring (pressurized water reactor~~PWR~~);
- Primary circuit leakage monitoring.

~~Note that t~~The settings ~~may~~might be different in different operational states. For example, at a low operating temperature, the relief system for the reactor pressure vessel ~~may~~might necessitate lower pressure settings.

4.4. The actions to be initiated~~, as described in para. 5.1,~~ in case of ~~of exceeded~~ safety system settings ~~limits~~ being exceeded or equipment failures~~, listed in paragraph 5.3,~~ ~~may vary~~might differ ~~according to~~depending on the reactor type and design. ~~,~~ For particular reactor types, ~~or~~ some of the settings ~~may~~ might not be applicable, and ~~. For particular reactor types, additional parameters~~ safety system settings should be specified in terms of additional parameters, which should be described in the safety

Commented [PS43]: Edited to link with the text before the list.

Commented [AKE44]: ‘modes of normal operation’?

Commented [AKE45]: OK?

analysis report~~, for which safety system settings should be specified~~.

5. LIMITS AND CONDITIONS FOR NORMAL OPERATION

5.1. Limits and conditions for normal operation are intended to ensure safe operation; that is, to ensure that the assumptions of the safety analysis report are valid and that established safety limits are not exceeded in the operation of the plant. In addition, acceptable margins should be ensured between the normal operating values and the established safety system settings to avoid undesirably frequent actuation of safety systems. Figure A–1 in the Annex demonstrates ~~a correlation~~the interrelationship between safety limits, safety system settings and limits for normal operation.

5.2. The limits and conditions for normal operation should include limits on operating parameters, stipulations for the minimum amount of operable equipment, minimum staffing levels, prescribed actions to be taken by ~~the~~ operating ~~staff~~ personnel in ~~the event~~case of deviations from ~~the established~~ OLCs and the allowed time frame to recover from these ~~situations~~deviations. The OLCs should also include parameters such as the chemical composition and radioactive content of working media~~, their activity contents~~ and limits on radioactive discharges ~~of radioactive material~~ to the environment.

Commented [PS46]: I am not sure it is clear what this covers - could you include some examples of the media?

5.3. Operability requirements should state ~~for the various operational states of normal operation~~ the number of systems or components important to safety that should be either in operating condition or in standby condition for each mode of normal operation. These operability requirements ~~together~~ collectively define the minimum safe plant configuration for each mode of normal operation. When defining this minimum safe configuration, ~~T~~the independence of the defence in depth levels and barriers implemented in the plant should be maintained~~, when defining the minimum safe plant configuration~~. Where operability requirements cannot be met~~ to the extent intended~~, the actions to be taken to ~~manoeuvre~~ put the plant ~~to~~ in a safer state, such as power reduction or reactor shutdown, should be specified, and the time allowed to complete the action should also be stated.

Commented [AKE47]: OK?

5.4. ~~Given the higher associated risks d~~During startup of the power plant after out~~-~~ages, the operability requirements ~~for this operational state~~ should be more stringent than those that are permitted for operational flexibility ~~in~~ during power operation. The ~~S~~safety system equipment that is ~~required to be operable~~necessary for startup should be specified.

5.5. After an anticipated operational occurence, including a reactor trip, the cause of the event should be determined and~~,~~ evaluated. ~~and a~~Appropriate ~~remedial~~ corrective actions should be taken ~~to the extent necessary~~ to provide assurance that it is safe to resume operation or, in case of a trip, to restart the reactor. Procedures for determining the evaluations and actions ~~and evaluations~~ to be ~~carried out~~performed should be available ~~beforehand~~ in advance. If OLCs have been exceeded, the cause should be investigated. ~~More information~~Further recommendations can be found in ~~Ref.~~ IAEA Safety Standards Series No. SSG-50, Operating Experience Feedback for Nuclear Installations, ~~IAEA Safety Standards Series No. SSG-50~~ [10].

5.6. When it is necessary to remove a component of a safety system from service, confirmation should be obtained that the safety logic continues to be in accordance with design provisions. The performance of a safety function ~~may~~ might be affected by process conditions~~,~~ or service system conditions~~,~~ that are not directly related to the equipment performing the function. It should ~~therefore~~ be ensured that any such ~~influences~~ effects are identified, and that appropriate limits are applied ~~and~~ to ensure that the minimum safe plant configuration ~~should be~~is maintained.

5.7. For the operability requirements for safety related equipment, the provisions in the design for redundancy and~~, the~~ reliability, ~~of the equipment~~ and the period over which equipment is inoperable without an unacceptable increase in risk, should be taken into consideration.

5.8. The allowable periods of inoperability and the cumulative effects of these periods should be assessed in order to ensure that any increase in risk is kept to an acceptable level~~s~~. ~~PSA~~Probabilistic safety assessment, or reliability analysis, should be used, as ~~the most~~ appropriate ~~means,~~ for this purpose. Shorter inoperability periods than those derived from a ~~PSA~~ probabilistic safety assessment should be stipulated in the OLCs, taking into account ~~on the basis of other~~ information such as pre-existing safety studies or ~~operational~~ operating experience.

5.9. Appendix I ~~presents the items~~contains a description of~~: a)~~ the parameters for which ~~operating~~ operational limits are ~~required to be defined~~necessary ~~or set and b)~~, and the conditions that are generally necessary for the normal operation of systems, structures and components ~~which are generally necessary~~. It should be recognized that, for a particular plant design, other limits ~~may~~ might be necessary to ensure that all parameters included in the design and in the safety analysis are adequately controlled.

6. SURVEILLANCE AND TESTING REQUIREMENTS

6.1. In order to ensure that safety system~~s~~ settings and limits and conditions for normal operation are met at all times, the relevant systems and components should be monitored, inspected, checked, calibrated and tested in accordance with an approved surveillance programme (see para. 2.1~~0~~1). The surveillance programme should be adequately specified to ensure ~~the inclusion of~~ all aspects of the ~~operational limits or conditions~~OLCs are addressed.

6.2. ~~Safety (and safety related/supporting) system~~ The testing requirements and the

Commented [PS48]: Please check that this has retained the intended meaning.

Commented [NM49]: Changed to operational limits

Commented [PS50]: To match SSR-2/2 (Rev. 1) and para. 2.5

surveillance test intervals ~~(STIs)~~ for safety systems — and for safety related systems and supporting systems — should be clearly defined. The frequency of the surveillance tests should take into account the safety importance of the equipment, and should be based on a reliability analysis. This analysis should includ~~eing~~, where available, a probabilistic safety assessment~~PSA~~ and experience gained from previous surveillance results; if these are not available, the reliability analysis ~~or, in the absence of both,~~should be based on the recommendations of the supplier. ~~PSAs~~ Probabilistic safety assessments can also be used to modify surveillance test intervals,~~STIs~~ based on a quantitative analysis of specific contributors to overall plant risk. This can be undertaken as part of the review and revision of existing ~~operational limits and conditions~~OLCs, or ~~and~~ as part of the~~for~~ development of specifications for new plants ~~Ref.~~[9].

6.3. The surveillance requirements should be specified in procedures that also contain~~with~~ clear acceptance criteria, to ensure ~~so~~ that there are no doubts concerning system operability or component operability. The relationship between the acceptance~~se~~ criteria and the ~~limit or condition~~OLC being confirmed should be ~~available in written form~~documented.

6.4. The surveillance requirements should also cover activities to detect ageing and other forms of deterioration due to corrosion, fatigue and other mechanisms. Such activities will include non-destructive examination of passive systems as well as of systems explicitly covered by limits and conditions for normal operation. If degraded conditions ~~were to be~~are found, then the effect on the operability of systems should be assessed and acted upon.

6.5. Further ~~guidance~~ recommendations on ~~concerning~~ surveillance activities ~~can be found~~are provided in DS475E ~~Ref.~~[6].

7. OPERATING PROCEDURES AND GUIDELINES

GENERAL

7.1. Requirement 26 of ~~in Ref.~~SSR-2/2 (Rev. 1) [1] states:

> ~~that~~ **"Operating procedures shall be developed that apply comprehensively (for the reactor and its associated facilities) for normal operation, anticipated operational occurrences and accident conditions, in accordance with the policy of the operating organization and the requirements of the regulatory body."~~.~~**

All safety related activities should be performed in conformity with ~~documents~~ procedures developed and issued in accordance with ~~recommendations~~a management

Commented [MN51]: I would write 'Probabilistic safety assessments' instead of 'this'.

Commented [PS52]: Moved up – it is better to start with the requirements

Commented [SP53]: I think it is better to have the full quote. OK?

system that meets the requirements established in IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [11], and para. 3.2 of SSR-2/2 (Rev. 1) [1]~~approved administrative procedures~~. The availability and correct use of written ~~OPs~~operating procedures, including surveillance procedures, ~~is~~ are an important contribution to the safe operation of a nuclear power plant.

7.2. ~~Requirement 26 in Ref.[1] states that "Operating procedures shall be developed that apply comprehensively (for the reactor and its associated facilities) for normal operation, anticipated operational occurrences and accident conditions". Requirement 19~~Paragraph 5.8 ~~in~~ of SSR-2/2 (Rev. 1) ~~Ref.~~[1] states ~~that~~:

> "An accident management programme shall be established that covers the preparatory measures, procedures and guidelines that are necessary for preventing the progression of accidents, including accidents more severe than design basis accidents, and for mitigating their consequences if they do occur."

~~7.1.~~7.3. In developing operating procedures, including emergency operating procedures for design basis accidents and design extension conditions —without significant fuel degradation, and severe accident management ~~procedures or~~ guidelines ~~(SAMG)~~, the influence of human and organizational factors on ~~one, several, or all~~the levels of defence in depth should be considered. ~~, to avoid negative impact on the reliability of these levels and the independence between the levels.~~ The operating procedure~~OPs~~s should be defined in such a way that the independence of the levels of defence in depth and their adequate reliability is ensured (~~. S~~see ~~principle 8 in Ref.~~paras 2.12–2.14 and Requirement 7 of SSR-2/1 (Rev. 1) ~~Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1~~ [2]).

7.4. Paragraph 4.26 of SSR-2/2 (Rev. 1) ~~Ref.~~[1] states ~~that~~:

> "A~~a~~ll activities important to safety shall be carried out in accordance with written procedures to ensure that the plant is operated within the established operational limits and conditions~~OLCs~~."

Operating p~~P~~rocedures should provide instructions for the safe conduct of all modes of normal operation, such as start~~ing~~ up, power operation, shutting down, shutdown, load changes, maintenance, testing and refuelling. Procedures should also provide instructions on how to ~~maneuver~~ move systems, equipment or components ~~in plant states~~, including systems, equipment or components that are used in plant states more severe than design basis accidents.

