CATEGORIES IN THE IAEA SAFETY SERIES

A new hierarchical categorization scheme has been introduced, according to which the publications in the IAEA Safety Series are grouped as follows:

Safety Fundamentals (silver cover)

Basic objectives, concepts and principles to ensure safety.

Safety Standards (red cover)

Basic requirements which must be satisfied to ensure safety for particular activities or application areas.

Safety Guides (green cover)

Recommendations, on the basis of international experience, relating to the fulfilment of basic requirements.

Safety Practices (blue cover)

Practical examples and detailed methods which can be used for the application of Safety Standards or Safety Guides.

Safety Fundamentals and Safety Standards are issued with the approval of the IAEA Board of Governors; Safety Guides and Safety Practices are issued under the authority of the Director General of the IAEA.

An additional category, Safety Reports (purple cover), comprises independent reports of expert groups on safety matters, including the development of new principles, advanced concepts and major issues and events. These reports are issued under the authority of the Director General of the IAEA.

There are other publications of the IAEA which also contain information important to safety, in particular in the Proceedings Series (papers presented at symposia and conferences), the Technical Reports Series (emphasis on technological aspects) and the IAEA-TECDOC Series (information usually in a preliminary form).
SAFETY ASSESSMENT OF EMERGENCY POWER SYSTEMS FOR NUCLEAR POWER PLANTS

A Safety Practice
The following States are Members of the International Atomic Energy Agency:

<table>
<thead>
<tr>
<th>Afghanistan</th>
<th>Holy See</th>
<th>Panama</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albania</td>
<td>Hungary</td>
<td>Paraguay</td>
</tr>
<tr>
<td>Algeria</td>
<td>Iceland</td>
<td>Peru</td>
</tr>
<tr>
<td>Argentina</td>
<td>India</td>
<td>Philippines</td>
</tr>
<tr>
<td>Australia</td>
<td>Indonesia</td>
<td>Poland</td>
</tr>
<tr>
<td>Austria</td>
<td>Iran, Islamic Republic of</td>
<td>Portugal</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Iraq</td>
<td>Qatar</td>
</tr>
<tr>
<td>Belarus</td>
<td>Ireland</td>
<td>Romania</td>
</tr>
<tr>
<td>Belgium</td>
<td>Israel</td>
<td>Russian Federation</td>
</tr>
<tr>
<td>Bolivia</td>
<td>Italy</td>
<td>Saudi Arabia</td>
</tr>
<tr>
<td>Brazil</td>
<td>Jamaica</td>
<td>Senegal</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Japan</td>
<td>Sierra Leone</td>
</tr>
<tr>
<td>Cambodia</td>
<td>Jordan</td>
<td>Singapore</td>
</tr>
<tr>
<td>Cameroon</td>
<td>Kenya</td>
<td>Slovenia</td>
</tr>
<tr>
<td>Canada</td>
<td>Korea, Republic of</td>
<td>South Africa</td>
</tr>
<tr>
<td>Chile</td>
<td>Kuwait</td>
<td>Spain</td>
</tr>
<tr>
<td>China</td>
<td>Lebanon</td>
<td>Sri Lanka</td>
</tr>
<tr>
<td>Colombia</td>
<td>Liberia</td>
<td>Sudan</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>Libyan Arab Jamihiya</td>
<td>Sweden</td>
</tr>
<tr>
<td>Cote d'Ivoire</td>
<td>Liechtenstein</td>
<td>Switzerland</td>
</tr>
<tr>
<td>Cuba</td>
<td>Luxembourg</td>
<td>Syrian Arab Republic</td>
</tr>
<tr>
<td>Cyprus</td>
<td>Madagascar</td>
<td>Thailand</td>
</tr>
<tr>
<td>Czechoslovakia</td>
<td>Malaysia</td>
<td>Tunisia</td>
</tr>
<tr>
<td>Democratic People's Republic of Korea</td>
<td>Mali</td>
<td>Turkey</td>
</tr>
<tr>
<td>Denmark</td>
<td>Mauritius</td>
<td>Uganda</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>Mexico</td>
<td>Ukraine</td>
</tr>
<tr>
<td>Ecuador</td>
<td>Monaco</td>
<td>United Arab Emirates</td>
</tr>
<tr>
<td>Egypt</td>
<td>Mongolia</td>
<td>United Kingdom of Great Britain and Northern Ireland</td>
</tr>
<tr>
<td>El Salvador</td>
<td>Myanmar</td>
<td>Ireland</td>
</tr>
<tr>
<td>Estonia</td>
<td>Namibia</td>
<td>United Republic of</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Netherlands</td>
<td>Tanzania</td>
</tr>
<tr>
<td>Finland</td>
<td>New Zealand</td>
<td>United States of America</td>
</tr>
<tr>
<td>France</td>
<td>Nicaragua</td>
<td>Uruguay</td>
</tr>
<tr>
<td>Gabon</td>
<td>Niger</td>
<td>Venezuela</td>
</tr>
<tr>
<td>Germany</td>
<td>Nigeria</td>
<td>Viet Nam</td>
</tr>
<tr>
<td>Ghana</td>
<td>Norway</td>
<td>Yugoslavia</td>
</tr>
<tr>
<td>Greece</td>
<td>Pakistan</td>
<td>Zaire</td>
</tr>
<tr>
<td>Guatemala</td>
<td>Zambia</td>
<td>Malawi</td>
</tr>
<tr>
<td>Haiti</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".  

© IAEA, 1992

Permission to reproduce or translate the information contained in this publication may be obtained by writing to the International Atomic Energy Agency, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria.

Printed by the IAEA in Austria
December 1992
FOREWORD

In 1974 the IAEA established a special Nuclear Safety Standards (NUSS) programme under which 5 Codes and 55 Safety Guides have been produced in the areas of governmental organization, siting, design, operation and quality assurance. The NUSS Codes and Safety Guides are a collection of basic and derived requirements for the safety of nuclear power plants with thermal neutron reactors. They have been developed in a complex process which ensures the best possible international consensus.

This broad consensus is one of the reasons for a relatively general wording of the main principles and is sometimes a cause of difficulties in their application to the detailed design of nuclear power plants. The requirements, particularly those of the Codes, often need interpretation when applied to actual cases. In many areas national regulations and technical standards are available, but often even these do not answer all questions and only the practice used in applying certain rules fully reflects the outcome of the detailed consideration given to solving individual cases.

In order to present further details on the application and interpretation and on the limitations of individual concepts in the NUSS Codes and Safety Guides, a series of Safety Practice publications have been initiated. It is hoped that many Member States will be able to benefit from the experience presented in these books.

The present publication should be useful in particular for the safety assessor, either within the design organization or working for the licensing authority. The manual covers the essential safety issues which have to be solved and gives a detailed reference for each subject to international and national technical standards which may assist the assessor in his or her work.

The Agency is grateful for the help of several experts in drafting and reviewing the publication, in particular C.J. Wylie (USA) and R.D. Bye (UK).
# CONTENTS

1. INTRODUCTION ................................................................. 1
   1.1. Background ................................................................. 1
   1.2. Objective ................................................................. 1
   1.3. Scope ........................................................................ 2
   1.4. Structure ................................................................... 2

2. SAFETY ASSESSMENT AND LICENSING ......................... 2

3. SAFETY ASSESSMENT AND REVIEW GUIDANCE ............... 4
   3.1. Off-site support to the EPS ........................................ 5
      3.1.1. Grid capability and reliability ......................... 5
      3.1.2. Transmission line connection ......................... 6
      3.1.3. Connection of the EPS to the off-site power supplies ... 6
   3.2. On-site power systems ............................................. 8
      3.2.1. Reliability, form and arrangement ................... 8
      3.2.2. Single failure and redundancy ....................... 9
      3.2.3. Independence and physical separation ............ 11
      3.2.4. Protection against natural phenomena ............ 12
      3.2.5. Protection against man-induced events and combinations of events ........................................ 13
      3.2.6. Protection against fire and explosion ............... 14
      3.2.7. Effects of environmental conditions and equipment failures ........................................... 14
      3.2.8. Safety system support features .................... 15
      3.2.9. Sharing of structures, systems and components in multi-reactor nuclear power plants ....................... 16
      3.2.10. Instrumentation, monitoring and control of the EPS .... 16
      3.2.11. Identification of equipment, components and documents ........................................... 17
      3.2.12. Provisions for in-service training ................... 18
      3.2.13. Inspection, maintenance and repair ................ 18
   3.3. On-site electrical power system .................................... 19
      3.3.1. Capacity and characteristics of electrical power supplies and components ........................................... 19
      3.3.2. Protection against fire ....................................... 24
      3.3.3. On-site DC electrical power system .................. 25
   3.4. Equipment and components ....................................... 26
      3.4.1. Equipment qualification .................................... 26
      3.4.2. Stand-by power supply units and support systems ... 27
3.4.3. Distribution system switching components .................................. 30
3.4.4. Transformers ........................................................................... 31
3.4.5. Batteries .................................................................................. 32
3.4.6. Battery charger ....................................................................... 33
3.4.7. DC/AC converter ................................................................... 33
3.4.8. Cables and buses .................................................................... 34
3.4.9. Electrical penetrations ............................................................ 34
3.4.10. Instrument/control air ............................................................. 35
3.5. Additional considerations ........................................................... 36
  3.5.1. Lightning protection ............................................................... 36
  3.5.2. Electrical system earthing ..................................................... 36
  3.5.3. Emergency lighting ............................................................... 37
  3.5.4. Corrosion protection .............................................................. 37
  3.5.5. Operating procedures ............................................................ 38

4. REFERENCE LIST OF RECOMMENDED INFORMATION FOR THE SAFETY ASSESSMENT .................................................. 38

5. BIBLIOGRAPHY ............................................................................. 55

CONTRIBUTORS TO DRAFTING AND REVIEW ................................. 73

LIST OF NUSS PROGRAMME TITLES ............................................... 75

SELECTION OF IAEA PUBLICATIONS RELATING TO THE SAFETY OF NUCLEAR POWER PLANTS .................................................... 79
1. INTRODUCTION

1.1. BACKGROUND

The IAEA programme for the establishment of Nuclear Safety Standards (NUSS) for land based nuclear power plants with thermal neutron reactors resulted in the development of five Safety Standards (Codes on the Safety of Nuclear Power Plants) in the areas of:

- governmental organization
- siting
- design
- operation
- quality assurance.

Each Code sets out basic requirements for the safety of nuclear power plants in its area and contains the main philosophy, objectives and principles which are considered essential for safety. The procedure for their development ensures that the practices of all Member States are taken into consideration. Fifteen Safety Guides in the design area were issued to describe acceptable methods of implementing specific parts of the Code. The list of titles of all NUSS publications is given at the end of this book.

The practices involved in design for safety have developed in various countries on the basis of national industrial practice and in relation to national experience with specific technologies. The final safety design of a nuclear power plant depends on the system and functional design as well as on the design, manufacture and construction of the hardware. Particularly in the field of hardware manufacture, the national industrial practice may influence to a large extent the acceptability of a certain component in view of its safety function in the plant. The NUSS Code on Design and the associated Safety Guides do not, however, establish any particular rules for the detailed design of systems and components.

In order to facilitate the application of the Safety Guides it was considered useful to describe the procedures and decisions necessary during the safety review, identify acceptance criteria to the extent practicable and make reference to existing technical standards.

1.2. OBJECTIVE

This publication is intended to assist the safety assessor within a regulatory body, or one working as a consultant, in assessing the safety of a given design of the emergency power systems (EPS) for a nuclear power plant.
1.3. SCOPE

The present publication refers closely to the NUSS Safety Guide 50-SG-D7 (Rev. 1), Emergency Power Systems at Nuclear Power Plants. It covers therefore exactly the same technical subject as that Safety Guide. In view of its objective, however, it attempts to help in the evaluation of possible technical solutions which are intended to fulfil the safety requirements. Section 2 clarifies the scope further by giving an outline of the assessment steps in the licensing process.

1.4. STRUCTURE

After a general outline of the assessment process in relation to the licensing of a nuclear power plant, the publication is divided into two parts. First, all safety issues are presented in the form of questions that have to be answered in order for the assessor to be confident of a safe design. The second part presents the same topics in tabulated form, listing the required documentation which the assessor has to consult and those international and national technical standards pertinent to the topics. An extensive reference list provides information on standards.

2. SAFETY ASSESSMENT AND LICENSING

The process of safety assessment can be divided into four parts. The first part deals with the assessment of the systems design and the component specifications. This area is the subject of the present publication. Several aspects are considered:

- The information the assessor may expect from the applicant to fulfil the task of safety review
- the main questions the reviewer has to answer in order to determine compliance with the requirements of the NUSS publication
- the national or international standards which give further guidance on a certain system or item of equipment
- comments and suggestions which may help to assess a variety of possible solutions.

It is important that the assessor obtain an understanding of the design bases of the plant’s structure, systems and components which interface with or are to be supported by the EPS. This understanding should include the identification of the safety systems, including their supporting systems, their layout within the plant, and the safety functions to be served under operational states and accident conditions.
Depending on the structure of the licensing process it may be appropriate to review at first in a cursory way the concept of the design, checking only the main features of balance of loads and supply, the connection of the distribution system to the grid and the basic principles of redundancy and diversity. In a second step the details of the system and component design would then be reviewed, including all necessary details such as layout, separation of cables, transient behaviour of the systems and component specifications. The information which is given by the applicant may also be structured in this way. In some practices, however, these two phases are combined into one such that all detailed descriptions, drawings and specifications are provided at once.

It has also to be kept in mind that often certain components have to be specified and ordered by the supplier some time prior to the system review taking place, while the acceptability of the component specification can be assessed only later. The assumptions about the required component performance and capability must then contain sufficient margin to accommodate later changes which may arise during the design or assessment process. Such a situation is typical of the design and construction of such complex installations as a nuclear power plant and is also true in areas other than the EPS.

This publication, however, does not address the possible variations in the licensing process but leaves them to agreement between regulator and applicant. Consequent details of the review process are therefore left to the individual reviewer.

The second part of the safety assessment process, which is not covered by this publication, is the quality control of components and equipment. This activity involves essentially the manufacturer and has to be performed under an appropriate quality assurance (QA) programme. Reference is therefore made to the QA publications of the NUSS series. The individual control measures will depend strongly on national industrial practice.

The third part of the assessment deals with the adequacy of the systems as constructed on site. It involves the QA programme, including inspection and testing practices prior to and including the commissioning procedure. This activity is also not a subject of the present publication.

The fourth part of the assessment concerns the confirmation that the EPS design, installation, operation and reliability are consistent with the safety limits, limiting conditions for operation and surveillance requirements established in the technical specifications for the plant. This activity is again outside the scope of this publication.

The present publication is intended to assist the safety assessor in reviewing the EPS of a nuclear power plant systematically but it should not be taken as the only possible way of doing this. It is not intended to replace the educated judgement of the responsible safety assessor. However, it reflects good practice in many countries and is based on the long experience of experts.
3. SAFETY ASSESSMENT AND REVIEW GUIDANCE

The emergency power systems (EPS) are integral parts of the safety systems and provide power to designated items important to safety. This power may be in the form of electricity, compressed air, steam, direct drive (e.g. diesel engines that directly drive pumps) or hydraulic power, depending on the design of the systems. The supplies may be used separately or in combination. The assessor must ensure that systems have been correctly categorized as EPS and that they are constructed and maintained to a standard appropriate to the service they supply.

As a starting point of the review, the safety assessor must become aware of the design basis established for the plant, including the postulated initiating events, the required reliability of safety systems, the safety functions of the systems to be supplied with power, the load characteristics and their time sequence of power supply under emergency conditions, as explained in paras 312 and 313 of Safety Guide 50-SG-07 (Rev. 1). The validity and completeness of this input information and these interface characteristics with the remainder of the plant are to be reviewed in relation to the safety concept of the plant. This is mainly done by other specialized review teams and the assessor for the EPS must be able to rely on such inputs as approved. However, the conceptual review of the plant and of the interfacing systems will normally be an iterative process involving the engineer responsible for the safety assessment of the EPS although this review is not part of the guidance given in this publication. It has to take place prior to the detailed review discussed here.

In order to assist the reviewer in addressing the important aspects of the review of the EPS itself, some general objectives and lists of a number of key questions to which the reviewer should obtain answers during the assessment process are given below for each item or group of items. The list of questions is not exhaustive but it gives useful guidance on the important considerations to be reviewed. Many questions are formulated in such a way as to require a positive answer for fulfilment of the safety requirements.