7.5. Operating procedures should be categorized, ~~according to~~based on the manner in which they are to be applied. For example, the following types of procedure should be clearly distinguished by this categorization:

(a) Operating procedures that are applied continuously in a step-by-step manner;~~,~~

Commented [SP54]: "Approved administrative procedures is very vague. Hence, it is better to introduce GSR Part 2 here.

Commented [SP55]: This is said in the next sentence - hence deleted.

Commented [SP56]: It is better to refer to the requirements than SF-1

Commented [NM57]: Is it ok to include 'load changes here? This is not included in the Glossary nor in the sentence in para. 2.2.

Commented [SP58]: OK? If not use the UK spelling "manoeuvre"

Commented [SP59]: I put this in a list for clarity.

(b) ~~p~~Procedures that are used as references to confirm the correctness of actions; ~~and p~~

(c) Procedures for informational use~~ should be clearly indicated through the method of categorization of procedures~~.

~~7.2.~~7.6. The use of step-by-step procedures should ~~require~~ involve confirmation of ~~the~~ each step~~s~~ after ~~they~~ it has~~ve~~ been ~~carried out~~completed ~~by the operator~~, ~~prior to~~before commencement of the next step. Procedures should contain hold points at which certain ~~critical~~ key tasks are to be performed, and ~~should require~~ independent checks ~~of these tasks, be~~ completed, as appropriate, before proceeding beyond the hold point.

~~7.3.~~7.7. ~~8.3.~~ Alarm response procedures should be developed in support of the main operating procedure~~OP~~s. They should ensure a timely and correct response to deviations from the limits ~~of~~ for steady state operation (see the Annex) and should ensure that the plant parameters are maintained within specified limits.

~~7.4.~~7.8. ~~8.3.A~~ Operator aids — including sketches, handwritten notes, curves and graphs, instructions, copies of procedures, prints, drawings, information tags and other information sources — that are used routinely by operating ~~ors~~personnel to assist them in performing their assigned duties ~~should~~ are required to be controlled in accordance with para. 7.5 of SSR-2/2 (Rev. 1) [1]~~be controlled by the operations department~~. ~~More~~ Further recommendations are provided in ~~details can be found in Ref. Conduct of Operations at Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-2.14~~DS497G [8].

~~7.5.~~7.9. ~~8.3.B~~ For anticipated operational occurrences, design basis accidents ~~(DBAs)~~ and design extension conditions ~~(DECs)~~ without significant core degradation, the operating procedure~~OP~~s should provide instructions for the return to a safe state. For ~~DBAs~~ design basis accidents and design extension condition~~DEC~~s without significant core degradation, the procedures to keep the plant ~~state~~ parameters within specified limits~~,~~ should be event based or symptom based (see paras 7.14, 7.17–7.20).

~~7.6.~~7.10. When verbal and/or written instructions are used ~~in operational practice~~ at a nuclear power plant, administrative procedures should be put in place to ensure that these ~~verbal and/or written~~ instructions do not diverge from the established operating procedure~~OP~~s and do not compromise established OLCs.

~~7.7.~~7.11. Operating procedures should be verified and validated to ensure that they are administratively and technically correct, are understandable ~~are~~ and easy for ~~the~~ operating personnel~~or~~ to use, ~~are understandable~~ and will function as intended. O~~P~~perating procedures should ~~be compatible~~take due account of ~~with~~ the environment in which they are intended to be used. The operating procedures~~OPs~~ should be validated in the form in which they will be used in the field.

Commented [SP60]: We try to avoid "should require"

Commented [SP61]: I am not clear what this means. Are you saying that there are other less restrictive limits, i.e. in addition to limits for steady state operation? Also, "specified limits" is too vague. Please can you reword to make this clearer.

Commented [NM62R61]: The phrase 'within specified limits' is also used in para. 7.9.

Commented [SP63]: OK?

7.12. Paragraph 7.4 of SSR-2/2 (Rev. 1) [1] states:

> "Operating procedures and supporting documentation … shall be subject to approval and ~~The OPs should be~~ periodically reviewed and revised as necessary to ensure their adequacy and effectiveness. ~~that they remain fit for their purpose and if necessary the procedures should be modified, verified, validated and approved, as required.~~ Procedures ~~should~~ shall be updated periodically and in a timely manner in the light of operating experience and the actual plant configuration ~~Ref.[1]~~."

~~7.8.~~7.13. Following the completion of a plant modification, the modified system or ~~/~~equipment should not be put into operation until the related operating procedures have been reviewed ~~for applicability~~ and modified ~~accordingly~~as necessary. A r~~R~~eview of procedures should also be performed as part of a p~~P~~eriodic s~~S~~afety r~~R~~eview to determine whether the operating organization's processes for managing, implementing and adhering to plant procedures and for maintaining compliance with ~~operational limits and conditions~~OLCs and regulatory requirements are adequate and effective to ensure plant safety. ~~More detailed guidance~~Further recommendations are provided ~~can be found~~ in ~~Ref.~~ IAEA Safety Standards Series No. SSG-25, Periodic Safety Review for Nuclear Power Plants~~, IAEA Safety Standards Series No. SSG-25~~ [12].

PARTICULAR ASPECTS OF EMERGENCY OPERATING PROCEDURES

7.14. Event based or symptom based E~~e~~mergency operating procedures ~~(EOPs)~~ ~~should~~are required to be developed, as appropriate: see para. 7.3 of SSR-2/2 (Rev. 1) [1]. These procedures should ~~as event based, or symptom based and~~ cover all ~~operation~~ modes of operation, including low ~~reactor low~~ power and shutdown modes. For ~~DBAs~~design basis accidents, both approaches can be used, although symptom based procedures are preferable, for the reasons stated in para. 7.19~~8.12~~. Symptom based emergency operating procedure~~EOP~~s should use parameters that indicat~~e~~ing the state of the plant ~~state~~, to help identify the optimum ~~recovery routes~~corrective actions to be taken by ~~for the~~ operating personnel ~~or~~ without the need for accident diagnosis.

~~7.9.~~7.15. Emergency operating procedure~~OP~~s should also ~~cover~~ address ~~both~~ ~~design basis accidents and~~ design extension conditions ~~–~~without significant fuel degradation. The purpose of ~~these~~ emergency operating ~~EOPs~~ procedures is to guide the main control room operators and other operating personnel in preventing fuel degradation, ~~while~~ considering the full design capabilities of the plant, using both safety systems and non-safety systems, including their possible use beyond their originally intended function and ~~anticipated~~ operating conditions. ~~EOPs should be used in the preventive domain of accident management.~~

~~7.10.~~7.16. Emergency operating ~~OP~~procedures should also ~~cover the~~be developed for locations where spent fuel is handled and stored. ~~These~~ Emergency operating ~~EOPs~~

Commented [SP64]: OK? "plant state" has a specific meaning.

Commented [SP65]: OK? "Recovery routes" could mean a number of different things. "Corrective actions" is used in SSR-2/2 (rev. 1).

Commented [SP66]: Already covered in the previous para.

Commented [SP67]: Prevention is made clear in the previous sentence – hence deleted.

procedures should ~~be suitable to~~address the management of accident conditions that simultaneously affect the reactor and the spent fuel, and should take into account the potential interactions between the reactor and the spent fuel systems. Depending on shutdown and spent fuel conditions, ~~EOP~~emergency operating procedures should take into ~~consideration~~ account ~~specific constraints~~ ~~like~~the following:

(a) In a shutdown mode, ~~M~~most of the automatic protection signals might have been inhibited and ~~there is~~ a high number of alarms might be ~~normally~~ activated ~~in a shutdown mode~~;

(b) There might be an increased risk of incidents due to human error during fuel handling, maintenance and periodic tests;

(c) ~~The unavailability of s~~Systems might be unavailable due to maintenance;

(d) The ~~set of~~ available instrumentation ~~can~~ might be limited;

(e) ~~Manual a~~Actions by operating personnel ~~can~~ might be ~~required~~ necessary within a short period of time.

~~7.11.~~7.17. Event based emergency operating procedure~~EOP~~s specify operator actions on the basis of the determination of the event. For event based procedures, the ~~decisions and measures~~ actions ~~to respond to accidents~~ should be ~~made on the~~ based~~is~~ on~~f~~ the state of the plant in relation to predefined events~~, which are~~ considered in the design and in the safety analysis report. In using the event based approach, the ~~operator should identify the~~ specific ~~DBA~~ design basis accident should be identified before ~~the recovery and/or mitigatory~~ ~~operator~~ actions ~~have begun~~are taken by operating personnel.

~~7.12.~~7.18. Event based ~~EOPs~~ emergency operating procedures should include at least the following:

(a) Symptoms for the identification of the specific accident (~~such as~~e.g. alarms, operating conditions, probable magnitudes of parameter changes, and characteristics of potential degradation of core cooling);

(b) Automatic actions that will probably be ~~taken~~ initiated as a result of the accident;

(c) Immediate operator actions for the operation of controls or the confirmation of automatic actions;

(d) Subsequent operator actions ~~directed~~ to return~~ing~~ the reactor to a normal condition or to provide for safe, extended and stable shutdown conditions.

~~7.13.~~7.19. Consideration should be given to the inherent limitations of event based procedures. These are as follows:

(a) Optimal corrective actions or actions to ~~recovery and/or~~ mitigate~~ion~~ the consequences of accidents is possible only after the proper identification of the type of event. Operating personnel~~ors~~ ~~may~~ might ~~be subject to the necessity~~need to respond to unexpected events and ~~may~~ might ~~thus~~ find themselves in

Commented [SP68]: "Constraint" a different Glossary meaning.

Commented [SP69]: Ambiguous – could mean the organization or specific personnel. Best to omit.

Commented [SP70]: Recovery is not the right word here.

Commented [AKE71]: 'Be taken' sounds like a person will take the action; or 'that will probably take place'. Is 'probably' correct?

situations for which they have had no specific training or for which there are no specific procedures to identify accurately the event that has occurred.~~;~~

(b) Only a finite number of events are analysed and accounted for in the safety analysis report, and un~~-~~analysed accidents beyond design extension conditions are outside the scope of the emergency operating procedures.~~;~~

(c) Most event based procedures ~~are oriented~~assume the event will evolve in a certain predetermined ~~'one~~ way~~'~~ and deal with only a limited number of combinations of events;

(d) There are no links or transition points between different procedures; therefore, there is no predefined method for ~~the operator to~~ dealing with multiple events (such as a steam line break in conjunction with a loss of coolant accident, or a loss of feed-water in conjunction with an anticipated transient without scram).

~~7.14.~~7.20. Symptom based emergency operating procedure~~EOP~~s can resolve some of the limitations of the event based approach by formally defining and prioritizing the ~~major~~ critical safety functions. In symptom based procedures, the decisions ~~for~~ on measures to respond to events should be specified with respect to the symptoms and the state of plant systems ~~of the plant~~ (such as the values of safety parameters and critical safety functions). This allows ~~the operator to maintain~~ optimum~~al~~ operating characteristics to be maintained ~~without the need to be concerned~~in the absence of information about ~~with~~ the continuing accident scenario.

~~7.15.~~7.21. The ~~EOPs~~ emergency operating procedures should contain decision points and criteria for taking various actions. The uncertainties and margins associated with the parameters used for taking decisions should be assessed. A comprehensive thermohydraulic analysis should be performed for the implementation of symptom based procedures. This analysis should ensure that the generic set of operator actions in connection with the deterioration of each critical safety function is sufficient to withstand the most severe challenge to that safety function. Wherever applicable, plant specific ~~PSA~~ probabilistic safety analysis should be used to identify bounding sequences for which realistic thermohydraulic analyses are performed and potential operator actions and timing are identified ~~Ref.~~[9].

~~7.16.~~7.22. Emergency operating procedure~~OP~~s should be easy to distinguish from other plant procedures. A consistent format should be used throughout. The title of the procedure should be short and descriptive to enable ~~the~~ operating personnel~~or~~ to quickly ~~to~~ recognize the abnormal condition to which it applies.

7.23. Explanatory text should be avoided in ~~EOPs~~emergency operating procedures, which should be limited to instructions for ~~the~~ operating personnel~~or~~ to ~~carry out~~perform an action or to verify the state of the plant~~ state~~. ~~EOPs~~ Emergency operating procedures ~~should~~ may contain supplementary ~~background~~ information to aid

Commented [SP72]: OK?

Commented [AKE73]: Correct meaning of 'oriented 'one way''? I found this phrasing in Safety Report 48

Commented [SP74]: This is always a concern – hence the rewording.

Commented [SP75]: OK? There is a danger otherwise of conflict with the first sentence.

Commented [SP76]: I suggest this should be deleted – OK?

operat~~or~~ing personnel~~s~~ ~~further~~ in taking the ~~proper~~ emergency actions, but this information should be separated from the main ~~procedural actions~~instructions. The ~~instructions~~ procedures should include actions, where appropriate, to initiate the ~~procedure for~~ determination of~~ing~~ the emergency class ~~of the accident conditions~~ and to initiate ~~beginning~~ the corresponding emergency ~~response actions~~plan; see IAEA Safety Standards Series No. GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency [13]. The instructions for these actions should be repeated whenever ~~execution of an EOP indicates~~there is a change in the severity of the event.

~~7.17.~~7.24. Further information on the development and review of emergency operating procedures is provided in Ref. [14].

SEVERE ACCIDENT MANAGEMENT GUIDELINES

~~7.18.~~7.25. ~~8.14.A Detailed guidance~~Recommendations on accident management, including severe accident management, ~~is~~ are provided in IAEA Safety Standards Series No. SSG-54 ~~[11].~~ Accident Management Programmes for Nuclear Power Plants [154].~~IAEA Safety Standards Series No. SSG-54 [11].~~

~~7.19.~~7.26. The ~~S~~severe accident management guidelines ~~(SAMGs)~~ that are necessary ~~to cope with severe accidents~~ should be identified by a systematic analysis of the plant's vulnerabilities to ~~such~~ severe accidents, and by the development of strategies to deal with these vulnerabilities.

~~7.20.~~7.27. S~~AMGs~~evere accident management guidelines should be developed from ~~the~~ accident management strategies and the measures to be used ~~in the~~to mitigate the consequences of ~~ory domain of~~ accidents~~ management~~. The purpose ~~of SAMGs~~ is to provide guidance fore ~~the~~ ~~emergency response organization~~operating personnel during severe accidents. The operating personnel responsible for executing ~~of~~ the severe accident management guidelines ~~SAMG~~ are the main control room operators and staff in the technical support centre at the site (or equivalent). Staff at a technical centre at a corporate, regional or national level can also ~~be the~~ users~~ of~~ ~~SAMGs~~ the guidelines in providing support to the ~~concerned~~ affected site. All ~~these categories of~~such personnel should be trained in the use and application of the severe accident management guidelines~~SAMGs~~.

~~7.21.~~7.28. Plant specific details should be taken into account in the identification and selection of the most suitable actions to cope with severe accidents. Severe accident management guidelines ~~should~~ are required to include all possible means — safety related and conventional;~~,~~ permanent and non-permanent; — in the plant, from neighbouring units and off-site~~,~~ — with the aim of maintaining the integrity of the containment and preventing the release of radioactive material to the environment: see para. 5.8B of SSR-2/2 (Rev. 1) [1]~~., see Ref.~~ and ~~Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No.~~ GSR Part 7~~,~~

Commented [AKE77]: I guess you mean 'emergency class' as defined in GSR Part 7, right? If so, better introduce it here

Commented [AKE78]: Safety Report 48 is right on topic here. It was issued in 2006, so after the last version of NS-G-2.2. Do you want to include it? It would become reference [14]

Commented [SP79]: 'response organization' is a broad term that includes all off-site organizations with an emergency response role. SAMGs are for plant personnel.

~~IAEA, Vienna (2015)~~ [134].

~~7.22.~~7.29. To ensure the effective use of severe accident management guidelines~~SAMGs~~, they should be carefully interfaced with the existing emergency operating procedures~~EOPs~~ to avoid any omissions. ~~For~~ Recommendations on ~~guidance about~~ the interfac~~eing~~ between emergency operating procedures~~EOPs~~ and ~~SAMGs~~ severe accident management guidelines and the transition from ~~EOPs to the SAMGs~~one to the other are provided in~~, see Ref. Accident Management Programmes for Nuclear Power Plants, IAEA Safety Standards Series No.~~ SSG-54 [154].

~~7.23. 8.18.A Deleted~~

~~7.24.~~7.30. ~~8.18~~ Severe accident management guidelines~~SAMGs~~ should be verified and validated in order to assess their technical accuracy and adequacy to the extent possible, as well as the ability of personnel to follow and implement the guidelines~~ance~~. It should also be ensured ~~and~~ that the interfac~~ing~~ between the emergency operating procedures ~~SAMGs~~ and severe accident management guidelines~~EOPs~~ is effective. Severe accident management guidelines~~The SAMGs~~ should be periodically reviewed to ensure that they remain fit for ~~their~~ purpose, and should be updated following ~~the completion of a related plant~~the modification of relevant parts of the plant.

~~7.25.~~7.31. ~~8.18.B~~ Severe accident management guidelines ~~SAMGs~~ should cover all modes ~~and states~~ of normal operation, all plant states, and all fuel locations, including the spent fuel pool and ~~in~~ on-site dry storage, if applicable. The severe accident management guidelines~~SAMGs~~ should ~~be suitable~~ address ~~to manage~~ severe accidents that simultaneously affect the fuel in the reactor and ~~in~~ the spent fuel in storage facilities.

ACCIDENTS AT MULTIPLE UNIT SITES

~~7.26.~~7.32. ~~8.18.C For multiple unit plant sites, the site personnel should be aware that specific hazards have the potential to impact several, or even all units on the site simultaneously.~~The ~~EOPs~~ emergency operating procedures and severe accident management guidelines ~~SAMGs should~~are required to address the possibility that more than one, or even all units, on a site containing multiple units, might be affected concurrently, including simultaneous accidents: see para. 5.8A of SSR-2/2 (Rev. 1) [1]. These procedures and guidelines~~, and~~ should address the possibility that damage propagates from one unit to the other(s), or is caused by the actions taken at one unit.

~~7.27.~~7.33. The emergency operating procedures ~~EOPs~~ and severe accident management guidelines ~~SAMGs~~ should contain decision points and criteria for taking actions needed to ensure the safe operation ~~in~~ of ~~other~~ units other than the one(s) affected by an accident at a multiple unit plant site, and if appropriate, placing ~~them~~ these other units in safe, shutdown state.

Commented [AKE80]: Is it clear what it means that an interface would be effective? Or 'that the transition from the EOPs to the SAMGs can be effectively undertaken'?

Commented [NM81]: I don't think we should mention the interface in this paragraph. This sentence looks like a repetition of the previous paragraph. I propose deleting it.

Commented [SP82]: Is this what you meant?

Commented [SP83]: True – but this is about the training of personnel, which is covered in a separate SG. The relevant part (i.e. about EOPs and SAMGs) is in the next para. Hence deleted.

Commented [AKE84R83]: Recommendation moved to DS497F

~~7.28.~~7.34. The means of making interconnections between units on a multiple unit site should be addressed in the severe accident management guidelines~~SAMGs~~. The severe accident management guidelines ~~SAMGs~~ should consider the use of any available ~~and~~ inter~~-~~connectable means between units during ~~a~~ design extension conditions.

OPERATING PROCEDURES ~~FOR OPERATION~~ IN THE COMMISSIONING ~~PHASE~~STAGE

~~7.29.~~7.35. ~~8.19~~ There are different groups of personnel undertaking ~~C~~construction, commissioning and operation~~ng groups co-exist in~~ during the commissioning ~~phase~~stage, and a gradual transfer of responsibilities takes place ~~from one group to the other~~, until all the responsibility ~~for the complete plant~~ resides with~~is taken over by~~ the management of the operating plant~~.~~. During this time, operations should be performed by the operating ~~group~~ personnel under the supervision of the commissioning ~~group~~personnel, and in accordance with test procedures prepared for ~~implementing~~ the commissioning programme in accordance with Requirement 25 of SSR-2/2 (Rev. 1) [1].

~~7.30.~~7.36. The test procedures for commissioning should follow normal plant operating procedure~~OP~~s to the extent practicable, in order to verify and, if necessary, amend such procedures (see also para. 6.9 of SSR-2/2 (Rev. 1) [1]). This process also provides an opportunity for operating personnel to become familiar with ~~normal~~ plant ~~OP~~operating procedures and with the plant response to these procedures. ~~guidance~~ Recommendations on the operating procedures ~~for operation~~ in the commissioning ~~phase~~ stage ~~can be found~~are provided in ~~Ref.~~ IAEA Safety Standards Series No. SSG-28, Commissioning for Nuclear Power Plants ~~IAEA Safety Standards Series No. SSG-28~~ [15].

8. DEVELOPMENT OF OPERATING PROCEDURES

8.1. ~~In order t~~To develop a set of operating procedures ~~for use in operation~~, a planned and systematic process should be applied. ~~This should be assisted by the use provision of a c~~Comprehensive guidance should be provided for the persons responsible for writing the procedures~~er's guide~~.

8.2. Paragraph 7.1. of SSR-2/2 (Rev. 1) states that "The level of detail for a particular procedure shall be appropriate for the purpose of that procedure." Each procedure should be sufficiently detailed for a qualified individual to be able to perform the necessary activities without direct supervision, but should not seek to provide a complete description of the plant processes involved.

8.3. The format of procedures ~~may~~ might differ~~vary~~ from plant to plant, depending on the policies of the operating organization, but all procedures should be developed in

Commented [AKE85]: OK?