Depending on the subject, other general comments or recommendations are given regarding good practice established in some countries or desirable ways of interpreting certain requirements.

For each subject item the reviewer will find in Table I (Section 4) a list of documents, drawings, specifications, etc., which should be available for the assessment.

Additional guidance on acceptance criteria to be applied can be found in many cases within the referenced national or international technical (nuclear) standards.

Table I provides a listing of national and international standards that are most often used. It should be understood that this information is provided for reference only and it must not be interpreted as an endorsement of these standards. In most
cases the practice represented by the standard will be acceptable but it should be noted that standards from different sources may not be fully consistent. The listing does not contain all standards that may pertain to the topic.

Engineering judgement derived from the experience of the safety assessor usually determines the depth to which a design should be reviewed. A practice that is used by assessors in making this determination is simply to audit the designs which are not new and to review in depth those designs that are new or unique. How the assessor finally determines the safety of the design will depend on the individual circumstances. A good deal of trust in the reliability and responsibility of the designer, manufacturer and the utility, supported by a QA programme, will be necessary to make the assessment process manageable. Considerable engineering judgement is required for the assessor to apply standards and national practices with a sense of proportion.

In general, the EPS are acceptable when it can be concluded that the systems have the required redundancy, meet the single failure criterion, are protected against the effects of postulated initiating events, are testable, and have the capacity and capability to supply power to all safety loads and other required equipment in accordance with the applicable requirements of Safety Series No. 50-C-D (Rev. 1) (hereinafter referred to as the Code), Safety Guide 50-SG-D7 (Rev. 1), other Safety Guides and international and national codes and standards as applicable.

The review guidance given on the following pages is structured according to the outline given in Table I.

3.1. OFF-SITE SUPPORT TO THE EPS

The only form of off-site support usually available to the EPS is the AC grid supply. The aim is to achieve the most reliable grid supply that is practicable by ensuring a highly reliable connection to the grid, taking into account any weaknesses in the grid system that it is not practicable to overcome.

Where the grid is known to be weak, one consideration for enhancing reactor safety would be to increase the capability and reliability of the EPS to compensate for this. The assessment process as dealt with in this Section should take this into account. Additional discussion of the interaction between the electrical power grid and nuclear power plants is given in IAEA Technical Reports Series No. 224.

3.1.1. Grid capability and reliability

*Basis for acceptance*1

Safety Guide 50-SG-D7, paras 201–211.

---

1 All references to Safety Guide 50-SG-D7 and its paragraph numbers are to Revision 1 issued in 1991.
Assessment questions

Is the grid designed and planned to be operated at all times with sufficient generating capacity, transmission lines and interconnections so that the grid will remain in service, stable and capable of supplying acceptable emergency power to the nuclear plant EPS upon the forced outage of the largest generating unit connected to the grid? If not, have adequate measures been taken to compensate for this deficiency and to ensure that the nuclear power plant safety objectives can be achieved?

3.1.2. Transmission line connection

Basis for acceptance


Assessment questions

Are the transmission line connections from the plant to the grid supply sufficiently reliable and available so as not to increase the forced outage frequency of the nuclear unit to an unacceptable level, given the number of transients specified in the design basis of the reactor systems?

3.1.3. Connection of the EPS to the off-site power supplies

The preferred approach of at least two transmission connections to the grid whenever practicable is strongly emphasized in view of the goal to provide electrical power with sufficient reliability and redundancy commensurate with the required design objectives of the EPS. There may be extreme situations, as described in paras 208 and 209 of Safety Guide 50-SG-D7, which hardly justify the installation of more than one such connection. In most cases the configuration of the existing grid permits the installation of this minimum of two connections.

The connections may originate from a common switchyard; mostly they are physically separated or otherwise protected to ensure their independence. Each connection is usually designed to be available in a sufficiently short period following the loss of the other connection. One of these connections is usually designed to supply electrical power to the EPS within a few seconds\textsuperscript{2} following a loss-of-coolant accident. Provisions are generally included to minimize the probability of losing electrical power from any of the remaining power supplies as a result of, or coincident with, the loss of power generated by the nuclear unit.

\footnote{2 This limit may be less strict for certain reactor designs.}
Basis for acceptance


Assessment questions

(1) Are the connections of the EPS to the off-site power supplies of sufficient capacity to provide reliable power and maintain adequate redundancy considering the on-site arrangements and design of the EPS?

(2) Have provisions been included to minimize the probability of losing electrical power to the EPS from any of the remaining power supplies as a result of, or coincident with, one of the following: the loss of power generated by the nuclear unit, loss of power from the off-site supplies, or the loss of all power from the on-site electrical power supplies?

(3) Are the connections from the off-site grid designed and protected so as to minimize, to the extent practical, failures (or simultaneous loss) under operational states and postulated accident conditions? Do other lines cross the connection? Are there any other structures or other hazards which by their failure can damage the connections, e.g. transmission towers, meteorological towers, lightning shield wires or potential explosions?

(4) If two circuits originate from a common switchyard does there exist any potential common cause failure mode, physical or otherwise, which can affect both circuits, such as the effects from apparatus explosions and/or fires, interactions of controls, electrical short circuits, inadequate protective relaying system design or co-ordination, non-independence of control power or support systems for apparatus for the two circuits?

(5) Do any common cause failure modes exist between the normally connected circuits to the grid and the stand-by power supplies such that power cannot be restored from the grid following the loss of either off-site circuit and a single failure in the EPS, in the time limits required to shut down the plant safely?

(6) Is the electrical power from the connections of the EPS to the grid available within specified time limits after a shutdown of the plant?

(7) Where there are two or more circuits extending from the grid connection to the EPS, have provisions been made to permit isolation of a failed circuit and the energization of the alternative circuit within the time limits required to fulfil the safety function?

(8) Do the components of the grid connections have sufficient capacity and capability to supply the loads which may be connected under operational states and accident conditions, taking into account the pertinent transient conditions?
(9) Do the one or more connections from the grid to the EPS possess sufficient independence and protective features that neither the loss of the unit generator or one of the grid connections nor the loss of the on-site stand-by power supplied will result in the loss of other connections from the grid to the EPS?

(10) Are the connections from the grid to the EPS sufficiently independent of the on-site power supplies and systems that no single event, including credible component failures, will prevent the connections from the grid from being separated?

(11) Have provisions been made to test, to the extent practical, the transfer of electrical power to the EPS from the grid connection during plant operation?

(12) If the circuits from the grid are shared between the different EPS of several nuclear units on multi-unit sites, do the circuits from the grid independently have sufficient capacity and capability to perform all required safety functions in the event of an accident in one unit, with the simultaneous orderly shutdown and cooldown of the remaining units?

(13) Is sufficient instrumentation available to permit the plant operator to determine the status and condition of the circuits from the grid to the EPS at all times?

3.2. ON-SITE POWER SYSTEMS

The EPS consists of the on-site components necessary for generating, converting and distributing power to those safety systems requiring it. The EPS receives electrical power from off the site and is able to generate on-site stand-by power. It is designed to incorporate high functional reliability, redundancy and independence. It is protected against damage from external causes as far as the site conditions require. The most common forms of emergency power are AC and DC electrical power and specific features of these are covered later in this section.

3.2.1. Reliability, form and arrangement

For the assessment of the overall reliability all contributing factors should be evaluated, e.g. independence, redundancy, component reliability, maintenance and testing. Probabilistic safety assessment (PSA) is accepted as an appropriate tool to be used in addition to deterministic assessment methods provided that the input data are applicable and of a high confidence level and system modelling has been done professionally.

Basis for acceptance

Assessment questions

(1) Is the arrangement of the EPS consistent with all the requirements of the safety systems to be served?
(2) Has a reliability analysis of the EPS been submitted? If not, how was the adequacy of its reliability demonstrated? Has the analysis shown that the EPS does not reduce significantly the reliability of the safety systems it serves?
(3) Has the single failure criterion for components been complied with?
(4) Have any weak components of the EPS with respect to its reliability been identified so that the operator training and maintenance programmes can take them into account?
(5) Has an analysis determined the permissible outage time for EPS components?
(6) Have operating procedures been established to determine under which conditions of reduced availability of the EPS the plant has to be shut down?

3.2.2. Single failure and redundancy

The single failure criterion and the related question of redundancy (see the Code, paras 329-336) both reflect a deterministic approach which should be fulfilled independently from the reliability objective.

Single failure

The compliance with the single failure criterion requires a clear understanding of the safety group concept and the definition of the safety function to be performed. The independence of the different divisions of the EPS should be part of the consideration.

It is important to note, in considering the single failure analysis, that passive electrical equipment is treated in the same way as active components in most countries. It must therefore be assumed that a random failure might disable a busbar or cable. However, it is also normal practice to assume that building structures and structural steel members will not randomly fail if they are designed against design basis loads (e.g. external events such as earthquakes).

In the case of protection system instrumentation it should be noted that a double failure criterion is imposed in some countries.

---

Redundancy

The design of the EPS must be adapted to the redundancy concept of the other safety systems. This means in simple applications that the number of divisions in the EPS is the same as the number of divisions of safety systems it supplies. Examples are:

- \( 2 \times 100\% \) divisions of safety systems powered by \( 2 \times 100\% \) divisions of the EPS. This form of redundancy takes into account the single failure criterion.
- \( 3 \times 100\% \) divisions of safety systems powered by \( 3 \times 100\% \) divisions of the EPS. This form of redundancy covers the combination of single failure, as above, and simultaneous outage of one division — either in the EPS or the powered safety systems — for maintenance.

Another form of redundancy, which gives similar results to the example above, is a \( 4 \times 50\% \) division redundancy.

Some components may not be connected to a single redundancy division. Such components, for example, are those which can be connected to either redundant division (e.g. spare converter). In other cases it is necessary to have redundant components within one fluid system (e.g. redundant containment isolation valves) which would therefore have to be powered from different divisions of the EPS to meet the single failure criterion. In these cases the reviewer must verify that the redundant components are physically separated by a sufficient distance and that appropriate isolation devices are incorporated.

Basis for acceptance

Code, paras 329-336.

Assessment questions

(1) Is the redundancy such that for on-site power operation of the EPS, power can be supplied to systems and components important to safety assuming unavailability of off-site power from the grid and a single failure within the EPS?
(2) Is the number of divisions which are considered independent at least as large as the largest number of functionally independent safety related system divisions which have to be supplied by the EPS?
(3) What provisions are incorporated to permit the outage of one redundant division for maintenance purposes without unacceptable increase of system unavailability?
(4) Has a quantitative outage time analysis identified the permissible outage period for one division?
(5) Is a maintenance and test plan available which is consistent with the permissible outage periods?

(6) Is the redundancy of the I&C system consistent with the redundancy of the EPS?

3.2.3. Independence and physical separation

Basis for acceptance


Assessment questions

(1) Are the redundant divisions of the EPS, including control, instrumentation and protection systems, sufficiently separated and independent from each other, both physically and electrically, to minimize the probability of common cause failures?

(2) Are the redundant divisions housed in separate enclosures so as to protect them against the effects of all postulated initiating events considered in the design basis, e.g. fire, chemical explosion, missiles and pipe ruptures?

(3) Will the components of the redundant division of the EPS be qualified to withstand the effects of environmental conditions identified for their locations, e.g. earthquakes, radiation, heat and humidity?

(4) Are the vital supporting systems for a division of the EPS arranged so that a failure of such a system will not affect more than one redundant division, e.g. one switchgear room ventilation circuit for each division? Are the vital supporting systems designed to the same criteria as for those safety systems and equipment that they support?

(5) Are interconnections between redundant divisions of the EPS, where these are necessary, made such that no single failure in an interconnection will cause redundant divisions to be connected? For example, where loads are arranged to be supplied from either of two redundant divisions independently, is interlocking between the two divisions sufficient to ensure that no single failure in the connection will cause the redundant divisions to be connected? Have the interconnections been designed to avoid the propagation of failures or faults in such loads to both divisions?

(6) Is the EPS sufficiently independent with respect to the normal power supplies that no single failure will prevent the separation of the normal power supplies and the connection of an adequate stand-by power supply to the EPS when it is required?
(7) Is the design such that no single protective relay or interlock failure will prevent disconnection of the normal power supply when it fails?

(8) Is the design of the normal power supply connection circuit and its controls such as to preclude the automatic reconnection of the normal power supply to the respective division of the EPS when it is being powered from its stand-by power supply?

(9) On failure of the normal power supply does the design provide for the automatic disconnection of the normal power supply and the startup and connection of the stand-by power supply to the appropriate division of the EPS within the specified time?

3.2.4. Protection against natural phenomena

The design basis for the plant will detail the natural phenomena which have to be taken into account in the design of the EPS.

Basis of acceptance

Code, paras 314, A205, A206.

Assessment questions

(1) Are all structures, systems and components of the EPS designed and qualified to remain functional following an earthquake of level SL2?4

(2) Are buildings, enclosures supports and anchors for the components and equipment of the EPS designed to remain functional following an earthquake of level SL2?

(3) Are the components and equipment for the EPS physically separated or otherwise protected from structures, systems and components which are not designed to remain functional or maintain their structural integrity following an earthquake of level SL2?

(4) Are the components and equipment for the EPS housed and/or otherwise protected so as to remain functional against the direct and consequential effects (including the failure of unqualified equipment and structures) of tornados, hurricanes, tsunami and seiches, i.e. high winds, missiles, floods, etc., as applicable?

---

4 For definition see Safety Guide 50-SG-S1. The level SL2 is often also called the safe shutdown earthquake.
3.2.5. Protection against man-induced events and combinations of events

The extent to which man-induced events and combinations of events are to be taken into account in the design of the EPS will be included in the design basis for the plant.

Basis for acceptance

Code, paras A203, A207-A211.

Assessment question

Are the structures, systems, components and equipment of the EPS housed and protected so as to remain functional against the direct and consequential effects (including failure of unqualified equipment and structures) of the man-induced events and combination of events identified and included in the design bases for the nuclear plant?

3.2.5.1. Station blackout

A combination of events that has a high enough likelihood to justify evaluation is station blackout. This is defined as the complete loss of AC power supplied from either off-site power on power sources on the site which may suffer a common cause failure. This does not include non-interruptible power sources, dedicated diesels or steam turbines if they can be proved to be independent from the other power sources.

Basis of acceptance

Code, paras A207-A211.

Assessment questions

(1) Are there emergency procedures for the event of station blackout?
(2) Are dedicated special purpose units completely independent?
(3) What is the estimated time from occurrence of station blackout until off-site or on-site power sources are recovered?
(4) Will core cooling be maintained during the blackout?
(5) Are there any alternative paths in the emergency procedures?
3.2.6. Protection against fire and explosion

Fire protection programme assessment is outside the scope of this publication; however, the following questions should be included in the review of fire protection and preventive measures.

Basis for acceptance

Code, paras 357–359.

Assessment questions

1. Are the physical separation, barriers, enclosures and fire zones of each redundant division of the EPS designed to contain the effects of fires and explosions within that division without affecting the other redundant divisions, including allowance for secondary effects, i.e. smoke, heat and fire propagation?

2. Is the fire suppression system (fluid and actuation) designed and zoned so that its operation (normal or spurious) or a rupture at any given point will affect only a single redundant division of the EPS, taking into account secondary effects, e.g. flooding, sprays and leaks?

3. Is the fire detection system designed so that a fire in one fire zone will not cause false actuation of the fire suppression system in other fire zones through infiltration and false detection of smoke or heat?

Note: further questions relating to electrical systems can be found in Section 3.3.2.

3.2.7. Effects of environmental conditions and equipment failures

Structures, systems and components of the EPS are protected or otherwise capable of withstanding the effects of the environmental conditions associated with anticipated operational states and accident conditions. Dynamic effects resulting from equipment failures included in the design basis, e.g. missiles, pipe whipping, fluid discharges and flooding, should be taken into account.

Basis for acceptance

Code, paras 360, 361, 1206, A204.
**Assessment questions**

For each structure, equipment and component of the EPS:

1. Has its physical location been identified?
2. Have all environmental conditions (temperature, pressure, humidity, radiation, chemicals, times of endurance, etc.) been identified for operational states and accident conditions, including necessary access (for operation and maintenance) in the long term accident recovery period, e.g. higher radiation levels?
3. Have these conditions been specified accordingly for the performance requirements of structures, equipment and components of the EPS, taking into account the length of time that they will be required to function?
4. Is the physical location or the protection provided adequate against the dynamic effects (including missiles, pipe whipping, discharging fluids and floods) that may result from equipment failures and from postulated initiating events?