Commented [SP86]: I think we need to avoid terms such as "operating group". The meaning of such phrases is not self-evident, and different MS (even different OOs) are likely to use different terms.

Commented [AKE87]: SSG-28 doesn't talk about 'procedures for operation', rather 'operating procedures'

Commented [SP88]: I suggest that it is useful to include this requirement here.

Commented [AKE89]: The second half of the sentence is about 'the procedures'. But if the second half is supposed to be about 'the format', we'll have to reword a bit accordance with ~~established requirements and recommendations~~a~~n~~ management system that meets the requirements established in GSR Part 2 [11] and Requirement 2 of SSR-2/2 (Rev. 1) [1].

8.4. Persons with appropriate competence and experience should be assigned to develop and verify procedures. Persons who verify procedures should not be the same as the persons who have been ~~ones~~ involved in the ~~process of~~ development of the procedures.

8.5. Techniques that ~~take account of~~involve human factors (~~, such as~~e.g. task analysis)~~,~~ should be used to develop safe, reliable and effective ~~OPs~~ operating procedures that~~in which~~ take into account ~~is taken of~~ the layout of the control room, the general design of the plant, ~~and~~ staffing arrangements and operating experience at the plant ~~concerned~~.

8.6. Guidance specific to the plant should be provided in the following areas:

(a) A clear ~~definition~~ description of ~~constraints~~ restrictions specified in the safety analysis report and in the OLCs;

(b) Appropriate links between procedures to avoid omissions, conflicting instructions, and duplication, and clear identification of entry and exit conditions for procedures, including for emergency operating procedures and severe accident management guidelines~~, including ending of the emergency situation~~;

(c) Effective ~~P~~presentation (i.e. to operating personnel) of the content of operating procedures~~to the operator in a manner conforming to good practice in relation to human factors~~, including clarity of objectives and meaning,~~;~~ and the use ~~where appropriate~~ of flow charts, diagrams and other presentational aids, where appropriate~~to the operator~~;

(d) The need for written explanations of the basis for ~~the~~ procedures, to assist both ~~the~~ users and persons modifying the procedure in the future;

(e) A verification and approval process that includes a validation that is specific to~~for~~ the plant ~~in question~~ (or ~~for~~ a simulation that is as relevant to the plant as practicable);

(f) The use of emergency operating procedure~~EOP~~s for ~~dealing with~~ accident conditions, including ~~DBA~~ design basis accidents and ~~DEC~~ design extension conditions without significant core degradation, and the use of severe accident management guideline~~SAMG~~s for ~~management of~~ design extension conditions with core melting~~severe accidents~~.

8.7. ~~In addition, proper identification of the r~~Relevant sensors, alarms and actuators should be properly identified in operating procedures, especially ~~with regard to~~ post-incident or post-accident procedures, ~~should be provided so as~~ to ensure a safe transition to a~~n~~ ~~adequately~~ safe state. ~~Further guidance on the approach to the~~

Commented [SP90]: The text in NS-G-2.2 referred to "quality assurance requirements and recommendations". By removing the words "quality assurance" the sentence loses meaning. Hence, it is better to refer to GSR Part 2 and Req 2 of SSR-2/2 (Rev. 1) here.

Commented [SP91]: This is unclear – guidance to whom? Also, this text does not link properly with the items in the list below.
Please reword.

Commented [AKE92R91]: Maybe it links back to para 8.1? "The comprehensive guidance for persons responsible for writing the procedures should cover the following areas:"?

Commented [SP93]: OK?

Commented [SP94]: "constraint" means "dose constraint" in the Safety Glossary – and not the meaning intended here.
Feel free to suggest an alternative word or phrase.

Commented [SP95]: It helps to mention EPOs and SAMGs here. Also, it allows deletion of "ending of the emergency situation", which is not a phrase we can use in this context.

Commented [SP96]: 'safe state' is in the Glossary – and I don't think we can apply "adequately" in front of it.

~~development of OPs is provided in Appendix II.~~

8.8. ~~9.7.A~~ Any modifications to ~~the~~ operating procedures should be made in accordance with the ~~applicable plant procedures~~management system. Modified operating procedures ~~should~~ are required to be verified and validated before use: see paras 7.1 and 7.4 of SSR-2/2 (Rev. 1) [1]. Any other operating procedures affected by the modifications to the procedure should also be revised accordingly, and operating personnel~~ors~~ should be trained, as ~~needed~~ appropriate, in the revised procedures ~~Ref.[8]~~.

~~8.8.~~8.9. Further guidance on the approach to the development of ~~OP~~operating procedures is provided in Appendix II.

9. COMPLIANCE WITH OPERATIONAL LIMITS AND CONDITIONS AND OPERATING PROCEDURES

9.1. The ~~plant's management~~operating organization of the nuclear power plant has~~ving~~ the prime~~ary~~ responsibility for safety: see Requirement 1 of SSR-2/2 (Rev. 1) [1]. The operating organization~~, Ref. Leadership and Management for Safety, IAEA Safety Standards Series No. GSR Part 2 [6],~~ is required to ~~should~~ ensure compliance with ~~the~~ OLCs: see Requirement 6 of SSR-2/2 (Rev. 1) [1].~~ To discharge this responsibility, relevant controls should be established in accordance with the Ref.[1].~~

9.2. A major contribution to compliance with OLCs is the provision of operating procedure~~OP~~s that are consistent with the OLCs. Some OLCs ~~may~~ might be directly stated in procedures or in other documents, and, if so, this should be clearly indicated in the ~~implementing~~ relevant document.

~~9.1.~~9.3. For sites with multiple unit~~s plants~~, the OLCs for each individual unit should ~~not be~~ presented ~~for more than one unit~~together, preferably in a single document specifically for use in that unit.

~~9.2.~~9.4. ~~Reference~~ Paragraph 9.3 of SSR-2/2 (Rev. 1) [1] states that "In the preparatory period for decommissioning ~~requires that~~ a high level of operational safety shall be maintained until the nuclear fuel has been removed from the plant." Therefore, operating procedure~~OP~~s and OLCs ~~shall~~ should be written in such a way that they are applicable also during th~~e~~is preparatory ~~decommissioning phase~~period.

~~9.3.~~9.5. ~~10.1.A~~ Independent verifications of the compliance with OLCs should be regularly ~~carried out~~performed by the operating organization.

~~9.4.~~9.6. ~~10.1.B~~ The allocation of responsibilities ~~to carry out the necessary~~for checking compliance ~~controls~~with OLCs and operating procedures and for responding to deviations ~~from OLCs and OPs should~~ is required to be ~~defined~~ included in ~~plant procedures~~the management system: see paras 3.2(b) and 3.2(e) of SSR-2/2 (Rev. 1) [1].

Commented [SP97]: Moved to end of subsection.

Commented [SP98]: IT is the OO that is responsible, not 'management'.

Commented [SP99]: You need to explain what you mean by "independent", i.e. where the OO is responsible for compliance and also for checking compliance?

~~9.5.~~9.7. In order to help ensure compliance, all persons who have responsibilities ~~in~~ for applying ~~the application of~~ OLCs should ~~always~~ have access to a ~~available a~~ copy of the current OLCs ~~currently in force~~ and should be adequately trained in their application. ~~If~~ Where possible, operational limits should be legibly indicated on instruments and displays so as to facilitate compliance. Similarly, the current operating procedure~~OP~~s should be immediately available to ~~the~~ control room personnel and to other personnel~~s~~ who need to use them or refer to them. Operating personnel should be adequately trained in the application of current procedures and appropriate retraining should be ~~planned and conducted~~provided when the OLCs and operating procedure~~OP~~s are modified.

~~9.6.~~9.8. If ~~it should occur that~~ an OLC is not ~~being~~ met or a procedure ~~cannot be~~is not followed, ~~then~~ this should be reported and the causes should be analysed. Based on the analysis, appropriate ~~remedial~~ corrective actions ~~should~~ are required to be taken to prevent a reoccurrence: see para. 4.13 of SSR-2/2 (Rev. 1) [1]. This ~~may~~ might lead to the modification of an OLC or operating procedure in accordance with ~~established procedures~~ processes established within the management system that~~which~~ allow for changes to be made in a controlled manner (see also para. 7.4 of SSR-2/2 (Rev. 1) [1]). The ~~R~~results of ~~routine or~~ commissioning tests or routine tests during operation should also ~~necessitate~~ be analysed~~is~~ ~~and consideration of~~to determine whether there is a need for modifications to the OLCs ~~and~~/or the ~~OP~~operating procedures.

~~9.7.~~9.9. Configuration management should be used when modifying OLCs or operating procedure~~OP~~s to ensure that ~~other~~ all documents remain consistent ~~with the modified OLCs and OPs~~. In particular, there should be a mechanism to ~~track from~~cross check the safety analysis report against ~~through the~~ OLCs ~~to the implementing~~and operating procedures, in order to aid configuration control and to avoid the accidental deletion or retention of an OLC or its accidental application.

~~9.8.~~9.10. There should be ~~limits and conditions~~OLCs ~~on in relation to~~addressing numbers of ~~staff~~operating personnel ~~numbers~~, ~~notably~~ especially in the control room (see Appendix I). The operating procedure~~OP~~s should be designed to be used by the available ~~staff~~operating personnel ~~available~~, in terms of both numbers and qualifications. The operating procedure~~OP~~s should make clear who is responsible for their implementation. Where there is a need for oral communication, this should be conducted in accordance with approved protocols.

~~9.9.~~9.11. The results of the surveillance programme to ensure compliance with OLCs (see Section 6) are required to be evaluated, recorded and retained: see para. 4.12 of SSR-2/2 (Rev. 1) [1]. Records of plant operation and demonstrations of compliance with OLCs and operating procedure~~OP~~s should be made and kept in an appropriate archive (see also para. 4.52 of SSR-2/2 (Rev. 1) [1]~~stored~~. Deviations from OLCs are required to be reported and appropriate actions taken in response: see para. 4.14 of

Commented [AKE100]: OLCs? Or 'limits for normal operation'?

Commented [SP101]: OK? "cannot be followed" is a narrower concept.

Commented [SP102]: OK? The original text was unclear – feel free to suggest better wording.

Commented [AKE103]: If anything were to be included in this Safety Guide about **pandemics** it would be here. Something about margins on numbers of staff so that the OPs can still be safely implemented if staffing is lower? Maybe there is some good practice from a Member State in this regard?

Commented [SP104]: You need to state the requirement first.