**3.2.8. Safety system support features**

Safety system support features are those systems and components which are essential for control of the environment and operation of the EPS within design limits, e.g. air conditioning, ventilation, cooling water, fuel, lubrication, compressed air and dewatering systems. The criteria used in the design of the support features will depend on the possible effect of those features on the safety loads, power supplies, power systems, instrumentation and control systems that they support. The support features of a redundant division of the EPS will be designed to preserve its redundancy, separation and independence.

**Basis for acceptance**


**Assessment questions**

1. Are the supporting systems designed so as to preserve the redundancy, separation and independence of the respective redundant division which they serve?
2. Are the functional designs, capacities and physical independence of the support systems adequate for the intended functions?
3. Are the instrumentation, control and electrical aspects of the supporting systems designed to conform to the same criteria as those for the systems they support?
4. Are the instrumentation, control devices and loads of the supporting systems powered from the same redundant division which they support?
3.2.9. Sharing of structures, systems and components in multi-reactor nuclear power plants

Basis for acceptance

Code, para. 362.

Assessment questions

(1) Where portions of the EPS are shared between units of a multi-reactor nuclear power station is the combined capability of the shared portions together with those portions dedicated to each of the reactors sufficient to accommodate the most demanding postulated initiating event that could credibly affect one or more reactors followed by the orderly shutdown and removal of heat from unaffected reactors?

(2) Where a power supply (normal or alternative) to a redundant division of the EPS is shared between units of a multi-reactor nuclear power station, is the capacity of the shared power supply sufficient to operate all loads required by the design basis. Does the stand-by power supply for each redundant division of the EPS satisfy this question assuming the loss of all normal and alternative power supplies?

(3) Is the total on-site power capacity (stand-by and/or alternative exclusive of the nuclear unit’s generating capacity) sufficient to cope with the most demanding postulated initiating event that could credibly affect one or more reactor units and the orderly shutdown of the remaining units assuming the loss of off-site power and a single failure in the on-site electrical system?

(4) Is the startup and switching of power supplies automatic, or if co-ordination between unit operating personnel is required to satisfy questions (1) and (2) above, are system descriptions and operating instructions complete, sufficient and available to unit operators?

(5) Where portions of the EPS or their power supplies are shared between units of a multi-reactor nuclear power station do they conform with the requirements related to redundancy, electrical and physical independence contained in Sections 2.2 and 2.3?

3.2.10. Instrumentation, monitoring and control of the EPS

Basis for acceptance

**Assessment questions**

(1) Is adequate equipment provided in the control room to control the EPS during normal operation, anticipated operational occurrences and accident conditions?

(2) Is sufficient instrumentation and control equipment to operate the EPS located at supplementary control points external to, and physically separated and electrically isolated from, those provided in the control room to permit control of the EPS in the event of those in the control room being made inoperable by an event such as a fire?

(3) Is sufficient operational information provided so that the status of the EPS and its controls can be determined during all operational states and accident conditions of the plant from within the control room, and independently from outside the control room?

(4) Where the control circuits of valves or breakers are interlinked, has the relay and switching logic been analysed to show that after an intended operation of a valve or breaker or an individual breaker circuit failure no other valves or switchgear are adversely affected?

### 3.2.11. Identification of equipment, components and documents

**Basis for acceptance**

Safety Guide 50-SG-D7, para. 413.
(Safety Guide 50-SG-D3, Section 7.17).

**Assessment questions**

(1) Are all equipment, components and associated design, operating and maintenance documents of the EPS identified in a distinctive manner, i.e. by tagging, labelling or colour coding, to differentiate those of the EPS from other plant systems?

(2) Are the pipes and equipment and components of a redundant division of the EPS identified in such a manner that they can readily be distinguished from those of other redundant divisions?

(3) Are the pipes and electrical cable raceways of the EPS marked in a distinct manner at intervals to an extent sufficient to identify them throughout their lengths and at points of entry and exit from enclosed areas?

(4) Are the pipes and electrical cables of the EPS permanently identified at each end and at intervals in accordance with design drawings and cable schedules and readily distinguishable between redundant division of the EPS and non-safety systems?
3.2.12. Provisions for in-service testing

Basis for acceptance

Code, paras 322, 323.

Assessment questions

(1) Has a periodic testing programme been established and documented to test the operability and functional performance of the components of the system and the operability of the EPS as a whole in a manner as close to design as practicable?
(2) Is the EPS designed to permit and facilitate the periodic test programme described?
(3) Can the operability of each redundant division of the EPS be verified independently during reactor operation?
(4) Has a periodic testing programme been established, documented and implemented for the stand-by power supply to demonstrate its capability to start up and meet its performance objectives?
(5) Is the stand-by power supply designed to be tested during operation of the nuclear power plant as well as while the plant is shut down?
(6) Does the test simulate as closely as practicable the required performance of the stand-by power supply when called on to fulfil its safety function?
(7) Does the design permit testing of the stand-by power supply without impairing the capability to start and fulfil the safety function within the required time upon receipt of a genuine demand?
(8) Are adequate written test procedures available covering the periodic testing of the EPS with the stand-by power supply?

3.2.13. Inspection, maintenance and repair

Basis for acceptance

Code, paras 322, 323.

Assessment questions

(1) Are the components of the EPS designed and arranged with sufficient access for inspection, maintenance and repair?
(2) Has appropriate redundancy been incorporated so that maintenance can be performed without significantly impairing the safety capability of the EPS?

(3) Is there an adequate documented preventive maintenance programme available for the EPS?

3.3. ON-SITE ELECTRICAL POWER SYSTEM

In addition to the general requirements of Section 3.2, the following points need to be considered when assessing the electrical part of the EPS.

3.3.1. Capacity and characteristics of electrical power supplies and components

In general, the EPS shall supply electrical power of adequate quality and quantity, in the time specified for the safety systems to fulfil their safety functions, assuming a single failure and any credible postulated initiating events or combinations thereof identified by the design basis for the nuclear power station. In order to specify acceptable electrical parameters for the EPS several aspects have to be considered including:

— Load surveys and studies
— Non-safety system loads
— Power supply capacity and characteristics
— Voltage considerations
— Overcurrent and short circuit considerations.

The optimal selection of system parameters and components is determined by an integrated analysis of loading, voltage regulation, short circuits, etc.

3.3.1.1. Load surveys and studies

In order to have the appropriate data available, the assessor uses the results of a load survey which the designer performs to identify all loads, safety and non-safety, supplied from each redundant division of the EPS. The study should identify, for each load, its rated and inrush power, voltage, current and power factor for operational states and those postulated accidents which are identified in the design for the plant. The starting sequence, initiating time and operating duration time shall be taken into account. From the load information developed, the actual total load demand for each division is usually produced in the form of a time-load curve.
**Basis for acceptance**


**Assessment questions**

1. Have all loads, safety and non-safety, which are to be supplied from the EPS been identified?
2. Have the electrical characteristics of each load been identified?
3. Have the starting sequence, actual load demand, initiation time and running time for operational states and accident conditions been identified for each load?
4. Has the load–time demand, including inrush loads, been calculated for each redundant division of the EPS?
5. Do the load tabulations include all loads to be supplied by the EPS separately for each division and for each design basis event?
6. For each division of the EPS and for each design basis event or credible combination of events, are the loading studies and calculations based on the finally selected loading sequence and maximum total loads applied to the normal and stand-by power supplies? Are the transient characteristics of each load included where practicable, so that the effects of active, reactive and apparent power are considered in the time–load and time–voltage studies?
7. Are the steady state and transient loads applied to the normal and stand-by power supplies within their respective design performance capabilities for all design basis events or credible combinations of events?
8. Has the impact of manually started loads which could be administratively placed on the EPS at any time been accounted for?

**3.3.1.2. Non-safety system loads**

With caution, loads other than safety loads (non-safety loads) may be supplied from the EPS providing that they do not degrade the EPS to an unacceptable level.

**Basis for acceptance**


**Assessment questions**

1. Have the non-safety system loads supplied from the EPS been included in the total load calculations and performance analysis for the EPS to ensure adequate rating of the EPS and its power supplies and acceptable performance under all anticipated operational occurrences and accident conditions?
(2) If non-safety system loads have not been included in the load calculations and performance analysis for the EPS, does the design provide for their automatic disconnection upon detection of any condition where emergency operation of the EPS is required?

(3) Are qualified safety system grade isolation devices, control circuits, cabling and connections used to connect the non-safety system circuits to the EPS?

(4) Does the design prevent both automatic and manual connection of non-safety system loads and circuits to the EPS during the transient stabilization period following initiation of the protective action associated with the postulated initiating events?

(5) Is the safety system fully protected against potential faults in the non-safety loads?

### 3.3.1.3. Power supply capacity and characteristics

From the information developed by the load surveys and with margins applied for future load growth and uncertainties in the load estimates, the capacity and capability of the power supplies are determined. The capacity and capability of each power supply will be sufficient for the total load demanded, including inrush loads plus a margin, from the time of initiation for as long as required for normal startup, shutdown and each postulated accident condition. The total capability of the power supply will accommodate the power factor of the loads. The reactance of the power supply is determined by the integrated analysis of loading, voltage and short circuit considerations and calculations.

**Basis for acceptance**


**Assessment questions**

(1) Has the capacity and capability of each power supply and its electrical characteristics of rated voltage, running time ratings, kVA and reactances been identified?

(2) Is the capacity and capability of each power supply adequate to supply the load demand described above?

(3) Has the reactance of the power supply been established so as to accommodate the loading demands within acceptable voltages and frequency and to limit short circuit currents to within the ratings of components and protective devices?

(4) Does the connection time for each safety system load meet the requirements of the design basis?
3.3.1.4. Voltage considerations

System voltage studies are performed for the EPS to optimize and establish operating voltage levels during normal operation, anticipated operational occurrences and accident conditions. The analysis should consider the effects of normal operation of the main unit generator and grid as well as transient conditions associated with startup, shutdown, unit trip, postulated accidents and abnormal grid conditions. The analysis will include the situations where the off-site grid is the only electrical power source available and the grid voltage is at the minimum level calculated with the nuclear unit in any anticipated condition and the situation where the grid voltage is at the maximum level calculated with the minimum loads supplied from the EPS, e.g. cold shutdown or refuelling.

The voltage studies cover the complete EPS, from the power supplies to the loads, at all voltage levels, to ensure that the loads are supplied with electrical power at acceptable voltages so as to permit the required performance of the EPS and equipment important to safety. The voltage studies should consider the effects of connecting loads to the EPS in proper sequence under the various conditions outlined above and the effects of inrush currents on starting motors.

Overvoltage and undervoltage protection will be provided to prevent adverse operation of the EPS and possible damage to safety system electrical equipment as the result of sustained abnormal voltage conditions of the EPS.

Basis for acceptance


Assessment questions

(1) Is the voltage at the terminals of the loads within the manufacturer’s rated continuous operating ranges for operating states and accident conditions when the EPS is supplied from:
(a) the grid;
(b) the unit main generator;
(c) the stand-by generator(s);
(d) a neighbouring unit;
when the voltage and frequency of each is at its maximum or minimum anticipated value?

(2) Considering all the conditions described in (1) above and, in addition, the voltage drops caused by the transient currents of load energization, can the loads be started safely and within the time limits required, so that the safety functions of equipment can be accomplished? For example:
— contactors or relays could drop out or fail to pick up;
— motors could fail to accelerate in an acceptable time;
— power supplies to the EPS could become overloaded.

(3) Are the voltages on the buses of the EPS and off-site power supplies indicated in the control room with abnormal high and low level alarms annunciated?

(4) Is the voltage sensing logic, incorporated in each division of the EPS to detect degraded conditions in the normal power supply, designed:
(a) to initiate protective action in sufficient time to ensure safe and orderly load shedding, startup and loading of the stand-by power supply?
(b) to be properly co-ordinated with the protective and control systems of the EPS so as to avoid, for example, spurious separation of the normal power supply when supplied from the grid, or spurious shedding of loads from the stand-by power supplies due to motor starting transients?
(c) to comply with protection system requirements?

3.3.1.5. Overcurrent and short circuit considerations

In order to achieve the protection sought with minimum disturbance, or unnecessary system service impairment, the protective devices must be calibrated and designed to interrupt the circuit without damage to themselves and in proper sequence, i.e. the protective device closest to the faulted component on the power supply side should open first in sequence and so on.

Overcurrent protective device co-ordination studies are conducted to ensure that the various devices are selective in their operation, i.e. co-ordinated with each other. In these studies transient inrush currents from energizing equipment such as transformers and motors as well as maximum and minimum short circuit currents for various given faults are considered. Proper co-ordination of protective devices allows energization and operation of the EPS, startup and operation of required loads, and the selective isolation of faults so as to localize the disturbance and minimize the effects on the EPS.

Short circuit studies are also performed for the EPS and are used to:

(1) Select overcurrent protective devices such as circuit breakers and fuses which must isolate the faults at a given location safely with a minimum of damage to circuits and equipment.

(2) Determine the maximum short circuit currents which pass through the various components of the EPS and for which the components must be designed to safely withstand the effects.

(3) Establish the short circuit currents used in co-ordinating the overcurrent protective device and/or protective relay settings.

Basis for acceptance

Assessment questions

(1) Have short circuit studies been performed and are results available to establish the maximum fault current values to be used in the proper selection of overcurrent protective devices and components of the EPS?

(2) Have short circuit studies been performed and are results available to establish short circuit currents for the co-ordination of the overcurrent protective devices and protective relays?

(3) Have protective device co-ordination studies been performed on the EPS?

(4) Do the protective device and relay setting co-ordination data permit energization and operation of the EPS, startup and operation of required loads, and the selective isolation of faults, so that the disturbance is localized to the extent possible with minimum cascading effects?

(5) Are the protective device ratings and capabilities adequate for the maximum overload and short circuit current service for which they are applied under all credible conditions?

3.3.2. Protection against fire

In addition to the requirements of Section 3.2.6 the following points need to be considered for electrical systems.

Basis for acceptance

Code, paras 357–359.

Assessment questions

(1) Are all indoor electrical apparatus and components (switchgear, transformers, buses, cable trays, cable supports and conduits) fire retardant?

(2) Are the cables fire retardant and tested to meet national standards test criteria for fire retardant cables?

(3) Has the use of flammable oil, insulating, cooling or interrupting media been eliminated to the extent practicable in electrical apparatus and other equipment, e.g. circuit breakers, switches, transformers and capacitors, within the vicinity of the EPS equipment?

(4) Are electrical cables, cable trays, raceways and conduits which penetrate fire barriers (e.g. floors, ceilings or walls) fitted with fire stops which have been qualified by test to meet national standards criteria?
(5) Where fire stops and other fire resisting materials (i.e. blankets) have been used in cable systems, have the cables been derated and/or raceway fill adjusted to ensure compliance with accepted national practices, or verified as adequate on some other basis?

(6) Does the design and arrangement of electrical apparatus enclosures and cabinets permit ready access for extinguishing fires?

3.3.3. On-site DC electrical power system

Electrical power is supplied to the DC systems from the AC systems of the EPS. Battery chargers and batteries serve as the DC power sources for the DC system, and inverters are used to convert DC to AC for instrumentation and control power as required. The DC system of the EPS is an integral part of the EPS and must meet the same acceptance criteria as the rest of the EPS. Several explanatory comments are offered in applying the acceptance criteria of Section 3.2 to the DC system:

(a) Single failure criterion. The DC system is an integral part of the EPS and the single failure criterion shall be applied taking this fact into account for the potential interaction with other parts of the EPS.

(b) Power supplies. The batteries, battery chargers and inverters shall be capable of performing their intended functions under the worst operating conditions with the maximum load demands and for the maximum periods specified for all credible conditions of startup, shutdown, normal operation and accident conditions. The battery charger shall have the capacity to supply the largest combined load demands of the DC system plus the capacity to restore the battery from the design minimum charge state in the time required.

In general, the DC system is acceptable when it can be concluded that it has the required redundancy, meets the single failure criterion, is protected, is testable, and has the capacity to supply all loads to be powered during operational states and accident conditions.

Basis for acceptance

As for the relevant parts of Section 3.3.1, plus Safety Guide 50-SG-D7, paras 515–520.

Assessment questions

(1) Is the DC system arranged with redundancy and independence consistent with the safety system it serves?

(2) Does the DC system conform to the design principles, requirements and acceptance criteria of Section 3.2?
(3) Does the DC system meet the single failure criterion?
(4) Do the batteries, battery chargers and inverters conform to the required capacities stated above?
(5) Are the batteries for each redundant division separately enclosed and protected? Are the enclosures adequately ventilated to prevent hydrogen buildup and to maintain design environmental conditions?
(6) Are adequate monitoring indicators and alarms provided in the control room to determine the service status of the battery and battery chargers? Do the alarms function independently of the DC system they monitor?
(7) Do the monitoring provisions include indications and/or alarms in the control room to signal battery charger failures, battery earth (ground) detection and DC bus voltage?
(8) Does the capability to perform battery capacity tests exist at the station?
(9) Have the DC loads been verified to be adequately rated for increased battery voltages encountered during equalization?

3.4. EQUIPMENT AND COMPONENTS

It is the objective of this section to address those aspects of the application, selection and qualification of equipment of the EPS which should be considered in the assessment to ensure high reliability and quality, adequate capability and performance of components and equipment.

In addition to the specific references given in the following subsections, attention is drawn to the wider requirements given in the Code, paras 318-321, 360, 361 and Section 7 of Safety Guide 50-SG-D7.

The verification which is performed before the installation of the units and their support systems on the site or by commissioning test in situ is not a subject of this publication.

3.4.1. Equipment qualification

All components important to safety shall be able to fulfil their safety function throughout their qualified life. This is especially important for components inside containments, e.g. cables and penetrations, which are subjected to a LOCA environment and may induce a common cause failure.

Basis for acceptance

Assessment questions

(1) Has the equipment or components been qualified for the intended service and does the documentation verify the qualification?

(2) Have the environmental conditions been identified for all components important to safety?

(3) Have the components been type tested according to a recognized standard or have some components been qualified by analysis?

(4) Is there an exchange programme for components qualified for a life shorter than the expected plant life?

3.4.2. Stand-by power supply units and support systems

Stand-by power supply units are essential to enable the EPS to fulfill their safety function on failure of other power sources. Consequently, it is important that the stand-by power supply units be of high quality and reliability. The prime movers of the stand-by power supplies may be hydroturbines, gas turbines, steam turbines, diesel engines, etc. The stand-by unit is acceptable if it is sufficiently reliable, has adequate capacity and performance characteristics, can start and deliver the required power to the loads in the required time, and is appropriately qualified.

Design documents, specifications, load balance calculations, including worst conditions during anticipated operational occurrences and accident conditions, should show that the unit will perform according to the required power output, taking into account startup time and the load sequence programme.

The calculations concerning cooling water system, combustion air supply, preheating power supply, starting power supply, installation room ventilation and fuel and lubrication oil consumption should be reviewed to prove that the unit can start and operate as required.

The power supply units include diesel and steam turbine driven pumps and generators but because the stand-by power supplies which are most often installed in nuclear plants are diesel generators, greater emphasis is given to them in the following guidance. In some cases units combine pumps and generators. ('Unit' refers to the prime mover plus the electrical generator, pump, etc. in the following questions.)

Basis for acceptance

Assessment questions

Power supply unit

(1) Does the pump or generator unit have the required capacity and performance characteristics? Is each generator unit capable of starting the maximum load on its own?

(2) Can the generator unit start and provide power within the time required by the overall plant design?

(3) In the case of a generator, can all loads be started and accelerated in the required time and proper sequence for anticipated operational occurrences and accident conditions? Is load sequencing arranged in such a way that the biggest loads are picked up first?

(4) Is the protection of the generator unit designed to trip and isolate a unit in the event of reverse power?

(5) Has the unit been qualified for the intended service and does the documentation verify the qualification?

(6) Have separate rooms been provided for each generator unit?

(7) What measures have been taken to avoid common cause failures in more than one unit?

(8) Has enough space been planned around the units to permit maintenance and repair without difficulty?

(9) Are there sufficient measures to protect electrical power and control cables from the effects of lubrication oil, fuel or cooling media and to prevent penetration into cable channels to a practicable extent in the event of leakage?

(10) Are the generator units accessible even under anticipated operational occurrences and accident conditions?

(11) What measures have been taken to guarantee sufficient separation between electrical cables and pipe lines for cooling water, fuel, exhaust fumes and lubrication oil?

(12) Are cables oil resistant and fire retardant?

(13) Are the measures for fire protection adequate (see Safety Guide 50-SG-D2)?

(14) Has the ventilation been designed to ensure that room temperature will not exceed specified limits?

(15) Is the monitoring of installation room ventilation sufficient (ventilator drive, shutter drive, shutter position)?

(16) Is there sufficient communication between the local control board of each unit and the main control room?

(17) Are all of the services required to support the unit either supplied by the unit itself or from guaranteed supplies? If they are supplied by the unit itself, are there alternatives for use during the start sequence?
Starting system

(1) Is the energy storage capacity for starting power in accordance with the specified number of start cycles?
(2) Is the time for recharging the storage in accordance with the required minimum period?
(3) Are the storage and recharge functions adequately monitored?
(4) Is independence of each unit maintained with respect to starting systems?
(5) Are there provisions for prelubricating and preheating?

Control system

(1) Is the independence of each unit maintained with respect to the control system?
(2) If the control systems rely on batteries or air reservoirs, is their capacity sufficient for the designed duration of use of the unit?
(3) If the control system is supplied by the unit once it is running, are there separate supplies for use during the start sequence?

Combustion air system and exhaust fume system

(1) Are ducts for combustion air and exhaust fumes sufficiently separated to avoid undue heating of the combustion air?
(2) Are the intake of combustion air and the outlet of exhaust fumes sufficiently separated to prevent recirculation of the exhaust?
(3) Are the combustion air intake and exhaust fume outlet protected against rain to prevent the penetration of water into the ducts?
(4) Are the provisions for combustion air cleaning sufficient?

Lubrication oil system

(1) Are there measures for changing oil filters so that there is no degradation of diesel availability during the change if the design basis requires long term operation?
(2) Is it possible to replenish the lubrication oil without interruption of unit operation if the design basis requires long term operation?
(3) Is the lubrication oil pressure adequately monitored?

Fuel system

(1) Are the fuel systems of each generator unit independent of those of the other units?
(2) Are daily fuel storage and main fuel storage provided for each unit?
(3) Is the storage volume in accordance with consumption calculations and anticipated postulated initiating events during the replenishment operation?
(4) Are there sufficient and reliable devices provided for monitoring the fuel level?
(5) Are there devices for monitoring the function of fuel transfer pumps?
(6) If suction pumps are employed, have measures been designed to prevent air inlet into fuel suction pipes?
(7) Are measures available to exchange fuel filters without interruption of unit operation?
(8) Are all components of the fuel transfer systems provided with an appropriate source of safety related power?

Steam system

(1) Is the working pressure range of the steam turbine such that it can reliably operate for the full pressure range of the steam generator down to the start of the low pressure cooling system in the primary circuit?
(2) Is the exhaust of steam to the atmosphere acceptable? If not (particularly in the case of a BWR), is a condenser foreseen?
(3) Is the problem with water condensing in the steam lines at start and during operation taken care of?
(4) Is there sufficient steam capacity to supply the loads on the system for the designed length of time?

Cooling system

(1) Is the cooling of each unit independent of that of the other units?
(2) Have cooling water pipelines been adequately protected against mechanical damage due to postulated initiating events?
(3) Is the unit cooling medium filtered and purified so that system corrosion and damage is minimized?
(4) Are there sufficient means to monitor unit temperature and the cooling system?

3.4.3. Distribution system switching components

This section applies to the AC and DC switchgear and motor control switching components of the electrical distribution system of the EPS.

Basis for acceptance

Assessment questions

(1) Are the AC and DC switchgear and motor controls:
   (a) Qualified to fulfil their performance requirements under their specified design basis conditions?
   (b) Selected and sized adequately to accommodate all loading conditions which may be applied within their ratings?
   (c) Rated to withstand and interrupt (where necessary) the maximum short circuit currents to which they may be subjected?

(2) Is the control power adequate to accommodate the switching of all circuit breakers and contactors as required under all conditions?

(3) Are there measures to monitor the status of the switchgear and motor controls for abnormal deviations of parameters, e.g. bus voltage, control voltage, air pressure and switch positions?

(4) Are there adequate means to indicate the mechanical position of plug-in breakers? Are alarms provided in the control room warning of deviations from normal conditions?

(5) Are there adequate measures to protect the switchgear or load against overcurrent and short circuit? This question deals with problems of selectivity. The assessor has to take into consideration that the set points of all protective devices will comply with the selectivity requirements.

(6) Are the components qualified, is documentation available and does the documentation substantiate the qualification?

(7) For ungrounded systems (AC or DC), are ground detectors provided to monitor for deviation of insulation resistance to ground and inadvertent grounding of a circuit?

(8) Where ‘isolating’ diodes are used to permit multiple feeding of a DC bus or load, what provisions are made to detect failure of the diodes to conduct or isolate?

3.4.4. Transformers

The assessor should ensure that the transformers will meet the operational requirements, taking into account the worst load condition determined by the load studies in Section 3.1.1.

Basis for acceptance


Assessment questions

(1) Will the transformer power rating be in accordance with the intended and designed power distribution?
(2) Will the supplied primary and secondary voltage be in accordance with plant voltage levels?

(3) Will the transformer impedance voltage be in accordance with the minimum value assumed in short circuit calculations and with the maximum values assumed in load transfer studies?

(4) If transformers are intended for parallel operation, are the switching modes of the transformers compatible (transformation ratio, short circuit voltage, nominal power ratio, etc.)?

(5) What measures are taken for monitoring, failure indication and protection?

3.4.5. Batteries

As well as supplying parts of the EPS via DC/AC converters, batteries may be used to support breaker operating circuits, engine starting and control, lighting, communications, etc.

Basis for acceptance


Assessment questions

(1) Are there adequate measures to avoid combustible gas concentration in battery rooms?

(2) If the room ventilation fails, can the batteries remain in full operation (especially in a high charge condition) for sufficient time to allow for the restoration of ventilation, or the implementation of an alternative, before gas concentrations exceed the acceptable maximum?

(3) Are there adequate measures in the control room to indicate any battery room ventilation defects?

(4) If the DC system is designed to operate ungrounded, is the resistance between battery terminals and earth after installation adequate to permit proper operation?

(5) Are measures provided to monitor and detect deterioration of the resistance from battery terminals to earth?

(6) Have the batteries been qualified by type test?

(7) Have acceptance tests been performed to assure that the batteries as installed meet specifications?

(8) Are batteries and their installations designed to meet the design basis environmental conditions and seismic loading?

(9) Is there sufficient access to the batteries to allow efficient maintenance?
3.4.6. Battery charger

The battery charger is required to supply the total DC load and at the same time to maintain the battery in a fully charged state or to recharge depleted batteries.

Basis for acceptance


Assessment questions

(1) Does the charger have sufficient capacity to supply the required load demands during operational states and accident conditions and to recharge depleted batteries at the same time?
(2) Are sufficient means provided in the control room to monitor the essential parameters which are important to the proper operation of the charger?
(3) Is the voltage regulation satisfactory when the batteries are disconnected?
(4) Is adequate ventilation or cooling provided to maintain the charger and room ambient temperatures within acceptable limits?

3.4.7. DC/AC converter

In reviewing the design and performance of the DC/AC converter, the assessor should take into account the load demands which have to be supplied. After examining the load and voltage studies mentioned in Section 3.3 the assessor should compare the frequency stability of the converter with the frequency dependence of the load.

Basis for acceptance


Assessment questions

(1) Does the DC/AC converter have sufficient capacity to supply the required load demands during operational states or accident conditions, including transient loads and reactive loads?
(2) Are the output wave shape, harmonic content and frequency stability in accordance with design limits and acceptable for the loads connected?
(3) Are sufficient means provided in the control room to monitor the essential parameters which are important to the proper operation of the converter?
(4) Is adequate ventilation or cooling provided to maintain the converter and room ambient temperatures within acceptable limits?
(5) Is the switching arrangement suitable for the load requirements, i.e. are static transfer switches necessary?
(6) Is there a backup AC source to allow inverter maintenance?

3.4.8. Cables and buses

Basis for acceptance


Assessment questions

(1) Are the conductors of the cables properly sized to accommodate the load demands, voltage drops and derating required as the result of cable installation requirements?
(2) Have the cables been adequately derated with respect to installation in raceways, fire stops, fire retardant coatings, etc.?
(3) Are the selected circuit protective devices able to protect the cable against overheating during steady state load, overloads and short circuits?
(4) Has the independence between redundant divisions of the EPS been maintained with the cable installations?
(5) Are the cables sufficiently fire retardant to prevent propagation of fires?
(6) Have cables been suitably qualified in areas with harsh environment?

3.4.9. Electrical penetrations

The scope of the assessment applies to those electrical penetration assemblies which are required to conduct electrical power, and control and instrument circuits through the reactor containment and preserve its leaktight integrity.

Basis for acceptance


Assessment questions

(1) Are the penetrations designed to take the identified loads?
(2) Are the penetrations compatible with the cables which are leading through them?
(3) Are the penetrations as installed capable of being tested for leaktightness?
(4) Are the penetrations designed to perform satisfactorily under the design basis incidents and accident conditions, including seismic conditions?
(5) Are the penetrations arranged and installed to preserve the independence and redundancy of the redundant safety divisions?

3.4.10. Instrument/control air

Instrument air is generally used for the operation or control of valves. It may also be used to transmit signals as an alternative means to electrical transmission.

Basis for acceptance


Assessment questions

(1) How will the redundancy requirements for safety related devices requiring pressure for proper operation be met? Have appropriate isolation devices been provided?
(2) Is the instrument air independent of working air?
(3) Can the system be designed to enable isolation of non-safety needs in favour of safety needs in an emergency?
(4) Are the compressor motors powered from separate load centres so that should one load centre trip all compressors would be lost?
(5) Is the storage capacity in the air reservoirs adequate to provide sufficient air at an acceptable pressure for the postulated period for which the compressors may be temporarily lost?
(6) Have sufficient capacity and a sufficient number of compressors been provided to permit a compressor to be out of service for a longer maintenance period?
(7) Have adequate controls been provided to limit instrument air usage to that for which it was designed?
(8) Have the water cooling requirements for the compressors and the after-cooler (if used) been included in the plant cooling water system requirements?
(9) What type of air drying device is most appropriate for the environment in which the system will be operated?
(10) What instrumentation is needed for:
(a) monitoring system performances?
(b) testing of the system to:
— compare its performance to the design criteria?
— determine the extent of and frequency of maintenance needed?
3.5. ADDITIONAL CONSIDERATIONS

The objective of this section is to address those features essential to the safe and reliable operation of the EPS which are not considered in other sections.

3.5.1. Lightning protection

The establishment of effective lightning protection and earthing is essential to the safe and reliable performance of the nuclear plant operation and it is required to protect buildings, structures, exposed electric circuits, equipment and components essential to the operation of the EPS.

Basis for acceptance


Assessment questions

(1) Are the earthing electrodes and their connections adequate for the purpose of conducting and distributing lightning discharges safely external to and away from buildings and equipment connected with the EPS?
(2) Will the lightning protection shield wires or conductors effectively shield and protect buildings, exposed electrical lines and electrical equipment?
(3) Are the connections from power supplies to the EPS which are exposed to the effects of lightning (i.e. connections to and from transformers, etc.) shielded and fitted with lightning arrestors?

3.5.2. Electrical system earthing

Effective earthing is essential for the safe and reliable performance of the EPS and required to prevent overvoltages or spurious tripping and to ensure positive isolation of electrical faults.

Basis for acceptance


Assessment questions

(1) Are the AC electrical systems of the EPS adequately earthed (e.g. electrical system neutrals are established and earthed by acceptable methods)?
(2) Are the earthing conductors and buses between the power supplies, electrical structures and equipment (motors, switchgear, motor controls, cable raceways, etc.) sized to conduct earthing fault currents and limit overvoltages to values which are safe for equipment and personnel?

(3) Are all the various earthing grids, systems and structures on the site bonded together so that differences of electrical potential cannot exist between them under any electrical discharge, e.g. earthing faults, arcing earth faults or lightning discharges?

(4) Are the frames of all building metal structures, metal supports, piping systems, ducts, electrical equipment, panels and electrically operated apparatus bonded to the earthing systems?

3.5.3. Emergency lighting

Emergency lighting is required to cope with the loss of normal lighting as the result of incidents, e.g. the loss of normal AC electrical power. It is installed in critical locations to permit the safe operation or shutdown of the plant during and following the loss of normal lighting. Emergency lighting is needed at strategic locations, e.g. control room and the supplementary control points, access and egress routes, stairways and security areas. In some Member States the control room emergency lighting is uninterruptible, being supplied from DC to AC inverters fed from batteries, while in others it is taken from the stand-by power supplies of the EPS.