SSR-2/2 (Rev. 1) [1]. Reports of non-compliance should be investigated to ensure that corrective actions areis implemented and to help prevent a reoccurrence of the ~~such~~ non-compliance in future. Typical documents and records relating to compliance with or deviations from ~~the~~ OLCs and operating procedure~~OP~~s are as follows:

(a) Operational records covering periods at each power level, including shutdown;
(b) Records of the surveillance programme (see Section 6);
(c) Records of the fuel inventory (new and used), fuel transfers, histories of fuel burnup and core verification;
(d) Records of releases of gaseous and liquid radioactive materials to the environment, and of solid and liquid radioactive wastes accumulated at the site;
(e) Records of pressure cycles and temperature cycles for the components of the ~~system for~~ primary heat transport system;
(f) Records of reviews of modifications made to operating procedure~~OP~~s or plant equipment ~~that were~~ relating~~ed~~ to the OLCs, or of the reviews of the modifications made to the OLCs;
(g) Records of training ~~or~~ and of briefings to operating personnel~~ors~~ ~~of~~ on amended operating ~~instructions~~procedures;
(h) Records of audits, their findings and corrective actions;
(i) Reports of deviations from OLCs or operating procedures;
(j) Reports of human errors or ~~component~~ failures in ~~the~~ safety systems that affected compliance with the OLCs;
(k) Special or temporary operating instructions for deviations from normal operation~~, abnormal occurrences and experimental requirements~~;
(l) Administrative procedures for the production and authorization of operating procedure~~OP~~s, including special and temporary operating procedure~~OP~~s.

~~9.10.~~9.12. Specific consideration should be given to configuring the documentation referred to in para. 9.11~~10.6~~ so that ~~the~~ records relevant to the decommissioning ~~phase~~ stage ~~should be~~are ~~readily~~ identified and readily retrieved when necessary. ~~For guidance~~Recommendations on decommissioning are provided in IAEA Safety Standards Series No. SSG-47, ~~see Ref.~~ Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities~~, IAEA Safety Standards Series No. SSG-47~~ [17].

Commented [SP105]: ...and also here.

Commented [AKE106]: this is about NPPs, otherwise we only use this phrase in research reactor standards. OK to delete?

abnormal occurrences would just be deviations from normal operation, right?

Appendix I

SELECTION OF LIMITS AND CONDITIONS FOR NORMAL OPERATION

REACTIVITY CONTROL

Negative reactivity ~~requirements~~

I.1. The minimum negative reactivity in the reactivity control devices available for insertion should be such that the degree of sub-criticality assumed in the safety analysis report can be reached immediately after shutdown from any operational state and in any relevant accident conditions, taking into account the single failure criterion.

I.2. The necessary negative reactivity should be specified in terms of the information available to the ~~reactor~~ operating personnel~~or~~, such as control rod positions, liquid poison concentration or neutron multiplication factors.

I.3. Limits on the temperature reactivity coefficient, xenon concentration and other transient reactivity effects should be specified so that sub-criticality can be maintained for an indefinite period of time after shutdown by the use of borated water or other neutron absorbers if the temperature, xenon concentration or other transient reactivity effects cannot be compensated for by normal reactivity control devices.

Reactivity coefficients

I.4. Where the safety analysis indicates the need, limits should be stated for the reactivity coefficients for different reactor conditions to ensure that the assumptions used in the accident and transient analyses remain valid through each fuelling cycle.

Rate of insertion for positive reactivity

I.5. Limits on the rate of insertion for positive reactivity should be stated. Compliance should be ensured either by means of reactivity system logic or by setting special limitations to be observed by operating personnel, in order to avoid reactivity related accident conditions ~~which~~ that might lead to excessive fuel temperatures.

Monitoring the neutron flux in the reactor core

I.6. Operability requirements for the instrumentation needed for adequate monitoring of the neutron flux for reactor power levels, including startup and shutdown conditions, should be stated. These ~~may~~ might include stipulations on the use of neutron sources for providing the necessary mini~~—~~mum flux level, and on the sensitivity of neutron detectors. ~~More information~~Recommendations on core management are provided ~~is available~~ in ~~Ref. Core Management and Fuel Handling for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-2.5~~DS497D [5].

(In this Appendix, use of standard uranium oxide fuels is assumed. Special attention should be paid for mixed oxide fuels).

Commented [SP107]: See comment in para. 4.3 – this appendix should be consistent with the list in that bpara.

Commented [SP108]: I realize that this is the same as NS-G-2.2; however, we now normally include a short introductory paragraph to explain what the Appendix is for.

Can you suggest some short text?

Commented [AKE109]: Or: mode of normal operation?

Commented [SP110]: It is unclear why this text is here. It looks like it should be a footnote – can you place it in the right position in the text?

Also, please specify what it is that special attention should be paid to in relation to MOX.

Devices for reactivity control

I.7. Operability requirements for reactivity control devices, including requirements for redundancy ~~or~~ and diversity as stated in the safety analysis report, and their position indicators, should be stated for the various modes of normal operation. These operability requirements should specifically define the proper sequence of operation and the actuation and insertion times for reactivity control devices. Operating times for reactivity control devices should be consistent with, or more conservative than, the design assumptions. (For boiling water reactor~~BWR~~s, reactivity can be controlled by changing the recirculation flow rate.)~~.~~

Reactivity differences

I.8. Limits on permissible reactivity differences between predicted and actual critical configurations of reactivity control devices should be stated, and ~~conformance~~ compliance with these limits should be verified in the initial criticality phase after each major refuelling, and at specified intervals. The cause of significant reactivity differences should be evaluated, and the necessary corrective action should be taken.

Liquid neutron absorber systems

I.9. Limits on parameters that affect solubility (e.g. ~~C~~concentration, storage conditions and temperature) ~~limits affecting solubility~~ should be stated for all liquid neutron absorber systems, and appropriate measures should be specified to ensure detection and correction of ~~deviations from~~non-compliance with these limits. Operability requirements to ensure proper actuation and functioning of the systems should be stated, and the actuation and injection times should be defined.

Alterations ~~of~~ to the core

I.10. After any alteration to the core, the location of fuel and in-core components should be confirmed and verified in accordance with ~~written~~ operating procedures, ~~in order~~ to ensure that every item is in the correct place.

Prevention of boron dilution events

I.11. In pressurized water reactor~~PWR~~s, particular attention should be paid to minimizing the possibility of a boron dilution event during shutdown operations. Limits ~~and conditions on~~ the boron concentration, and conditions on the neutron flux monitoring in the range of the source, the isolation of un-borated water sources and emergency boron systems should be stated, ~~-~~and emergency boron systems should be in stand~~-~~by mode.

REACTOR PROTECTION SYSTEM AND INSTRUMENTATION

Reactor protection system and instrumentation for other safety systems

I.12. Operability requirements should be stated for the reactor protection system and for the instrumentation ~~and logic~~ for other safety systems, together with limits on

Commented [SP111]: This is unclear – and could be confused with "operating lifetime" (see Glossary). Can you use a different phrase with a clearer meaning?

Commented [SP112]: You cannot deviate from a limit – OK?

Commented [SP113]: Please check this for change of meaning. It needs to be clear where limits are applied, and where conditions are applied (it does not make sense to place a limit on the monitoring for example).

Commented [SP114]: As written this means conditions being applied to the isolation of emergency boron systems – is this correct?

Commented [SP115]: Does this represent an OLC? If not, it should be deleted.

Commented [SP116]: This doesn't work grammatically ("operability of logic" – surely it is either correct or it is not?). If it needs to be retained, please reword.

response times, instrument drift and instrument accuracy, where appropriate. Interlocks required ~~by~~ on the basis of the safety analysis report should be identified and relevant operability requirements should be stated.

Instrumentation and control for remote shutdown

I.13. Where instrumentation and control for remote shutdown (i.e. ~~are provided for in the plant design~~ in case of the ~~possible~~ loss of habitability of the main control room) are provided for in the plant design, the ~~operability requirements~~OLCs for ~~the~~ essential parameters (e.g.~~such as~~ temperature, pressure, coolant flow and neutron flux) should be stated to permit the plant to be shut down and maintained in a safe condition from a location or locations outside the main control room.[to here]

CORE COOLING

Temperature and critical power ratio of the reactor coolant system

I.14. Limits on the coolant temperature (maximum ~~or~~ and minimum) and on the rate of temperature change should be stated for the various ~~states~~ modes of normal operation to ensure that ~~specified~~ the safety limits ~~of~~ for core parameters are not exceeded and that temperatures affecting coolant system integrity are maintained within appropriate bounds.

~~I.14.~~I.15. For boiling water reactor~~BWR~~s, the critical power ratio is the most important parameter ~~specifying~~ indicating the core cooling status. Limits on the critical power ratio should be stated for normal power operation.

Pressure and water level of the reactor coolant system

~~I.15.~~I.16. Limits on the permissible pressure of the reactor coolant system and on the water level in the reactor pressure vessel of boiling water reactors ~~BWRs~~ should be stated for the various modes of normal operation. ~~For some purposes, for example in order t~~To take account of limitations in the properties of materials, these ~~operational~~ limits on the permissible pressure of the reactor coolant system and on the water level of the reactor pressure vessel should be stated in conjunction with other parameters such as temperature or coolant flow. In such cases, the relationships between different limits should be clearly stated, and any ~~curves~~ graphs or calculational techniques necessary to ensure that permissible conditions are not exceeded should be provided. ~~Likewise, where applicable,~~Any special ~~requirements~~ conditions associated with interrelated parameters should be stated. Limits should be selected so that the initial conditions assumed ~~for~~ in the various accident analyses are not exceeded and the integrity of the primary coolant system is maintained.

Reactor power

~~I.16.~~I.17. Limits on the total reactor power should be established and defined in the safety analysis report, ~~in order~~ to ensure that the capacity of the core cooling systems is not exceeded.

Commented [SP117]: I do not think "operability" can be applied to parameters.

Commented [SP118]: OK?

Commented [NM119]: Should this be 'limits'?

Commented [SP120]: Or should this be the relationships between different parameters?

Commented [SP121]: OK? The original meaning was very vague. Reword, as appropriate.

Distribution of reactor power

~~I.17.~~I.18. The special logic for reactivity control, or control rod and/or absorber patterns, together with reactivity values for the control rods, should be stated, where necessary, ~~in order~~ to ensure that the specified ~~limits and conditionsations~~OLCs for permissible flux differences, power peaking factors and power distribution for various modes of normal operation are met. Proper control of flux distributions should ensure that the ~~limiting~~ limits on fuel temperature~~s~~ and heat flux, and the initial conditions assumed in the accident analyses, are not exceeded. Suitable calculational methods~~,~~ or measuring techniques should be provided to enable ~~the reactor~~ operating personnel~~or~~ to confirm compliance.

Chemical quality of the reactor coolant

~~I.18.~~I.19. In addition to the ~~limits and conditionsations~~OLCs ~~mentioned on~~ for pressure and temperature, limits should also be stated ~~for~~ in terms of the chemical quality of the reactor coolant.~~;~~ F~~f~~or ~~instance~~example, in water cooled reactors, the conductivity, the pH value, the oxygen content and the levels of impurities such as chlorine and fluorine are important.

Pressure safety valves and/or relief valves

~~I.19.~~I.20. Operability requirements should be stated for the ~~number of~~ safety valves and/or relief valves ~~required for~~in the reactor coolant system. For direct cycle boiling water ~~plants~~reactors, this system includes the steam system relief valves and safety valves. The pressure settings for valve actuation should be stated. The ~~S~~selection of these values should be such that system integrity is maintained ~~in~~ for all modes of normal operation~~al states~~, including operation at low temperatures.

Moderator and cover gas system

~~I.20.~~I.21. As appropriate, ~~limits~~ OLCs for moderator temperature, chemical quality and contaminant levels should be stated. ~~Limits~~ OLCs for permissible concentrations of explosive gas mixtures in the cover gas should also be stated, and~~. In this regard,~~ operability requirements for associated equipment for on-line process monitoring should be specified.

Steam generators

~~I.21.~~I.22. Operability requirements consistent with those described in the safety analysis report should be stated for steam generators. These ~~requirements~~ should include requirements for the operability of emergency feed-water systems and of safety valves and isolation valves of the steam system, as well as ~~requirements limits and conditions~~OLCs for satisfactory water quality and ~~specified~~ limit~~ation~~s on the water level and on the minimum capacity for heat exchange.

Leakage of the reactor coolant system

I.23. Leakage limits should be such that the coolant inventory can be maintained by

Commented [SP122]: OK? There will also be a design requirement on the number of such valves – but I assume that is not what is being discussed here.

Commented [SP123]: OK? Elsewhere, the text refers to BWRs, not plants.

Commented [SP124]: This means normal operation and AOO – is that what is intended?

normal make-up systems and ~~that~~ the system integrity can be maintained to the degree assumed in the safety analysis report. Specifications of maximum leakage from particular components important to safety, commensurate with their safety function, should be provided. In establishing leakage limits, consideration should be given to the permissible limits ~~of~~ for contamination of the environment or of secondary systems by the leaking media.

~~I.22.~~I.24. Operability requirements should be stated for systems for the detection ~~of, or for~~and measurement ~~ing systems for,~~of leakage of reactor coolant. In general, leakages should be classified as identified leakages or unidentified leakages. Identified leakages include, ~~(~~for example, leakages into collection systems such as those at pump seals, into the containment atmosphere or through the steam generator; these leakages should be measured in order not to mask ~~the~~ unidentified leakages~~) or unidentified leakages~~.

Reactor coolant radioactivity

~~I.23.~~I.25. ~~Limits~~ OLCs for the permissible ~~specific~~ activity concentration of the reactor coolant should be stated in order to ensure the protection of operating personnel (and potentially the protection of the public and the environment) as well as to provide an indicator ~~measure~~ of fuel integrity~~, as discussed in the safety analysis report~~. If on-line measurement of coolant activity is used to monitor the fuel cladding integrity in operation, the minimum provisions for the detection and, where appropriate, identification of failed or suspect fuel should be stated.

Ultimate heat sink

~~I.24.~~I.26. ~~The ultimate heat sink is usually the river, lake or sea from which cooling water for equipment and condensers is drawn. In some cases, dry or wet cooling towers are also used.~~ Limitations on power production levels consistent with the cooling capabilities of the ultimate~~se~~ heat sink~~s~~ should be specified.

Removal of decay heat at shutdown

~~I.25.~~I.27. Operations in the shutdown state ~~may~~ might ~~cause a restriction in~~affect the capability of the reactor cooling systems. ~~Limits and conditions~~OLCs ~~on~~in relation to decay heat levels ~~should be stated~~ before the commencement of certain operations, such as reducing coolant levels or opening the reactor coolant system and containment boundaries, should be stated. Additional ~~limits and conditions~~OLCs should be specified to identify the ~~necessary~~ cooling systems that need to be operable in all shutdown states. In light water reactors, particular attention should be paid to the monitoring and control ~~and monitoring~~ of water levels during shutdown operations to prevent the loss of ~~the~~ systems for the removal of decay heat. ~~Limits and conditions~~OLCs on ~~allowable~~ water levels and the necessary operable instrumentation should be provided.

Emergency core cooling systems

I.28. Operability requirements should be stated for the various systems used for

Commented [SP125]: OK? I know this is from NS-G-2.2, but the original text made no sense.

Commented [SP126]: "Activity concentration" is preferred over "specific activity" -see Glossary. Or would "levels of activity" be better? That would encompass the total activity on the coolant, and may be more appropriate in terms of setting limits

Commented [SP127]: I think this text is redundant? If not – can we find an alternative to "discussed" – it sounds wrong in the context of this sentence.

Commented [SP128]: This is just a basic description – hence deleted.

emergency core cooling. These should include ~~requirements on~~: equipment operability and the associated environmental conditions; adequacy of the injection and circulation of coolant; and the integrity of piping systems. ~~; specified lLimits and conditions~~OLCs ~~ations~~ on minimum quantities of fluids for all systems relied upon for emergency core cooling should also be stated. Thes~~se~~ operability requirements should cover all the provisions necessary to cope with ~~relevant~~ the accidents analysed in the safety analysis report. ~~In particular, to ensure the continuous avail- ability of these systems, o~~

~~I.26.~~I.29. Operability requirements should also be stated for emergency power supply systems and for other auxiliary systems, such as heating circuits used to prevent freez~~e-up~~ing of ~~solutions~~liquids, for equipment cooling systems and for ventilation systems. The long-term capability of these emergency systems ~~after the occurrence of a~~following ~~relevant~~ accident conditions should also be ~~considered and~~ specified to ensure that any radioactive release ~~of radioactive substances to~~ the environment is below acceptable limits.

THE ~~C~~CONTAINMENT AND ASSOCIATED SYSTEMS

I.30. Operability requirements for the containment and associated systems should be stated and should include the ~~plant conditions~~ modes of normal operation for which containment integrity is not necessary. Permissible leakage rates should be specified, and the operability and condition of the following should be stated:

(a) I~~i~~solation valves;

(b) ~~v~~Vacuum breaker valves;

(c) ~~a~~Actuation devices;

(d) ~~S~~systems for filtration, cooling, dousing and spraying;

(e) Systems for control and analysis ~~systems for~~of combustible gases;

(f) ~~v~~Venting and purging systems;

(g) ~~a~~Associated instrumentation.

~~I.27.~~I.31. The OLCs ~~specified~~ should be such that any ~~the~~ radioactive releases ~~of radioactive materials~~ from the containment ~~system~~ and associated systems will be restricted to those leakage paths and rates assumed in the accident analyses. Precautions for access control should be specified in order to ensure that the effectiveness of the containment system is not impaired.

OTHER SYSTEMS

Ventilation systems

~~I.28.~~I.32. ~~If applicable, appropriate limits should be established on the o~~Operability requirements should be stated for~~of~~ ventilation systems ~~where such systems have been~~

Commented [SP129]: To match the title of SSG-53

Commented [KEA130]: Is this correct? Is containment integrity not always to be ensured? Maybe:

“and should include the plant states for which containment integrity could be challenged”?

Commented [SP131]: Easier to read in a list.

~~provided for the purpose of~~ that are intended to ~~controlling~~maintain the levels of airborne radioactive substances ~~material~~ within stated limits, or that are intended to ~~in~~ support ~~of~~ a safety system.

Ventilation of secondary containment

~~I.29.~~I.33. If secondary containment is provided, ~~it should be ventilated and kept at an appropriate absolute pressure as described in the safety analysis report, to ensure that any possible direct leakage will remain below the value assumed.~~ Aappropriate ~~limits~~ OLCs in terms of pressures or leakage rates should be stated.

Service systems

~~I.30.~~I.34. The reliable operation of many safety systems is dependent on the operation of service systems such as compressed air systems and service water systems. ~~Limits and conditions~~OLCs for these service systems should be considered if they can have a major effect on plant safety.

Electrical power systems and other power sources

I.35. ~~Requirements for the a~~Availability and operability requirements ~~of~~for the electrical power sources in all operational states should be stated ~~for all operational states~~. These power sources include the following:

(a) ~~o~~Off-site power supply~~ources~~;

(b) ~~o~~On-site generators (diesels and gas turbines, including associated fuel reserves);

(c) ~~b~~Batteries and associated control systems;

(d) ~~p~~Protective, distribution and switching devices.

~~I.31.~~I.36. The operability requirements should be such that sufficient power will be available to supply all safety systems ~~related equipment~~ necessary for safe shutdown of the ~~plant~~reactor, and for the mitigation and control of accident conditions. The operability requirements should determine the necessary power, redundancy of supply lines, maximum permissible time delays and necessary duration of the emergency power supply. Equivalent requirements should be stated for other power sources (for example, the pneumatic power system). Particular care should be taken to ensure that electrical supplies remain adequate in shutdown operations, when many systems and components will be out of service for maintenance.

Seismic monitorings

~~I.32.~~I.37. Where applicable, O~~o~~perability requirements for seismic monitoring instrumentation should be stated. Settings should be established for alarms or for any corrective action, consistent with the safety analysis report. The number of devices should be specified and should be sufficient to ensure that any necessary automatic action is initiated at the specified limits.

Commented [SP132]: OK?

Commented [SP133]: This is background information – not needed. Hence deleted.

Commented [SP134]: Or is “significant” a better word?

Commented [SP135]: OK? Operability requirements are mentioned in the next para.

Commented [AKE136]: Or: ‘for all modes of normal operation’

Commented [KEA137]: Yes?

Commented [SP138]: All NPPs should have seismic monitoring?

Movement~~s~~ of heavy objects

~~I.33.~~I.38. ~~Limits and conditions~~OLCs should be ~~provided~~ stated to prevent the movement of heavy objects over, or adjacent to, areas where items important to safety ~~related systems or components~~ could be damaged as a result of the misuse or failure of ~~the~~ lifting equipment. It is likely that such ~~limits and conditions~~OLCs will ~~vary~~ differ with the ~~operational~~ mode of normal operation.

Commented [SP139]: OK?

Fuel handling

I.39. OLCs for fuel and absorber handling should be stated and should include limits on the amount of fuel ~~which~~ that can be handled at one time and, if necessary, on the temperature and decay time of irradiated fuel. If appropriate, ~~the~~ operability requirements for ~~operability of~~ fuel handling equipment should be stated.

~~I.34.~~I.40. Provision should be made for monitoring the core reactivity during fuel loading or refuelling operations to ensure compliance with ~~that~~ the reactivity OLCs~~requirements are met~~. The procedures and instrumentation ~~required~~ necessary for such monitoring should be specified. To ensure that operations ~~which~~ that might give rise to a ~~nuclear excursions or~~ radiation hazard or a criticality accident~~s~~ are not undertaken during fuel movements, ~~requirements~~ conditions for communication between the fuel handling personnel and the operating personnel in the control room should be stated.