Assessment questions

(1) Is emergency lighting provided at strategic locations as identified and described above?

(2) Is the emergency lighting provided for the control room independent of normal lighting?

3.5.4. Corrosion protection

Where support features for the EPS, e.g. fuel oil tanks and associated piping for stand-by generators, are buried in the ground or otherwise subject to corrosion they should be protected with corrosion protective coatings, coverings and/or cathodic protection.

Assessment question

Are the support features for the EPS adequately protected against corrosion?
3.5.5. Operating procedures

Where the operation of the EPS is not automatic it is necessary to have clear, written instructions covering the actions required during normal operation and following a postulated initiating event.

Assessment questions

(1) Do the written instructions to operators reflect the designed use of the EPS?
(2) Do the written instructions to operators cover the actions required if remote control or indication of the EPS is lost?

4. REFERENCE LIST OF RECOMMENDED INFORMATION FOR THE SAFETY ASSESSMENT

This section provides information and references to NUSS, and national and international standards for use by the assessor, as appropriate, for the safety review of the EPS. Care must be taken to ensure that the latest version of a standard is used and in some cases standards will have been replaced since this list was compiled.

The list is presented in tabular form for ease of use and follows the structure presented in Section 3. The first major section deals with the interface of the EPS with off-site systems, the second and the third deal with the system design aspects of the EPS and the fourth with the hardware as individual components. The last part is concerned with additional considerations going somewhat beyond the EPS design.

The first column of the table identifies the subject and the second describes the type of information the assessor is expected to receive from the applicant in order to be able to prepare the assessment of the item. This information may be available in different forms depending on the country of origin and its licensing practice. It may also be given at different times; some may be contained in the safety analysis report and some in separate documents.

The references given to the NUSS design publications in the third column are the main references but they are not necessarily complete. This should be particularly understood as the possible interfaces and other aspects not referred to may influence the requirement, though to a lesser extent. Also, the subject matter may sometimes depend on the proper design of parts which are not even identified in Safety Guide 50-SG-D7. Typical examples are the requirement for high reliability of fire protection systems. Not all parameters which actually influence the overall system
reliability are mentioned in Safety Guide 50-SG-D7 explicitly in this connection — for example testability and maintainability or other aspects which involve operator actions. Further, the references in Sections 3.2.6 and 3.2.2 to Safety Guide 50-SG-D2 on fire protection are not intended to mean that the safety assessor for the EPS should refer to all aspects of fire protection such as location of sprinkler systems in the diesel generator building in detail but rather to those questions which are addressed in the respective questionnaire. There has to be a separate review of the fire protection measures in the process of the overall safety assessment of a nuclear power plant.

It should also be understood that this third column often refers to sections of the various NUSS Safety Guides in order to direct the assessor to the specific requirements. But this should not mislead the assessor to assume that other sections are of no significance.

In the table, NUSS references are abbreviated, e.g. Safety Guide 50-SG-D2, Rev. 1 paras 431 and 442 is written as D2 — 431, 442. The Code on Design is abbreviated as C. A Safety Practice is referred to by the letter P.

The table provides, in the fourth column, a listing of national and international standards that relate to each of the subject items and are most often used. Sometimes particular sections of a standard are quoted after the standard number. It should be noted that the different national standards appearing under one subject item are not necessarily equivalent. They may even not require the same technical solution for a specific problem. It may, however, be assumed that the standards from each country are consistent. The listing should be understood as an aid to the safety assessor and not as an all comprehensive list.

In the last column additional references are given that provide in-depth information. The bibliography explains the acronyms used.
<table>
<thead>
<tr>
<th>1. Off-site support to the EPS</th>
<th>Documentation to be submitted by applicant</th>
<th>Reference to NUSS documents</th>
<th>International or national standards*</th>
<th>Additional references</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. Grid capability and reliability</td>
<td>Description of the off-site power grid system and its interconnections to other grids</td>
<td>D7 — 201-211</td>
<td>KTA 3701.1</td>
<td>4.1, 4.2</td>
</tr>
<tr>
<td></td>
<td>Grid reliability report and results, including grid stability analysis and frequency analysis study reports</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2. Transmission line connection</td>
<td>Description of the connections of the nuclear power plant to the grid, indicating number and routing of transmission lines</td>
<td>D7 — 207-211</td>
<td>KTA 3701.1</td>
<td>4.3</td>
</tr>
<tr>
<td>1.3. Connection of the EPS to the off-site power supplies</td>
<td>Description of the connections from the grid to the EPS, including physical arrangement drawings, single line diagrams, protective relay diagrams and data, electrical schematics, logic diagrams, system voltage and</td>
<td>D7 — 212-215, 507</td>
<td>IEEE 308</td>
<td>KTA 3701.1</td>
</tr>
</tbody>
</table>
### TABLE I. (cont.)

<table>
<thead>
<tr>
<th>Documentation to be submitted by applicant</th>
<th>Reference to NUSS documents</th>
<th>International or national standards</th>
<th>Additional references</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.3. (cont.)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>short circuit study results,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>grounding design information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lightning protection and shielding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2. On-site power systems</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.1. Reliability, form and arrangement</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description of the on-site power systems</td>
<td>D7 — 201, 202,</td>
<td>KTA 3701.1</td>
<td>IEEE 308</td>
</tr>
<tr>
<td>including single line diagrams</td>
<td>216, 217</td>
<td></td>
<td></td>
</tr>
<tr>
<td>indicating distribution, bus arrangements,</td>
<td>304–306</td>
<td>IEC 300</td>
<td></td>
</tr>
<tr>
<td>valve and switching provisions, manual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and automatic interconnections,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>safety and non-safety loads, protective</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>provisions, load shedding and sequencing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>provisions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System analysis under normal operation</td>
<td>KTA 3701.1</td>
<td></td>
<td>IEC 727</td>
</tr>
<tr>
<td>and anticipated operational occurrences,</td>
<td></td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>i.e. degraded grid, unit load rejection,</td>
<td></td>
<td>IEEE 352</td>
<td></td>
</tr>
<tr>
<td>etc.</td>
<td></td>
<td>IEEE 577</td>
<td></td>
</tr>
<tr>
<td>Preferably in the form of a quantitative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fault tree analysis to verify system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>reliability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documentation to be submitted by applicant</td>
<td>Reference to NUSS documents</td>
<td>International or national standards</td>
<td>Additional references</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------------</td>
<td>------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>2.2. Single failure and redundancy (same as 2.1)</td>
<td>C — 329–336 D7 — 307, 308, 401 P1</td>
<td>KTA 3701.1 5.5</td>
<td>IEEE 279</td>
</tr>
<tr>
<td>2.3. Independence and physical separation</td>
<td>General arrangement, structural, piping, cable raceway and EPS layout drawings; EPS installation specifications, including cabling; description of design criteria for buildings enclosing and protecting the EPS, piping systems, ventilating systems and other systems which could affect the EPS</td>
<td>C — 340–342, 345 D7 — 309, 402–407</td>
<td>IEEE 308 IEEE 384 IEEE 420</td>
</tr>
<tr>
<td>2.4. Protection against natural phenomena As 2.3, with description of precautions against identified events</td>
<td>C — 314, A205, A206</td>
<td>IEEE 308 IEEE 384</td>
<td></td>
</tr>
</tbody>
</table>

*This publication is no longer valid. Please see [http://www-ns.iaea.org/standards/](http://www-ns.iaea.org/standards/)*
TABLE I. (cont.)

<table>
<thead>
<tr>
<th>Documentation to be submitted by applicant</th>
<th>Reference to NUSS documents</th>
<th>International or national standards(^a)</th>
<th>Additional references</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2.5. Protection against man-induced events and combinations of events</strong></td>
<td>Description of precautions taken against these events including station blackout. The events considered should be identified.</td>
<td>C — A203, A207-211, D5, D7 — 309-311, 314-317</td>
<td>IEEE 308, IEEE 567, RFS 1.2.a, RFS 1.2.b, RFS 1.2.d</td>
</tr>
<tr>
<td><strong>2.6. Protection against fire and explosion</strong></td>
<td></td>
<td>C — 357-359, D2, D7 — 309, 310, 357, 583</td>
<td>KTA 3702.1, IEEE 308, IEC 695 (-1,-2,-3), DIN 4102, DIN 14675, KTA 2103</td>
</tr>
<tr>
<td><strong>2.7. Effects of environmental conditions and equipment failures</strong></td>
<td></td>
<td>C — 360, 361, 1206, A204, D4, D7 — 703-707</td>
<td>IEEE 308, IEC 544 (-1,-2,-3), BS 2011</td>
</tr>
<tr>
<td><strong>2.8. Safety system support features</strong></td>
<td>(same as 2.3)</td>
<td>D7 — 532</td>
<td>IEEE 308, IEEE 384, IEEE 603</td>
</tr>
</tbody>
</table>

\(^a\) This publication is no longer valid. Please see http://www-ns.iaea.org/standards/
<table>
<thead>
<tr>
<th>Documentation to be submitted by applicant</th>
<th>Reference to NUSS documents</th>
<th>International or national standards</th>
<th>Additional references</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.9. Sharing of structures, systems and components in multi-reactor nuclear power plants</td>
<td>Description of design basis and justifications, for shared structures, systems or components related to the EPS</td>
<td>C — 362</td>
<td>IEEE 308, 8.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D7 — 415</td>
<td>IEEE 567, 1.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.3.2.2, 5.5.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>KTA 3701.2</td>
</tr>
<tr>
<td>2.10. Instrumentation monitoring and control of the EPS</td>
<td>Control and instrumentation system descriptions, logic diagrams, electrical control room and control board layout drawings, remote control location drawings</td>
<td>D7 — 408–412</td>
<td>IEC 744</td>
</tr>
<tr>
<td></td>
<td></td>
<td>537–541</td>
<td>IEEE 308</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D3 — 7, 8</td>
<td>IEEE 384</td>
</tr>
<tr>
<td></td>
<td></td>
<td>kTA 3501</td>
<td>IEEE 420</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KTA 3702.1</td>
<td>IEEE 566</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>KTA 3703</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>KTA 3704</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>KTA 3904</td>
</tr>
<tr>
<td>2.11. Identification of equipment, components and documents</td>
<td>Description of programme to be followed for the identification of equipment, components and documents</td>
<td>D7 — 413</td>
<td>IEEE 308, 5.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(D3 — 7.17)</td>
<td>IEEE 279, 4.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IEEE 497, 6.1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RFS IV.1.a</td>
<td>IEEE 603, 5.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IEEE 384, 6.1.2, 6.6.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NFC 30–201</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NFC 04–200</td>
</tr>
<tr>
<td>Documentation to be submitted by applicant</td>
<td>Reference to NUSS documents</td>
<td>International or national standards</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>-----------------------------</td>
<td>-----------------------------------</td>
<td></td>
</tr>
<tr>
<td>2.12. Provisions for in-service testing</td>
<td>O2</td>
<td>IEEE 308</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C – 322, 323</td>
<td>IEEE 338</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D7 – 601-606</td>
<td>IEEE 387</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEEE 603</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>KTA 3702.2</td>
<td></td>
</tr>
<tr>
<td>2.13. Inspection, maintenance and repair</td>
<td>C – 322, 323</td>
<td>IEEE 336, 6.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D7 – 601-606</td>
<td>IEEE 338, A2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEEE 387, 6.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEEE 450</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEEE 622, 6.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>KTA 3702.2; 10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 599</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 706</td>
<td></td>
</tr>
<tr>
<td>3. On-site electrical power system</td>
<td>D7 — 312, 313, 401, 408-</td>
<td>KTA 3701.1</td>
<td></td>
</tr>
<tr>
<td>3.1. Capacity and characteristics of power supplies and components</td>
<td>401, 408-414, 507, 508, 514, 520, 522, 526, 531, 533-535, 542, 543, 566</td>
<td>KTA 3504</td>
<td></td>
</tr>
<tr>
<td></td>
<td>401, 408-</td>
<td>KTA 3702.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>414, 507,</td>
<td>KTA 3703</td>
<td></td>
</tr>
<tr>
<td></td>
<td>508, 514,</td>
<td>KTA 3704</td>
<td></td>
</tr>
<tr>
<td></td>
<td>520, 522,</td>
<td>KTA 3705</td>
<td></td>
</tr>
<tr>
<td></td>
<td>526, 531,</td>
<td>IEEE 308</td>
<td></td>
</tr>
<tr>
<td></td>
<td>533–535,</td>
<td>IEEE 141</td>
<td></td>
</tr>
<tr>
<td></td>
<td>542, 543,</td>
<td>BS 4752</td>
<td></td>
</tr>
<tr>
<td></td>
<td>566</td>
<td>IEC (34–1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEEE 384 (5.6)</td>
<td></td>
</tr>
<tr>
<td>Documentation to be submitted by applicant</td>
<td>Reference to NUSS documents</td>
<td>International or national standards&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Additional references</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>----------------------------</td>
<td>---------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>voltage studies, short circuit analyses and protective device co-ordination studies and set point data</td>
<td>C — 357–359</td>
<td>IEEE 308</td>
<td>IEEE 384</td>
</tr>
<tr>
<td>Specifications to show that equipment does not contain flammable materials. All cables to be fire retardant. Drawings to show fire barriers in raceways and between items of plant</td>
<td>D7 — 309, 310, 567, 583 (-1,-2,-3)</td>
<td>IEC 331</td>
<td>NFC 32–070</td>
</tr>
<tr>
<td>Same as for 3.1 except as pertains specifically to DC power systems</td>
<td>Same as for 2 plus</td>
<td>IEEE 450</td>
<td>KTA 3702.1</td>
</tr>
<tr>
<td>C — 318–321</td>
<td>KTA 3701.1</td>
<td>ANSI C37.09</td>
<td></td>
</tr>
<tr>
<td>360, 361</td>
<td>KTA 3702.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D7 — Sect. 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documentation to be submitted by applicant</td>
<td>Reference to NUSS documents</td>
<td>International or national standards</td>
<td>Additional references</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>----------------------------</td>
<td>-----------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td><strong>4.1. Equipment qualification</strong></td>
<td>Evidence that equipment has been qualified for the intended service and the expected environment under normal and accident conditions</td>
<td>D7 — 703-706 IEEE 308 IEEE 535 IEEE 572 KTA 3702.1 4.6 IEC 780</td>
<td></td>
</tr>
<tr>
<td><strong>4.2. Stand-by power supply units and support systems</strong></td>
<td>General specifications, design basis descriptions, construction drawings, installation manual (these apply to all items of 4.2)</td>
<td>D7 — Sects 3, 4, 523-526, 587-591 KTA 3702.1, 4.6 IEEE 308 IEEE 387 Also see 4.3</td>
<td></td>
</tr>
<tr>
<td><strong>Power supply unit</strong></td>
<td>Component specification and design basis including fuel and lubrication oil consumption calculation, specified limits for overload, overspeed, oil pressure, cooling water temperature, etc., rated electrical characteristics and specified operational limits</td>
<td>VDMA 6280 DIN 6270 KTA 3702.1 4.7, 4.8, 4.9 IEEE 308 IEEE 387 BS 5514 VDE 0530</td>
<td></td>
</tr>
<tr>
<td>Documentation to be submitted by applicant</td>
<td>Reference to NUSS documents</td>
<td>International or national standards&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Additional references</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>----------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>General functional description.</td>
<td></td>
<td>KTA 3702.1</td>
<td></td>
</tr>
<tr>
<td>For each subsystem in addition:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>system description, design basis,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>specifications, schematic diagrams,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>layout drawings, performance parameters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(operational states and accidents),</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>setpoint alarms and supporting calculations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>as required from case to case</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starting system</td>
<td>See above</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control room</td>
<td>See above</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combustion air system and exhaust fume</td>
<td>See above</td>
<td></td>
<td></td>
</tr>
<tr>
<td>system</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> This publication is no longer valid. Please see [http://www-ns.iaea.org/standards/](http://www-ns.iaea.org/standards/)
<table>
<thead>
<tr>
<th>Documentation to be submitted by applicant</th>
<th>Reference to NUSS documents</th>
<th>International or national standards&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Additional references</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lubrication oil system</td>
<td>See above</td>
<td>KTA 3702.1</td>
<td></td>
</tr>
<tr>
<td>Fuel system</td>
<td>See above</td>
<td>KTA 3702.1</td>
<td></td>
</tr>
<tr>
<td>Cooling system</td>
<td>See above</td>
<td>KTA 3702.1</td>
<td></td>
</tr>
<tr>
<td>Component specification and design basis including related electrical characteristics such as isolation voltage, steady current, ambient temperature; short circuit power, rated current, rated voltage, switching frequency required; control power</td>
<td>D7 — 533–535</td>
<td>KTA 3705 (draft)</td>
<td>IEEE 323</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VDE 0100</td>
<td>VDE 0660 Pt.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VDE 0101</td>
<td>IEC 255–0–20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NEMA SG-4</td>
<td>IEC 255–5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ANSI C37.5</td>
<td>VDE 0105</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ANSI C37.04</td>
<td>IEEE 649</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ANSI-C37.06</td>
<td>NFC 15–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ANSI-C37.10</td>
<td>NFC 63–410</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ANSI-C37.16</td>
<td></td>
</tr>
<tr>
<td>Documentation to be submitted by applicant</td>
<td>Reference to NUSS documents</td>
<td>International or national standards</td>
<td>Additional references</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-----------------------------</td>
<td>-----------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>4.3. (cont.)</td>
<td></td>
<td>ANSI-C37.100</td>
<td>IEEE 627</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NEMA-S5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NEMA-S6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 152</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 466</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NFC 63-110</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NFC 64-400</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEEE 27</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>KTA 3701.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VDE 0660</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VDE 0670</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BS 5311</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NFC 64-100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BS 5419</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 265</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 265-1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 420</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 282-1</td>
<td></td>
</tr>
</tbody>
</table>