Storage of irradiated fuel

I.41. The conditions for storage of irradiated fuel should be stated and should include the following:

Commented [SP140]: Should there also be a limit on the amount of stored fuel?

(a) ~~t~~The minimum cooling capability of the cooling system for spent fuel, and the minimum water level above the fuel;

(b) ~~a~~A prohibition against storage of fuel in any position other than that designated for irradiated fuel;

(c) ~~t~~The minimum reserve capacity for storage;

(d) ~~and t~~The appropriate reactivity margins to guard against criticality in the storage area.

Appropriate radiation monitoring should also be specified for the storage area for irradiated fuel.

Storage of fresh fuel

~~I.35.~~I.42. The ~~conditions~~ OLCs for fresh fuel storage should be stated. Any special measures to prevent criticality in fresh fuel during handling or storage should also be stated. Manufacturing data for ~~F~~fresh fuel ~~manufacturing data~~ should be checked against specification.

Commented [SP141]: Are there some words missing here? What specification? Please can you reword to clarify the meaning.

Instrumentation for radiation monitoring

~~I.36.~~I.43. Operability requirements for radiation monitoring instrumentation, including for monitoring of radioactive effluents, should be stated. These operability requirements should be such as to ensure that appropriate areas and ~~release paths~~discharge routes are adequately monitored in accordance with ~~the requirements for~~a radiation~~ological~~ protection programme established and implemented in accordance with Requirement 20 of SSR-2/2 (Rev. 1) [1], and to ensure that an alarm ~~or~~ and an appropriate action is initiated if ~~the~~ prescribed radiation ~~limit~~ levels or activity ~~limit~~ levels are~~is~~ exceeded.

Plant staffing

~~I.37.~~I.44. The ~~plant~~ operating personnel necessary ~~required to be on duty~~ for ~~the various~~different ~~operational~~ plant states should be ~~specified~~ stated~~: and shall~~ these are required to be sufficient to implement the ~~necessary~~ emergency operating procedures (see Requirement 4 of SSR-2/2 (Rev. 1) [1]). The minimum staffing ~~required for~~of the control room should be stated, including the ~~necessary~~ qualifications ~~for their duties~~of personnel.

Fire protection systems

~~I.38.~~I.45. Availability requirements for fire protection systems ~~should be stated~~ in all operational states~~.~~ should be stated.

Consumables and spare parts

~~I.39.~~I.46. ~~Limits and conditions~~OLCs for the availability and storage of consumables and spare parts at the site should be considered if the ~~they can~~storage arrangements could have a major effect on plant safety.

Commented [SP142]: OK?

Commented [SP143]: OK?

Commented [KEA144]: If you were to add something about **pandemics** into this Safety Guide, this would be the place to do it. Would there be special provisions within the OLCs for staffing in the case of a pandemic, for example?

Commented [SP145]: This means normal operation and AOO – is that what is intended? Or should it be "plant states"?

Commented [AKE146R145]: Or 'for all modes of normal operation'?

Commented [SP147]: Or is "significant" a better word?

Appendix II

DEVELOPMENT OF OPERATING PROCEDURES (OUTLINES)

II.1. ~~Plant o~~Operating procedures may be developed using the process ~~along the lines~~ shown in Fig. II.1~~, following quality management principles.~~ Recommendations relating to Boxes 1–10 in Figure II.1 are provided paras II.2–II.11.

II.2. The drafting of operating procedures (Box 1) should normally be done by ~~the~~ operating personnel ~~group~~ (Box 1). The main documents used as references should include:

(a) Documents containing design assumptions and intentions;
(b) Contractual documents and relevant equipment specifications giving guidance on the operation of systems and components;
(c) Commissioning documents (see section 5 of SSG-28 ~~Ref.~~[1~~4~~6]);
(d) Documents containing procedures from other plants of the same or similar type~~s~~.

II.3. ~~The operating group should ensure in any case that procedures are consistent with safety analysis reports, OLCs~~Operating procedures are required to be developed in accordance with ~~and any other~~ regulatory requirements, as well as with the policy of the operating organization as contained in the ~~plant~~ management system: see Requirement 26 of SSR-2/2 (Rev. 1) [1]. It should also be ensured that procedures are consistent with the safety analysis report and with OLCs.

II.4. The ~~R~~review of the first draft of the operating procedure~~OP~~s (Box 2)~~,~~ ~~and~~ in particular of the safety aspects, ~~(Box 2),~~ should be performed by ~~a suitably qualified~~ persons whose qualifications are at least equal to those~~at~~ of the persons that ~~the~~ drafted~~r~~ ~~of~~ the ~~document~~procedures. The review~~er~~ should ~~check~~ confirm that ~~the draft does state that~~ all relevant ~~features of the plant~~items important to safety and ~~its~~ their performance ~~that are assumed as cornerstones in the safety analyses are~~ requirements~~d~~ ~~to be operable or to be complied with~~have been considered. ~~The review should also consider the formal and editorial aspects of the document.~~

II.5. Comments on the draft should be requested from ~~the~~ relevant operating ~~staff~~ personnel and, as appropriate, from persons responsible for the design~~er~~ and construction of the plant~~or~~ (Boxes 3 and 3(a)).

II.6. After ~~authorization~~ endorsement by the o~~O~~perations m~~M~~anager (Box 4), the procedure should be validated (Box 5) by ~~first~~ attempting to apply it in the ~~actual~~ initial operation of each sys-tem or if necessary, during simulated operation ~~(Box 5)~~. This validation should be per-formed, wherever possible, by personnel other than those responsible for the drafting and review of the procedure. In those cases where only a simulated operation was ~~carried out~~peformed, the procedure should be finally ~~be~~ validated by application to the actual operation of the system as soon as this is possible.

Commented [SP148]: Too vague – hence deleted.

Commented [KEA149]: As before, let's avoid operating group

Commented [SP150]: Text rearranged to state requirements first, and then recommendations.

Commented [SP151]: Unclear what 'formal aspects" means, and we do not need to give recommendations on editorial aspects. Hence deleted.

Commented [SP152]: In the standards, "authorization" normally means by the regulatory body (see Glossary). I also think that this is not the correct word at this stage in the flow chart.

If you can think of another suitable word or phrase, then please suggest it.

Please also change the text in Box 4

Commented [SP153]: Will all MS understand this phrase? Maybe an explanatory footnote (to include plant manager as well) would help?

The purpose of validating procedures is to ensure that they are correct, achieve their purpose and are compatible with the technology and the human resources available.

Commented [NM154]: I would propose deleting this sentence. Validation is mentioned throughout the text and I believe the purpose of validation is quite obvious.

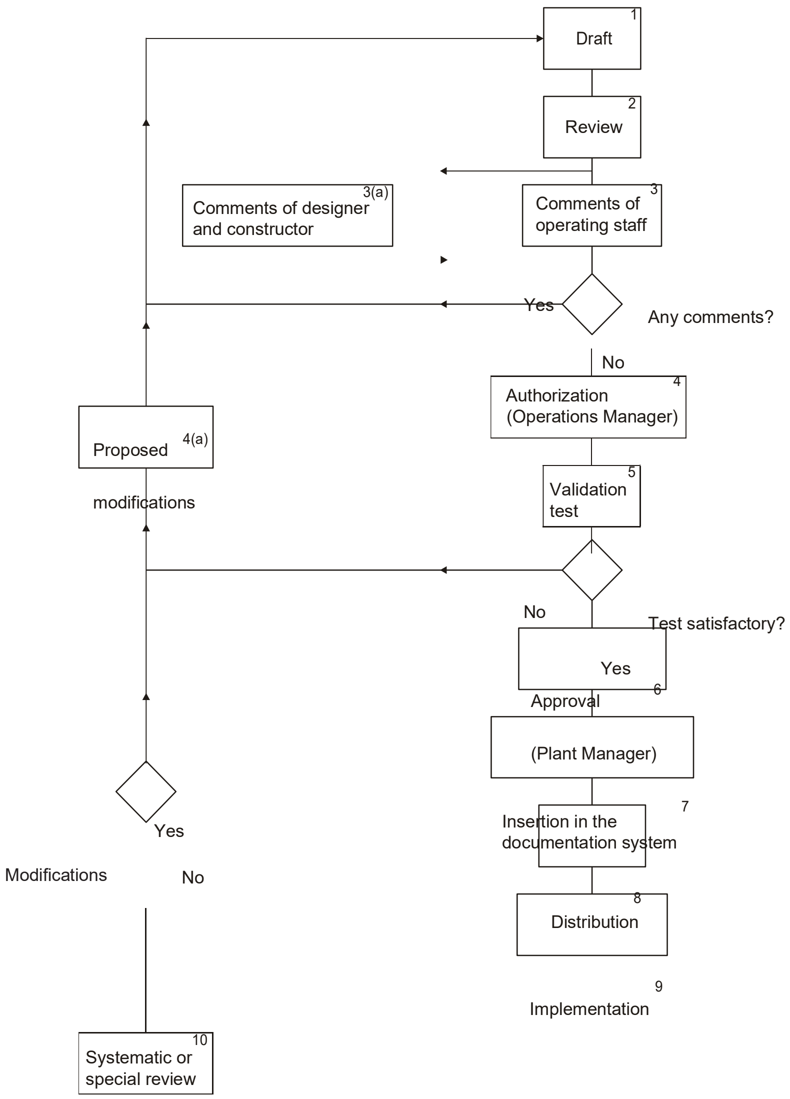

FIG. II.1. Flow diagram for the development of operating procedures.

Commented [SP155]: You will need to supply MTCD with a high-resolution version of this figure in a separate file.

Change the text in Box 3 to read "Comments from operating personnel"

Please ensure that all lines, boxes and text are properly aligned and spaced (the version in NS-G-2.2 is not especially good). I also suggest that the "Box Number" could be put as the start of the text in each box, rather than being squeezed into a corner.

II.7. If the results of the validation test ~~is~~ are not satisfactory, the draft should be sent back for redrafting with proposed modifications (Box 4(a)). If the results of the test are satisfactory, the draft should be sent to the plant man~~–~~ager with the recommendation that it be approved and issued. ~~If the draft is not satisfactory, it should be sent back to the drafter with proposed modifications (Box 4(a)).~~

II.8. The procedures should be approved by the plant manager ~~and issued~~ after it has been confirmed that no further modifications are considered necessary (Box 6). The procedures should then be entered into the documentation system, included in the plant manual, and treated in accordance with quality management principles (Box 7).

II.9. All procedures ~~which~~ that have been approved should be issued and distributed in accordance with ~~written administrative procedures~~the management system of the operating organization, and made available for use ~~in the control room~~by the relevant operating personnel (Boxes 8 and 9).

~~II.10.~~ Reviews should be ~~carried out~~performed at stated intervals (usually one or two years) or whenever considered necessary ~~in the light~~on the basis of operating experience (Box 10).

~~II.11.~~ Any modification to the procedures as a result of these ~~above mentioned~~ reviews should be made following the same ~~flow of the arrangements~~process as for the initial ~~document~~procedure.

Commented [SP156]: See comment about "operations manager" – can we explain what we mean by this?

Commented [SP157]: By default, "approval" implies the regulatory body. So, we need to be specific.

Commented [SP158]: It is not just about the control room.

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[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Commissioning and Operation, IAEA Safety Standards Series No. SSR-2/2 (Rev. 1), IAEA, Vienna (2016).

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~~[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-2.6, IAEA, Vienna (2002) Under Revision~~

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[4] INTERNATIONAL ATOMIC ENERGY AGENCY, The Operating Organization for Nuclear Power Plants, IAEA Safety Standards Series No. DS497C, IAEA, Vienna (in preparation).

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[13] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL CIVIL AVIATION ORGANIZATION, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL

Commented [SP159]: Now Ref. [6]

MARITIME ORGANIZATION, INTERPOL, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, PREPARATORY COMMISSION FOR THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS, WORLD HEALTH ORGANIZATION, WORLD METEOROLOGICAL ORGANIZATION, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSR Part 7, IAEA, Vienna (2015).

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[1~~5~~4] INTERNATIONAL ATOMIC ENERGY AGENCY, Accident Management Programmes for Nuclear Power Plants, IAEA Safety Standards Series No. SSG-54, IAEA Vienna (2019).

[16~~5~~] INTERNATIONAL ATOMIC ENERGY AGENCY, Commissioning for Nuclear Power Plants, IAEA Safety Standards Series No. SSG-28, IAEA, Vienna (2014).

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~~[12] INTERNATIONAL ATOMIC ENERGY AGENCY, Conduct of Operations at Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-2.14, IAEA, Vienna (2008) Under Revision~~

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~~[16] EUROPEAN ATOMIC ENERGY COMMUNITY, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006)~~

~~[17] EUROPEAN COMMISSION, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION,~~

Commented [SP160]: Now Ref. [3].

Commented [SP161]: Now Ref. [8].

Commented [SP162]: Now Ref. [5].

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~~Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna (2014)~~

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Annex

EXAMPLE TO ILLUSTRATE THE INTERRELATIONSHIP BETWEEN A SAFETY LIMIT, A SAFETY SYSTEM SETTING AND A LIMIT FOR NORMAL OPERATION~~EXPLAIN SOME TERMS USED~~

INTRODUCTION

A–1. Figure A–1 ~~explains and~~ illustrates the interrelationship between a safety limit, a safety system setting and ~~an operational~~a limit for normal operation, using fuel cladding temperature as an example.

~~A–2. For clarity, the example given in Fig. A–1 illustrates only the case in which the critical parameter of concern is the fuel cladding temperature.~~

~~A–3.~~A–2. It is assumed for the purposes of Fig. A–1 that a correlation has been established in the safety analysis report between a monitored parameter (in this case, coolant temperature) and a parameter ~~the maximum fuel cladding temperature,~~ for which a safety limit has been established (in this case, maximum fuel cladding temperature). The safety analysis will have ~~would~~ shownns that actuation of the safety system ~~by the monitored coolant temperature~~ at the safety system setting for the coolant temperature ~~should~~ will pre~~–~~vent the fuel cladding temperature from reaching the ~~set~~ safety limit beyond which releases of significant amounts of radioactive material from the fuel might occur.

RANGE OF STEADY STATE OPERATION

~~A–4.~~A–3. The monitored parameter ~~should be~~is kept within the steady state range by the control system or by ~~the~~ operating personnel~~or~~ in accordance with the operating procedures~~OP~~s.

ALARM SETTING EXCEEDED (CURVE NO. 1)

~~A–5.~~A–4. The monitored parameters ~~may~~ might exceed the steady state range, for example, as a result of load changes or imbalance of the control system~~, for example~~. If the temperature ~~rise~~ reaches an alarm setting, then ~~the~~ operating personnel~~or~~ will be alerted ~~and~~ to ~~will~~ take action to supplement any automatic systems in reducing the fuel cladding temperature to within the range of steady state values ~~without allowing the temperature to~~before it reaches the ~~operational~~ limit for normal operation. ~~The~~ A possible delay in the response of operat~~or~~ing personnel~~'s response should~~also needs to be taken into consideration.

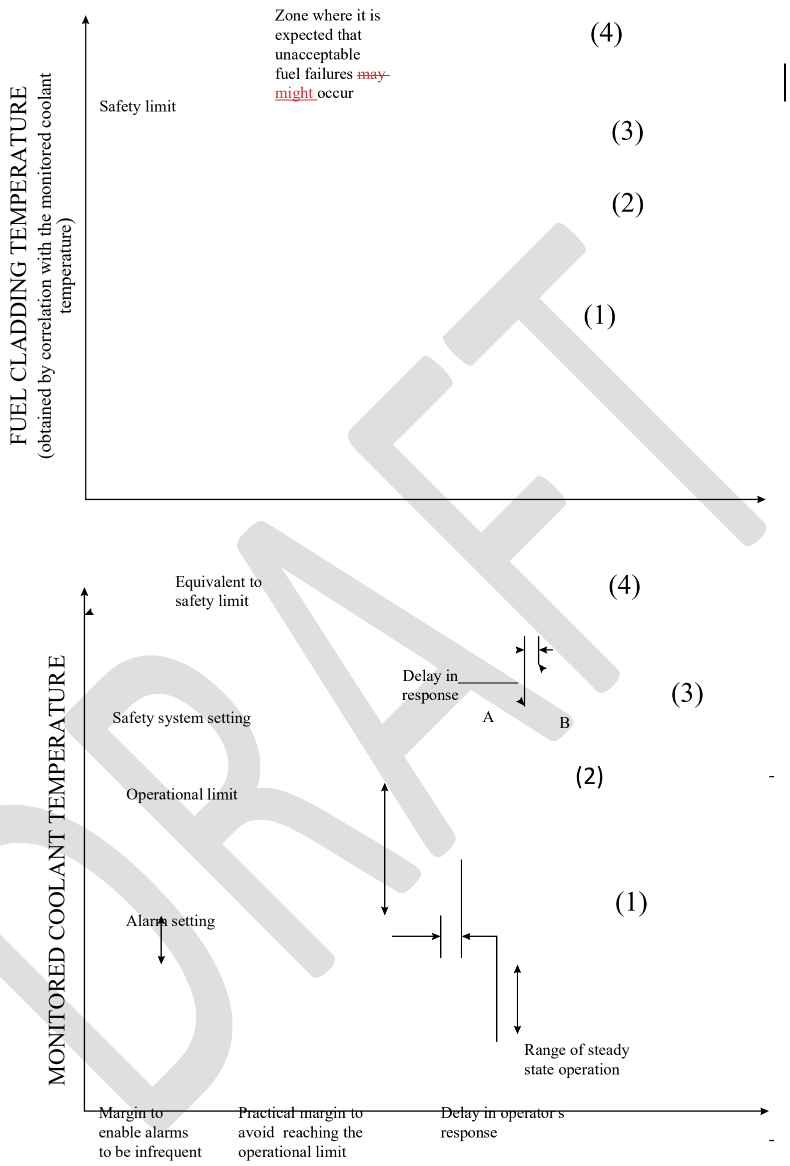
~~OPERATIONAL~~ LIMIT FOR NORMAL OPERATION EXCEEDED (CURVE NO. 2)

~~A–6.~~A–5. Limits for normal operation may be set at any level between the range of steady state operation and the ~~actuation setting for the~~ safety system setting, on the basis of the results of the safety analysis. It is normal to have margins between alarm settings and ~~operational~~ limits for normal operation in order to take account of routine fluctuations arising in normal operation. There may also be a margin between the ~~operational~~ limit for normal operation and the safety system setting to allow the

Commented [SP165]: The original heading is not good – this is a suggestion based on the text below. Feel free to suggest an alternative.

Commented [AKE166]: To clearly use the same language as in the first 3 bullets of SSR-2/2 (Rev. 1) para 4.10

operator to take action to control a transient without activating the safety system. If ~~the~~ a ~~operational~~ limit for normal operation is reached and the operator is able to take corrective action to prevent the safety system setting being reached, then the transient will be of the form of curve 2.



FUEL CLADDING TEMPERATURE
(obtained by correlation with the monitored coolant temperature)
Safety limit
Zone where it is expected that unacceptable fuel failures ~~may~~ might occur
(4)
(3)
(2)
(1)
MONITORED COOLANT TEMPERATURE
Equivalent to safety limit
(4)
Delay in response
A
B
(3)
Safety system setting
(2)
Operational limit
(1)
Alarm setting
Range of steady state operation
Margin to enable alarms to be infrequent
Practical margin to avoid reaching the operational limit
Delay in operator's response

FIG. A–1. Interrelationship between a safety limit, a safety system setting and ~~an operational~~a limit for normal operation.

SAFETY SYSTEM SETTING EXCEEDED (CURVE NO. 3)

~~A–7.~~A–6. In ~~the event~~case of a malfunction of the control system or operator error or for other reasons, the monitored parameter might reach the safety system setting at point A (see Fig. A–1) ~~with the consequence that~~and the safety system is actuated. This corrective action only becomes effective at point B (see Fig. A–1) owing to inherent delays in ~~the instrumentation and equipment of~~ the safety system. The ~~response~~ actions taken ~~should~~ need to be sufficient to prevent the safety limit being reached, although local fuel damage cannot be excluded.

SAFETY LIMIT EXCEEDED (CURVE NO. 4)

~~A–8.~~A–7. In ~~the event~~case of an ~~failure~~accident that is more ~~exceeds the most~~ severe ~~one~~ thant the design basis accident for the plant ~~was designed to cope with, or a failure or multiple failures in a safety system~~, it might be possible for the temperature of the cladding to exceed the safety limit, and consequently for significant radioactive releases to occur. Additional safety systems may be actuated by other parameters to bring other engineered safety features into operation to mitigate the consequences, and measures for accident management may be activated.

Commented [SP167]: Separate high-resolution images are needed for publication.
I assume this Figure (which has not been fully reproduced here) is the same as in NS-G-2.2. If so:
- Do we actually need both graphs (the 2nd one is enough?)
- If we keep the 1st graph, the phrase "zone where it is expected that unacceptable fuel failures may occur" should be deleted. These words are problematic, and the text covers the point well enough.
- In the 2nd graph, edit the text to read "Delay in the response of operating personnel"

Commented [AKE168R167]: 'operational limits' in the figure should be replaced by 'limits for normal operation' (2 places in the 2nd figure)

Commented [SP169]: This is the usual wording

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Commented [SP170]: The deleted persons in this list were on the original Contributors list for NS-G-2.2. They should only be included here if they also contributed to this revision.

If any are reinstated – please check that the affiliation is correct.

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