This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
<table>
<thead>
<tr>
<th>Documentation to be submitted by applicant</th>
<th>Reference to NUSS documents</th>
<th>International or national standards $^a$</th>
<th>Additional references</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4. Transformers</td>
<td>Component specification design basis and installation drawings</td>
<td>D7</td>
<td>VDE 0532</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>KTA 3705</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IEEE 65</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IEEE 462</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ANSI C57.12.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NEMA TR-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BS 171</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IEC 606</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NFC 52–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Also see 4.3</td>
</tr>
<tr>
<td>4.5. Batteries</td>
<td>System description, design basis and specifications including load balance calculation, calculation of room ventilation, time history of discharging current</td>
<td>D7 — 514, 515, 520</td>
<td>KTA 3703</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IEEE 484</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IEEE 485</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IEC 86 (-1, -2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>VDE 0510</td>
</tr>
<tr>
<td>Documentation to be submitted by applicant</td>
<td>Reference to NUSS documents</td>
<td>International or national standards</td>
<td>Additional references</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>-----------------------------</td>
<td>-----------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>4.6. Battery charger System description, design basis D7 — 517-519 and specification including wiring schematic, operational limits, such as — overvoltage — overcurrent — ripple factor — environmental conditions which have to be monitored, list of alarms</td>
<td>KTA 3703</td>
<td>IEEE 323</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VDE 0510</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEEE 484</td>
<td></td>
</tr>
<tr>
<td>4.7. DC/AC converter Component specification, design D7 — 521, 522 basis including converter performance operational limits, such as — overcurrent — overvoltage — overspeed — frequency deviation which have to be monitored, list of alarms</td>
<td>KTA 3704</td>
<td>IEEE 323</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 146</td>
<td>VDE 0160</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>UTEC-96-822</td>
</tr>
<tr>
<td>4.8. Cables and buses</td>
<td>Documentation to be submitted by applicant</td>
<td>Reference to NUSS documents</td>
<td>International or national standards</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------------------------</td>
<td>-----------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>Listing of cable types, specifications, including conductor cross-sections and material in view of — line drop and — overtemperature insulation quality with respect to fire retardance</td>
<td>D7 — 522-558</td>
<td>DIN 43671</td>
<td>IEEE 323</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 55-1</td>
<td>IEEE 383</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 55-2</td>
<td>VDE 0220-0299</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 183</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 228</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NFC 32-020</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NFC 32-050</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NFC 32-200</td>
<td></td>
</tr>
</tbody>
</table>

4.9. Electrical penetrations

Specification, design basis and listing of penetrations

D7 — 559-562

KTA 3403

IEEE 323

D12 — 4.2, 5.2

IEEE 317

4.10. Instrument/control air

System description, design basis and specifications including system loadings, required response times, capacities, alarms and instrumentation

D7 — 584-586

5. Additional considerations

5.1. Lightning protection

Design basis and system specification, including descriptions of external and internal measures. Layout drawings, wiring diagrams for overvoltage protection devices, provisions for testing

D7 — 563-565

KTA 2206* Sect. 3&4

IEEE 141

ANSI C 5.1

IEC 99 (-1, -2)

VDE 0185

VDE 0845

This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
<table>
<thead>
<tr>
<th>Table I (cont.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.2. Electrical System</strong></td>
</tr>
<tr>
<td><strong>Earthing</strong></td>
</tr>
<tr>
<td>Design basis and system specification including analysis of postulated fault conditions</td>
</tr>
<tr>
<td>D7 544-551</td>
</tr>
<tr>
<td>IEC 1209</td>
</tr>
<tr>
<td>IEEE 142</td>
</tr>
<tr>
<td>VDE 0141</td>
</tr>
<tr>
<td><strong>5.3. Emergency Lighting</strong></td>
</tr>
<tr>
<td>System specification, design, power balance calculations, layout drawings, wiring schematic diagrams</td>
</tr>
<tr>
<td><strong>5.4. Corrosion Protection</strong></td>
</tr>
<tr>
<td>Specification for the protection of all systems liable to be adversely affected by corrosion</td>
</tr>
<tr>
<td>KTA 3702.1</td>
</tr>
<tr>
<td><strong>5.5. Operating Procedures</strong></td>
</tr>
<tr>
<td>Rules and instructions for the operation of the EPS</td>
</tr>
<tr>
<td><strong>Additional References</strong></td>
</tr>
<tr>
<td>Reference to International or NuSS documents, national standards</td>
</tr>
<tr>
<td><strong>See Bibliography for more complete titles. The sequence in which the documents are listed in this column does not constitute an order of importance.</strong></td>
</tr>
</tbody>
</table>

This publication is no longer valid. Please see [http://www-ns.iaea.org/standards/](http://www-ns.iaea.org/standards/)
5. BIBLIOGRAPHY

The bibliography aims to serve two objectives. The first is to provide a complete reference to the national and international standards listed in Section 4, Table I.

The second objective is to identify to the safety assessor additional national and international standards that usually provide in-depth information on a particular subject. Special documents and topical reports are included to act as sources of current information. Obviously this listing cannot be complete.

The documents are listed sequentially under the authorities which issued them. Where a standard has been identified in Table I, it is marked with an asterisk.

France

*Règles fondamentales de sûreté (RFS) (Fundamental Safety Regulations) obtainable from Service central de sûreté des installations nucléaires (SCIN), 99 rue de Grenelle, 75700 Paris, France

*Conception générale de la centrale et principes généraux applicables à l'ensemble de l'installation (General Design of the Power Station and General Principles Applicable to the Whole of the Installation)

*RFS 1.2.a — Prise en compte des risques liés aux chutes d'avions (5 août 1980) (Allowance for the Risk of Falling Aircraft (5 August 1980))

*RFS 1.2.b — Prise en compte des risques d'émissions de projectiles par suite de l'éclatement des groupes turbo-alternateurs (5 août 1980) (Allowance for the Risk of Missile Generation as a Result of the Explosion of Turbogenerator Sets (5 August 1980))

*RFS 1.2.c — Détermination des mouvements sismiques à prendre en compte pour la sûreté des installations (1er octobre 1981). Mise en application à titre provisoire (Determination of Seismic Movements to be Taken into Account for the Safety of Installations (1 October 1981). Implementation on a Provisional Basis)

*RFS 1.2.d — Prise en compte des risques liés à l'environnement industriel et aux voies de communication (7 mai 1982) (Allowance for Risks from the Industrial Environment and Transportation Routes (7 May 1982))

This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
Règles applicables aux études de fonctionnement (Rules Applicable to Operational Studies)

*RFS IV.1.a — Classement des matériels mécaniques, des systèmes électriques, structures et ouvrages de génie civil (21 décembre 1984) (Classification of Mechanical Components, Electrical Systems and Civil Engineering Structures (21 December 1984))

Règles générales concernant plusieurs systèmes, structures ou équipements (General Rules Concerning a Number of Systems, Structures or Components)

RFS V.2.d — Règles générales applicables à la réalisation des matériels électriques (28 décembre 1982) (General Rules Applicable to the Manufacture of Electrical Components (28 December 1982))

Règles de conception et de construction des matériels électriques des ilôts nucléaires (RCCE) (Regulations for the Design and Construction of Electrical Components of Nuclear Steam Supply Systems) obtainable from l’Association française pour les règles de conception et de construction des matériels des chaudières électro-nucléaires (AFCEN), Tour Fiat, Cedex 16, F-92084, Paris la Défense, France


*NFC 32-070 — Essais de classification des conducteurs et câbles du point de vue de leur comportement au feu. Juin 1979 et additif 1 (Tests for Classification of Conductors and Cables from the Point of View of their Fire Resistance. June 1979 and Supplement 1)

*NFC 32-200 — Conducteurs et câbles comportant une enveloppe ou une gaine en polychlorure de vinyle: règles. Septembre 1965 et additifs 2, 3, 4 (Conductors and Cables with PVC Coverings or Sheaths: Regulations. September 1965 and Supplements 2, 3, 4)

NFC 51-111 — Règles d'établissement des machines électriques tournantes. Novembre 1975 et additifs 1, 2 (Regulations for the Installation of Revolving Electrical Machines. November 1975 and Supplements 1, 2)


*NFC 64-100 — Disjoncteurs à courant alternatif à haute tension. Février 1976 et additif 1 (High Voltage AC Circuit Breakers. February 1976 and Supplement 1)

*NFC 64-400 — Appareillage à haute tension sous enveloppe métallique de tensions nominales inférieures ou égales à 72,5 kV. Mars 1975 et additif 1 (Metal-clad High Voltage Devices of Nominal Voltage Lower than or Equal to 72.5 kV. March 1975 and Supplement 1)


Germany

**VDE Standards**, obtainable from VDE-Verlag GmbH, Bismarckstrasse 33, 1000 Berlin 12, Germany

<table>
<thead>
<tr>
<th>VDE No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>*0100</td>
<td>Errichten von Starkstromanlagen mit Nennspannungen bis 1000 V (Power Installations with Rated Voltages up to 1000 V)</td>
</tr>
<tr>
<td>*0101</td>
<td>Errichten von Starkstromanlagen mit Nennspannungen über 1000 V (Power Installations with Rated Voltages over 1000 V)</td>
</tr>
<tr>
<td>*0105</td>
<td>Betrieb von Starkstromanlagen (Specifications for the Operation of Electrical Power Installations)</td>
</tr>
<tr>
<td>*0141</td>
<td>Erdungen für Starkstromanlagen mit Nennspannungen über 1 kV (Earthing System for Power Installations with Rated Voltages above 1 kV)</td>
</tr>
<tr>
<td>*0160</td>
<td>Ausrüstung von Starkstromanlagen mit elektronischen Betriebsmitteln (Electronic Equipment to be Used in Electrical Power Installations and their Assembly into Electrical Power Installations)</td>
</tr>
<tr>
<td>*0220–0299</td>
<td>Bestimmungen für Kabel und Leitungen (Specifications for Cables and Wires)</td>
</tr>
<tr>
<td>*0510</td>
<td>Bestimmungen für Akkumulatoren und Batterie-Anlagen (Specifications for Electric Storage Batteries and Battery Plants)</td>
</tr>
<tr>
<td>*0530</td>
<td>Umlaufende elektrische Maschinen (Rotating Electrical Machines)</td>
</tr>
<tr>
<td>*0532</td>
<td>Transformatoren und Drosselspulen (Transformers and Reactances)</td>
</tr>
</tbody>
</table>
**Other Guidelines** obtainable from Deutsches Institut für Normung e.V., Postfach 1107, D-1000 Berlin 30, Germany

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>*DIN 43671</td>
<td>Stromschienen aus Kupfer (Busbars made of Copper)</td>
</tr>
<tr>
<td>*VDMA 6280</td>
<td>Stromerzeugungssaggregate mit Kolbenkraftmaschinen (Electrical Generating Equipment with Piston Engine Drives)</td>
</tr>
<tr>
<td>*DIN 4102</td>
<td>Widerstandsfähigkeit von Baustoffen und Bauteilen gegen Feuer und Wärme (Resistance of Materials and Components against Fire and Heat)</td>
</tr>
<tr>
<td>*DIN 14675</td>
<td>Feuermelde- und Alarmanlagen (Fire Indicating and Alarm Systems)</td>
</tr>
</tbody>
</table>

**KTA Safety Standards**, obtainable from the Carl Heymanns Verlag, Gereonstrasse 18–32, D-5000 Köln, Germany. English translations are obtainable for most KTA Standards from Gesellschaft für Reaktorsicherheit, Schwertnergasse 1, D-5000 Köln, Germany

<table>
<thead>
<tr>
<th>KTA No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>*2101.3</td>
<td>Brandschutz in Kernkraftwerken; Teil 1: Grundsätze des Brandschutzes (Fire Protection in Nuclear Power Plants; Part 1: Basic Principles)</td>
</tr>
<tr>
<td>*2103</td>
<td>Explosionsschutz in Kernkraftwerken mit Leichtwasser- und Hochtemperaturreaktoren (6/89) (Explosion Protection in Nuclear Power Plants with Light Water and High Temperature Reactors)</td>
</tr>
</tbody>
</table>

60
Auslegung von Kernkraftwerken gegen Blitzeinwirkungen (6/89) (Design of Nuclear Power Plants Against Lightning Effects)

Schutz von Kernkraftwerken gegen Hochwasser (6/82) (Protection of Nuclear Power Plants against Floods)

Kabeldurchführungen im Reaktorsicherheitsbehälter von Kernkraftwerken (10/80) (Cable Penetrations through the Reactor Containment Vessel)

Reaktorschutzsystem und Überwachungseinrichtungen des Sicherheitssystems (6/85) (Reactor Protection System and Monitoring Equipment of the Safety System)

Elektrische Antriebe des Sicherheitssystems in Kernkraftwerken (9/88) (Electrical Drives of the Safety System in Nuclear Power Plants)

Lüftungstechnische Anlagen in Kernkraftwerken (6/90) (Ventilation Systems in Nuclear Power Plants)

Übergeordnete Anforderungen an die elektrische Energieversorgung des Sicherheitssystems in Kernkraftwerken; Teil 1: Einblockanlagen (6/78) (General Requirements for the Electrical Power Supply of the Safety System in Nuclear Power Plants; Part 1: Single Unit Plants)

Übergeordnete Anforderungen an die elektrische Energieversorgung des Sicherheitssystems in Kernkraftwerken; Teil 2: Kernkraft-Mehrblockanlagen (6/82) (General Requirements for the Electrical Power Supply of the Safety System in Nuclear Power Plants; Part 2: Multi-Unit Plants)

Notstromerzeugungsanlagen mit Dieselaggregaten in Kernkraftwerken; Teil 1: Auslegung (6/80) (Emergency Power Facilities with Diesel Generators; Part 1: Design)

Notstromerzeugungsanlagen mit Dieselaggregaten in Kernkraftwerken; Teil 2: Prüfungen (11/82) (Emergency Power Facilities with Diesel Generators; Part 2: Tests and Examinations) (under revision)

Notstromerzeugungsanlagen mit Batterien und Gleichrichtgeräten in Kernkraftwerken (6/84) (Emergency Power Facilities with Batteries and Rectifiers)

Notstromanlagen mit Gleichstrom-Wechselstrom-Umformern in Kernkraftwerken (6/84) (Emergency Power Facilities with DC/AC Converters)

Schaltanlagen, Transformatoren und Verteilungssysteme zur elektrischen Energieversorgung des Sicherheitssystems in Kernkraftwerken (9/88) (Switching Facilities, Transformers)
and Distribution Networks for the Electrical Power Supply of Safety Systems in Nuclear Power Plants)

3706 Nachweis der Beständigkeit von elektrischen Einrichtungen unter Störfallbedingungen (Proof of the Resistance of Electrical Equipment under Incident Conditions)

*3904 Warte, Notsteuerstelle und örtliche Leitstände in Kernkraftwerken (6/85) (Control Room and the Emergency and Local Control Facilities in Nuclear Power Plants)

United Kingdom


British Standards, obtainable from British Standards Institution, Sales Department, Linford Wood, Milton Keynes MK14 6LE, United Kingdom

BS No. Title

142 Electrical Protection Relays
162 Specification of Electrical Power Switchgear and Associated Apparatus
*171 Power Transformers
476 Fire Tests on Building Materials and Structures
*2011 Basic Environmental Testing Procedures
2757 Classification of Insulating Materials
4547 Classification of Fires
4727 Glossary of Terms. Electro-Technical, Power, etc.
*4752 Specification for Switchgear and Control Gear
4941 Specification for Motor Starters
4999 General Requirements
5000(40) Motors for Driving Power Station Auxiliaries
5227 AC Metal Enclosed Switchgear and Control
5306 Fire Extinguishing Installations and Equipment on Premises
*5311 AC Circuit Breakers of Rated Voltage above I K
*5419 Specifications for Air Break Switches, Air Break Disconnectors and Fuse Combination Units
*5514 Specification for Reciprocating Internal Combustion Engines Performance
5425 Specification for Control Gear
5486 Specification for Factory Built Assemblies of Switchgear and Control Gear

62
6231 Specification of PVC Insulated Cables for Switchgear and Control Gear Wiring
6290 Station Batteries
6581 Specification for Common Requirements for High Voltage Switchgear and Control Systems
6423 Code of Practice for Maintenance of Electrical Switchgear and Control Gear up to 650 V
6626 Code of Practice for Maintenance of Electrical Switchgear and Control Gear above 650 V and up to 36 kV

United States of America

USNRC Design Criteria and Guidelines, obtainable from National Technical Information Service, Springfield, VA 22161, USA or Superintendent of Documents, US Government Printing Office, P.O. Box 37082, Washington, DC 20013–7982, USA

Title 10 of the Code of Federal Regulations — Energy (10 CFR)
Chapter 1 Nuclear Regulatory Commission
Part 50 Domestic Licensing of Production and Utilization Facilities (50);
   Section 63 (10CFR 50.63) Loss of Alternating Current Power

Appendix A — General Design Criteria for Nuclear Power Plants (GDC)

<table>
<thead>
<tr>
<th>GDC No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quality Standards and Records</td>
</tr>
<tr>
<td>2</td>
<td>Design Bases for Protection Against Natural Phenomena</td>
</tr>
<tr>
<td>3</td>
<td>Fire Protection</td>
</tr>
<tr>
<td>4</td>
<td>Environmental and Missile Design Bases</td>
</tr>
<tr>
<td>5</td>
<td>Sharing of Structures, Systems and Components</td>
</tr>
<tr>
<td>13</td>
<td>Instrumentation and Control</td>
</tr>
<tr>
<td>17</td>
<td>Electric Power Systems</td>
</tr>
<tr>
<td>18</td>
<td>Inspection and Testing of Electrical Components</td>
</tr>
<tr>
<td>19</td>
<td>Control Room</td>
</tr>
<tr>
<td>21</td>
<td>Protection System Reliability and Testability</td>
</tr>
<tr>
<td>22</td>
<td>Protection System Independence</td>
</tr>
<tr>
<td>50</td>
<td>Containment Design Bases</td>
</tr>
</tbody>
</table>

Appendix B Quality Assurance for Nuclear Power Plants and Fuel Reprocessing Plants

This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
### NUREG — 0800 Standard Review Plan (SRP)

<table>
<thead>
<tr>
<th>SRP No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>Electric Power — Introduction</td>
</tr>
<tr>
<td>8.2</td>
<td>Off-site Power System</td>
</tr>
<tr>
<td>8.3.1</td>
<td>AC Power System</td>
</tr>
<tr>
<td>8.3.2</td>
<td>DC Power System</td>
</tr>
<tr>
<td>Appendix 8-A</td>
<td>Branch Technical Positions (PSB)</td>
</tr>
<tr>
<td>Appendix 8-B</td>
<td>General Agenda, Station Site Visits</td>
</tr>
</tbody>
</table>

### Division 1 Regulatory Guides (RG) — Power Reactors

<table>
<thead>
<tr>
<th>RG No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6</td>
<td>Independence Between Redundant Stand-by (On-Site) Power Sources and Between Their Distribution Systems (Rev.0, 3/71)</td>
</tr>
<tr>
<td>1.9</td>
<td>Selection of Diesel Generator Set Capacity for Stand-by Power Supplies (Rev.0, 3/71)</td>
</tr>
<tr>
<td>1.22</td>
<td>Periodic Testing of Protection System Actuation Functions (Rev.0, 2/72)</td>
</tr>
<tr>
<td>1.29</td>
<td>Seismic Design Classification (Rev.1, 8/73)</td>
</tr>
<tr>
<td>1.32</td>
<td>Criteria for Safety Related Electric Power Systems for Nuclear Power Plants (Rev.0, 8/72)</td>
</tr>
<tr>
<td>1.40</td>
<td>Qualification Tests of Continuous Duty Motors Installed Inside the Containment of Water Cooled Nuclear Power Plants (Rev.0, 3/73)</td>
</tr>
<tr>
<td>1.41</td>
<td>Preoperational Testing of Redundant On-Site Electric Power Systems to Verify Proper Load Group Assignment (Rev.0, 3/73)</td>
</tr>
<tr>
<td>1.47</td>
<td>Bypasses and Inoperable Status Indication for Nuclear Power Plant Safety Systems (Rev.0, 5/73)</td>
</tr>
<tr>
<td>1.53</td>
<td>Application of the Single Failure Criterion to Nuclear Power Plant Protection Systems (Rev.0, 6/73)</td>
</tr>
<tr>
<td>1.62</td>
<td>Manual Initiation of Protective Action (Rev.0)</td>
</tr>
<tr>
<td>1.63</td>
<td>Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants.</td>
</tr>
<tr>
<td>1.73</td>
<td>Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants (Rev.0, 1/74)</td>
</tr>
<tr>
<td>1.75</td>
<td>Physical Independence of Electric Systems</td>
</tr>
<tr>
<td>1.81</td>
<td>Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants</td>
</tr>
</tbody>
</table>
1.89 Qualification of Class 1E Equipment for Nuclear Power Plants
1.93 Availability of Electric Power Sources
1.97 Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions during and following an Accident
1.100 Seismic Qualification of Electric Equipment for Nuclear Power Plants
1.106 Thermal Overload Protection for Electric Motors on Motor-Operated Valves
1.108 Periodic Testing of Diesel Generator Units Used as On-Site Electric Power Systems at Nuclear Power Plants
1.118 Periodic Testing of Electric Power and Protection Systems
1.128 Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants
1.129 Maintenance, Testing and Replacement of Large Lead Storage Batteries for Nuclear Power Plants
1.131 Qualification Tests of Electric Cables, Field Splices and Connections for Light-Water-Cooled Nuclear Power Plants
1.153 Criteria for Power, Instrumentation and Control Portions for Safety Systems
1.158 Qualification of Safety Related Lead Storage Batteries for Nuclear Power Plants

Institute of Electrical and Electronics Engineers Standards (IEEE Standards), obtainable from Institute of Electrical and Electronics Engineers, Inc., 345 East 47 Street, New York, NY 10017, USA

<table>
<thead>
<tr>
<th>IEEE No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-1973</td>
<td>Low Voltage AC Power Circuit Breakers Used in Enclosures</td>
</tr>
<tr>
<td>*27</td>
<td>Switchgear Assemblies Including Metal-Enclosed Bus</td>
</tr>
<tr>
<td>32</td>
<td>Neutral Grounding Devices</td>
</tr>
<tr>
<td>55</td>
<td>Temperature Correlation in the Connection of Insulated Wire and Cables to Electric Equipment, Guide for</td>
</tr>
<tr>
<td>*65</td>
<td>Thermal Evaluation of Ventilated Dry-Type Power and Distribution Transformers, Test Procedure for</td>
</tr>
<tr>
<td>80</td>
<td>Safety in AC Substation Grounding, Guide for</td>
</tr>
<tr>
<td>81</td>
<td>Ground Resistance and Potential Gradients in the Earth, Guide for Measuring</td>
</tr>
</tbody>
</table>

* It should be noted that RG 1.153 endorses (with some modification) IEEE Standard 603–1980.
This publication is no longer valid
Please see http://www-ns.iaea.org/standards/

112A Polyphase Induction Motors and Generators, Test Procedures for
*141–1976 IEEE Recommended Practice for Electric Power Distribution for Industrial Plants
*142–1972 Recommended Practice for Grounding of Industrial and Commercial Power Systems
143 Application Guides for Ground Fault Neutralizers Grounding of Synchronous Generator Systems, Neutral Grounding of Transmission Systems
242–1975 Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
273 Protective Relay Applications to Power Transformers, Guide for
*279–1971 Criteria for Protection Systems for Nuclear Power Generating Stations
288 Induction Motor Protection, Guide for
*308–1980 Criteria for Class 1E Power Systems for Nuclear Power Generating Stations
*317–1976 Electrical Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations
*323–1974 Qualifying Class 1E Equipment for Nuclear Power Generating Stations
*334–1974 Type Test of Continuous Duty Class 1E Motors for Nuclear Power Generating Stations
*336–1980 Installation, Inspection and Testing Requirements for Instrumentation and Electric Equipment During the Construction of Nuclear Power Generating Stations
*338–1977 Criteria for Periodic Testing of Nuclear Power Generating Station Safety Systems
*352–1975 General Principles for Reliability Analysis of Nuclear Power Generating Station Protection Systems
*379–1977 Application of the Single Failure Criterion to Nuclear Power Generating Station Class 1E Systems
380–1972 Definition of Terms Used in IEEE Nuclear Power Generating Station Standards
381–1977 Criteria for Type Tests of Class 1E Modules Used in Nuclear Power Generating Stations
*382–1980 Type Test of Class 1E Electric Valve Operators for Nuclear Power Generating Stations
*383–1974 Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations

66
This publication is no longer valid
Please see http://www-ns.iaea.org/standards/

*384–1981 Criteria for Independence of Class 1E Equipment and Circuits
*387–1977 Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Generating Stations
415–1976 Planning for Pre-Operational Testing Programs for Class 1E Power Systems for Nuclear Power Generating Stations
*420–1973 Trial-Use for Class 1E Control Switchboards for Nuclear Power Generating Stations
446–1974 Recommended Practice for Emergency and Standby Power Systems
*450–1980 Recommended Practice for Maintenance, Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Substations
*462–1973 General Requirements for Distribution, Power and Regulating Transformers
467–1980 Quality Assurance Program Requirements for the Design and Manufacture of Class 1E Instrumentation and Electric Equipment for Nuclear Power Generating Station Safety Systems
*484–1975 Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations
*485–1978 Recommended Practice for Sizing and Large Lead Storage Batteries for Generating Stations and Substations
*497–1981 Trial-Use Criteria for Post Accident Monitoring Instrumentation for Nuclear Power Generating Stations
498–1980 Supplementary Requirements for Calibration and Control of Measuring and Test Equipment Used in the Construction and Maintenance of Nuclear Power Generating Stations
*535–1986 Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations
*566–1977 Recommended Practice for the Design of Display and Control Facilities for Central Control Rooms of Nuclear Power Generating Stations
*567–1980 Criteria for the Design of the Control Room Complex for a Nuclear Power Generating Station
*572–1985 Qualification of Class 1E Connection Assemblies for Nuclear Power Generating Stations
*577–1976 Requirements for Reliability Analyses in the Design and Operation of Safety Systems for Nuclear Power Generating Stations
*622-1979 Design and Installation of Electric Pipe Heating Systems for Nuclear Power Generating Stations
*627-1980 Design Qualification of Safety Systems Equipment Used in Nuclear Power Generating Stations
628 Standard for Design, Installation and Quality of Raceway Systems for Class 1E Circuits for Nuclear Power Generating Stations
634-1978 Cable Penetration Fire Stop Qualification Test
*649-1980 Qualifying Class 1E Motor Control Centers for Nuclear Power Generating Stations
650-1979 Qualification of Class 1E Static Battery Chargers and Inverters for Nuclear Power Generating Stations
666 Electrical Power Service Systems for Generating Stations
690 Standard for Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations

American National Standards Institute (ANSI) Standards, obtainable from American National Standards Institute, 1430 Broadway, New York, NY 10018, USA

No. | Title
---|---
C1 | National Electric Code
C2 | National Electric Safety Code
*C5.1 | Lightning Protection Code NFPA No. 78
*C84.1-1970 | Voltage Ratings for Electric Power Systems and Equipment
C37.98-1978 | Seismic Testing of Relays
NQA-1-1983 | Quality Assurance Program Requirements for Nuclear Power Plants
C2 | National Electrical Safety Code
*C37.04-1964 (R 1969) Rating Structure for AC High Voltage Circuit Breakers, including Supplements C37.04a-1964
*C37.06-1971 | Schedules of Preferred Ratings and Related Required Capabilities for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
*C37.09-1964 (R 1969) Test Procedure for AC High Voltage Circuit Breakers, including Supplement C37.09a-1970
*C37.10-1972 | Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
Preferred Ratings, Related Requirements and Application Recommendations for Low Voltage Power Circuit Breakers and AC Power Circuit Protectors

Definitions for Power Switchgear

Requirements for Transformers, 138 000 Volts and Below 501 Through 10 000/13 333/16 667 kVA, Single Phase, 501 Through 30 000/40 000/50 000 kVA, Three Phase

Requirements for Instrument Transformers

Guide for Loading Oil Immersed Distribution and Power Transformers

Guide for Loading Dry-Type Distribution and Power Transformers

Voltage Ratings for Electric Power Systems and Equipment

Guidelines for Handling and Disposal of Capacitor- and Transformer-Grade Askarels Containing Polychlorinated Biphenyls

National Electric Manufacturers Association Standards (NEMA), obtainable from National Electrical Manufacturers Association, 2101 L Street, N.W., Suite 300, Washington, DC 20037, USA

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG 1</td>
<td>Motors and Generators</td>
</tr>
<tr>
<td>AB1-1975</td>
<td>Molded-Case Circuit Breakers</td>
</tr>
<tr>
<td>FU1-1972</td>
<td>Low Voltage Cartridge Fuses</td>
</tr>
<tr>
<td>ICS-1970</td>
<td>Industrial Controls and Systems</td>
</tr>
<tr>
<td>SG 2-1975</td>
<td>High Voltage Fuses</td>
</tr>
<tr>
<td>SG 4-1975</td>
<td>AC High Voltage Circuit Breakers</td>
</tr>
<tr>
<td>SG 5-1975</td>
<td>Power Switchgear Assemblies</td>
</tr>
<tr>
<td>SG 6-1974</td>
<td>Power Switching Equipment</td>
</tr>
<tr>
<td>TR 1-1974</td>
<td>Transformers, Regulators and Reactors</td>
</tr>
</tbody>
</table>

International Electrotechnical Commission

IEC Publications available from IEC Central Office, 3 rue de Varembé, 1211 Geneva 20, Switzerland

<table>
<thead>
<tr>
<th>IEC No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>34-1</td>
<td>Rotating Electrical Machines; Part 1: Rating and Performance (1983), Eighth Edition</td>
</tr>
</tbody>
</table>
This publication is no longer valid
Please see http://www-ns.iaea.org/standards/

*55-1  Paper-Insulated Metal-Sheathed Cables for Rated Voltages up to 18/30 kV (with Copper or Aluminium Conductors and Excluding Gas-Pressure and Oil-Filled Cables); Part 1: Tests (1978), Fourth Edition

*55-2  Paper-Insulated Metal-Sheathed Cables for Rated Voltages up to 18/30 kV (with Copper or Aluminium Conductors and Excluding Gas-Pressure and Oil-Filled Cables); Part 2: General and Construction Requirements (1981), First Edition

*86-1  Primary Batteries; Part 1: General (1982), Fifth Edition

*86-2  Primary Batteries; Part 2: Specification Sheets (1982), Fifth Edition


*99-2  Lightning Arresters; Part 2: Expulsion-type Lightning Arresters (1962), First Edition

*129  Alternating Current Disconnectors (Isolators) and Earthing Switches (1984), First Edition

*146  Semiconductor Converters (1973), Second Edition

*152  Identification by Hour Numbers of the Phase Conductors of 3-phase Electric Systems (1963), First Edition


*214  On-Load Tap-Changers (1976), Second Edition

*228  Conductors of Insulated Cables (1978), Second Edition


*255-5  Electrical Relays; Part 5: Insulation Tests for Electrical Relays.

*265  High Voltage Switches

*265-1  High Voltage Switches; Part 1: Containers for Round Winding Wires (1968), First Edition


*300  Reliability and Maintainability Management (1984), Second Edition


*599  Interpretation of the Analysis of Gases in Transformers and Other Oil-Filled Electrical Equipment in Service (1978), First Edition

*605  Equipment Reliability Testing (Parts 1, 5, 7)


*695–2  Fire Hazard Testing; Part 2: Test Methods

*695–3  Fire Hazard Testing; Part 3: Examples of Fire Hazard Assessment Procedures and Interpretation of Results


*709  Separation within the Reactor Protection System (1981), First Edition

*727  Evaluation of Electrical Endurance of Electrical Insulation Systems


*780  Qualification of Electrical Items of the Safety System of Nuclear Power Stations

*980  Recommended Practices for Seismic Qualification of Electrical Equipment of the Safety System for Nuclear Generating Stations

This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
CONTRIBUTORS TO DRAFTING AND REVIEW

Salomoni, R. Embalse Nuclear Power Station, Argentina
Molloy, T.J. Atomic Energy Control Board, Canada
Hermant, C. Electricité de France, France
Hauser, A. Siemens-KWU, Germany
Wegener, H. Technischer Überwachungsverein Norddeutschland, Germany
Choi, Kyu Shik Korea Power Engineering Co., Republic of Korea
Bye, R.D. Nuclear Installations Inspectorate, United Kingdom
Ipolitto, T. Nuclear Regulatory Commission, United States of America
Furet, J. International Electrotechnical Commission
Fischer, J. International Atomic Energy Agency

Consultants Meetings

Advisory Group Meeting
Vienna, Austria: 19–23 August 1985

This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
LIST OF NUSS PROGRAMME TITLES

It should be noted that some books in the series may be revised in the near future. Those that have already been revised are indicated by the addition of '(Rev. 1)' to the number.

1. GOVERNMENTAL ORGANIZATION

50-C-G (Rev. 1) Code on the safety of nuclear power plants: Governmental organization 1988

Safety Guides

50-SG-G1 Qualifications and training of staff of the regulatory body for nuclear power plants 1979

50-SG-G2 Information to be submitted in support of licensing applications for nuclear power plants 1979

50-SG-G3 Conduct of regulatory review and assessment during the licensing process for nuclear power plants 1980

50-SG-G4 Inspection and enforcement by the regulatory body for nuclear power plants 1980

50-SG-G6 Preparedness of public authorities for emergencies at nuclear power plants 1982

50-SG-G8 Licences for nuclear power plants: Content, format and legal considerations 1982

50-SG-G9 Regulations and guides for nuclear power plants 1984

2. SITING

50-C-S (Rev. 1) Code on the safety of nuclear power plants: Siting 1988

Safety Guides

50-SG-S1 (Rev. 1) Earthquakes and associated topics in relation to nuclear power plant siting 1991

50-SG-S3 Atmospheric dispersion in nuclear power plant siting 1980

50-SG-S4 Site selection and evaluation for nuclear power plants with respect to population distribution 1980
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-SG-S5</td>
<td>External man-induced events in relation to nuclear power plant siting</td>
<td>1981</td>
</tr>
<tr>
<td>50-SG-S6</td>
<td>Hydrological dispersion of radioactive material in relation to nuclear power plant siting</td>
<td>1985</td>
</tr>
<tr>
<td>50-SG-S7</td>
<td>Nuclear power plant siting: Hydrogeological aspects</td>
<td>1984</td>
</tr>
<tr>
<td>50-SG-S8</td>
<td>Safety aspects of the foundations of nuclear power plants</td>
<td>1986</td>
</tr>
<tr>
<td>50-SG-S9</td>
<td>Site survey for nuclear power plants</td>
<td>1984</td>
</tr>
<tr>
<td>50-SG-S10A</td>
<td>Design basis flood for nuclear power plants on river sites</td>
<td>1983</td>
</tr>
<tr>
<td>50-SG-S10B</td>
<td>Design basis flood for nuclear power plants on coastal sites</td>
<td>1983</td>
</tr>
<tr>
<td>50-SG-S11A</td>
<td>Extreme meteorological events in nuclear power plant siting, excluding tropical cyclones</td>
<td>1981</td>
</tr>
<tr>
<td>50-SG-S11B</td>
<td>Design basis tropical cyclone for nuclear power plants</td>
<td>1984</td>
</tr>
</tbody>
</table>

3. DESIGN

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-C-D (Rev. 1)</td>
<td>Code on the safety of nuclear power plants: Design Safety Guides</td>
<td>1988</td>
</tr>
<tr>
<td>50-SG-D1</td>
<td>Safety functions and component classification for BWR, PWR and PTR</td>
<td>1979</td>
</tr>
<tr>
<td>50-SG-D2 (Rev. 1)</td>
<td>Fire protection in nuclear power plants</td>
<td>1992</td>
</tr>
<tr>
<td>50-SG-D3</td>
<td>Protection system and related features in nuclear power plants</td>
<td>1980</td>
</tr>
<tr>
<td>50-SG-D4</td>
<td>Protection against internally generated missiles and their secondary effects in nuclear power plants</td>
<td>1980</td>
</tr>
<tr>
<td>50-SG-D5</td>
<td>External man-induced events in relation to nuclear power plant design</td>
<td>1982</td>
</tr>
<tr>
<td>50-SG-D6</td>
<td>Ultimate heat sink and directly associated heat transport systems for nuclear power plants</td>
<td>1981</td>
</tr>
<tr>
<td>50-SG-D7 (Rev. 1)</td>
<td>Emergency power systems at nuclear power plants</td>
<td>1991</td>
</tr>
<tr>
<td>50-SG-D8</td>
<td>Safety-related instrumentation and control systems for nuclear power plants</td>
<td>1984</td>
</tr>
<tr>
<td>50-SG-D9</td>
<td>Design aspects of radiation protection for nuclear power plants</td>
<td>1985</td>
</tr>
<tr>
<td>50-SG-D10</td>
<td>Fuel handling and storage systems in nuclear power plants</td>
<td>1984</td>
</tr>
</tbody>
</table>

76
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-SG-D11</td>
<td>General design safety principles for nuclear power plants</td>
<td>1986</td>
</tr>
<tr>
<td>50-SG-D12</td>
<td>Design of the reactor containment systems in nuclear power plants</td>
<td>1985</td>
</tr>
<tr>
<td>50-SG-D13</td>
<td>Reactor coolant and associated systems in nuclear power plants</td>
<td>1986</td>
</tr>
<tr>
<td>50-SG-D14</td>
<td>Design for reactor core safety in nuclear power plants</td>
<td>1986</td>
</tr>
<tr>
<td>50-SG-D15</td>
<td>Seismic design and qualification for nuclear power plants</td>
<td>1992</td>
</tr>
</tbody>
</table>

### 4. OPERATION

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-C-O (Rev. 1)</td>
<td>Code on the safety of nuclear power plants: Operation</td>
<td>1988</td>
</tr>
<tr>
<td>50-SG-O1 (Rev. 1)</td>
<td>Staffing of nuclear power plants and the recruitment, training and authorization of operating personnel</td>
<td>1991</td>
</tr>
<tr>
<td>50-SG-O2</td>
<td>In-service inspection for nuclear power plants</td>
<td>1980</td>
</tr>
<tr>
<td>50-SG-O3</td>
<td>Operational limits and conditions for nuclear power plants</td>
<td>1979</td>
</tr>
<tr>
<td>50-SG-O4</td>
<td>Commissioning procedures for nuclear power plants</td>
<td>1980</td>
</tr>
<tr>
<td>50-SG-O5</td>
<td>Radiation protection during operation of nuclear power plants</td>
<td>1983</td>
</tr>
<tr>
<td>50-SG-O6</td>
<td>Preparedness of the operating organization (licensee) for emergencies at nuclear power plants</td>
<td>1982</td>
</tr>
<tr>
<td>50-SG-O7 (Rev. 1)</td>
<td>Maintenance of nuclear power plants</td>
<td>1990</td>
</tr>
<tr>
<td>50-SG-O8 (Rev. 1)</td>
<td>Surveillance of items important to safety in nuclear power plants</td>
<td>1990</td>
</tr>
<tr>
<td>50-SG-O9</td>
<td>Management of nuclear power plants for safe operation</td>
<td>1984</td>
</tr>
<tr>
<td>50-SG-O10</td>
<td>Core management and fuel handling for nuclear power plants</td>
<td>1985</td>
</tr>
<tr>
<td>50-SG-O11</td>
<td>Operational management of radioactive effluents and wastes arising in nuclear power plants</td>
<td>1986</td>
</tr>
</tbody>
</table>

### 5. QUALITY ASSURANCE

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-C-QA (Rev. 1)</td>
<td>Code on the safety of nuclear power plants: Quality assurance</td>
<td>1988</td>
</tr>
<tr>
<td>50-SG-QA1</td>
<td>Establishing of the quality assurance programme for a nuclear power plant project</td>
<td>1984</td>
</tr>
<tr>
<td>Document Code</td>
<td>Description</td>
<td>Year</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>50-SG-QA2</td>
<td>Quality assurance records system for nuclear power plants</td>
<td>1979</td>
</tr>
<tr>
<td>50-SG-QA3</td>
<td>Quality assurance in the procurement of items and services for nuclear power plants</td>
<td>1979</td>
</tr>
<tr>
<td>50-SG-QA4</td>
<td>Quality assurance during site construction of nuclear power plants</td>
<td>1981</td>
</tr>
<tr>
<td>50-SG-QA5 (Rev. 1)</td>
<td>Quality assurance during commissioning and operation of nuclear power plants</td>
<td>1986</td>
</tr>
<tr>
<td>50-SG-QA6</td>
<td>Quality assurance in the design of nuclear power plants</td>
<td>1981</td>
</tr>
<tr>
<td>50-SG-QA7</td>
<td>Quality assurance organization for nuclear power plants</td>
<td>1983</td>
</tr>
<tr>
<td>50-SG-QA8</td>
<td>Quality assurance in the manufacture of items for nuclear power plants</td>
<td>1981</td>
</tr>
<tr>
<td>50-SG-QA10</td>
<td>Quality assurance auditing for nuclear power plants</td>
<td>1980</td>
</tr>
<tr>
<td>50-SG-QA11</td>
<td>Quality assurance in the procurement, design and manufacture of nuclear fuel assemblies</td>
<td>1983</td>
</tr>
</tbody>
</table>

**SAFETY PRACTICES**

<table>
<thead>
<tr>
<th>Document Code</th>
<th>Description</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-P-1</td>
<td>Application of the single failure criterion</td>
<td>1990</td>
</tr>
<tr>
<td>50-P-2</td>
<td>In-service inspection of nuclear power plants: A manual</td>
<td>1991</td>
</tr>
<tr>
<td>50-P-3</td>
<td>Data collection and record keeping for the management of nuclear power plant ageing</td>
<td>1991</td>
</tr>
<tr>
<td>50-P-4</td>
<td>Procedures for conducting probabilistic safety assessments of nuclear power plants (Level 1)</td>
<td>1992</td>
</tr>
<tr>
<td>50-P-5</td>
<td>Safety assessment of emergency power systems for nuclear power plants</td>
<td>1992</td>
</tr>
</tbody>
</table>
### SELECTION OF IAEA PUBLICATIONS RELATING TO THE SAFETY OF NUCLEAR POWER PLANTS

#### SAFETY SERIES

<table>
<thead>
<tr>
<th>Publication</th>
<th>Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Basic safety standards for radiation protection, 1982 edition</td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>Radiological surveillance of airborne contaminants in the working environment</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>Factors relevant to the decommissioning of land-based nuclear reactor plants</td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>Planning for off-site response to radiation accidents in nuclear facilities</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>Generic models and parameters for assessing the environmental transfer of radionuclides from routine releases: Exposures of critical groups</td>
<td></td>
</tr>
<tr>
<td>67</td>
<td>Assigning a value to transboundary radiation exposure</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>Management of radioactive wastes from nuclear power plants</td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>Principles for establishing intervention levels for the protection of the public in the event of a nuclear accident or radiological emergency</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>Emergency preparedness exercises for nuclear facilities: Preparation, conduct and evaluation</td>
<td></td>
</tr>
<tr>
<td>75-INSAG-1</td>
<td>Summary report on the post-accident review meeting on the Chernobyl accident</td>
<td></td>
</tr>
<tr>
<td>75-INSAG-2</td>
<td>Radionuclide source terms from severe accidents to nuclear power plants with light water reactors</td>
<td></td>
</tr>
<tr>
<td>75-INSAG-3</td>
<td>Basic safety principles for nuclear power plants</td>
<td></td>
</tr>
<tr>
<td>75-INSAG-4</td>
<td>Safety culture</td>
<td></td>
</tr>
<tr>
<td>75-INSAG-5</td>
<td>The safety of nuclear power: INSAG-5</td>
<td></td>
</tr>
<tr>
<td>75-INSAG-6</td>
<td>Probabilistic safety assessment</td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>Principles for limiting releases of radioactive effluents into the environment</td>
<td></td>
</tr>
</tbody>
</table>
Design of radioactive waste management systems at nuclear power plants 1986

Derived intervention levels for application in controlling radiation doses to the public in the event of a nuclear accident or radiological emergency: Principles, procedures and data 1986

Basic principles for occupational radiation monitoring 1987

Techniques and decision making in the assessment of off-site consequences of an accident in a nuclear facility 1987

Systems for reporting unusual events in nuclear power plants 1989

Response to a radioactive materials release having a transboundary impact 1989

Principles and techniques for post-accident assessment and recovery in a contaminated environment of a nuclear facility 1989

On-site habitability in the event of an accident at a nuclear facility: Guidance for assessment and improvement 1989

Operational radiation protection: A guide to optimization 1990

Provision of operational radiation protection services at nuclear power plants 1990

Extension of the principles of radiation protection to sources of potential exposure 1990

The regulatory process for the decommissioning of nuclear facilities 1990

The role of probabilistic safety assessment and probabilistic safety criteria in nuclear power plant safety 1992

TECHNICAL REPORTS SERIES

Guidebook on the introduction of nuclear power 1982

Interaction of grid characteristics with design and performance of nuclear power plants: A guidebook 1983

Decommissioning of nuclear facilities: Decontamination, disassembly and waste management 1983
<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>237</td>
<td>Manual on quality assurance programme auditing</td>
<td>1984</td>
</tr>
<tr>
<td>239</td>
<td>Nuclear power plant instrumentation and control: A guidebook</td>
<td>1984</td>
</tr>
<tr>
<td>242</td>
<td>Qualification of nuclear power plant operations personnel: A guidebook</td>
<td>1984</td>
</tr>
<tr>
<td>249</td>
<td>Decontamination of nuclear facilities to permit operation, inspection, maintenance, modification or plant decommissioning</td>
<td>1985</td>
</tr>
<tr>
<td>262</td>
<td>Manual on training, qualification and certification of quality assurance personnel</td>
<td>1986</td>
</tr>
<tr>
<td>267</td>
<td>Methodology and technology of decommissioning nuclear facilities</td>
<td>1986</td>
</tr>
<tr>
<td>268</td>
<td>Manual on maintenance of systems and components important to safety</td>
<td>1986</td>
</tr>
<tr>
<td>271</td>
<td>Introducing nuclear power plants into electrical power systems of limited capacity: Problems and remedial measures</td>
<td>1987</td>
</tr>
<tr>
<td>274</td>
<td>Design of off-gas and air cleaning systems at nuclear power plants</td>
<td>1987</td>
</tr>
<tr>
<td>282</td>
<td>Manual on quality assurance for computer software related to the safety of nuclear power plants</td>
<td>1988</td>
</tr>
<tr>
<td>292</td>
<td>Design and operation of off-gas cleaning and ventilation systems in facilities handling low and intermediate level radioactive material</td>
<td>1988</td>
</tr>
<tr>
<td>294</td>
<td>Options for the treatment and solidification of organic radioactive wastes</td>
<td>1989</td>
</tr>
<tr>
<td>296</td>
<td>Regulatory inspection of the implementation of quality assurance programmes: A manual</td>
<td>1989</td>
</tr>
<tr>
<td>299</td>
<td>Review of fuel element developments for water cooled nuclear power reactors</td>
<td>1989</td>
</tr>
<tr>
<td>300</td>
<td>Cleanup of large areas contaminated as a result of a nuclear accident</td>
<td>1989</td>
</tr>
<tr>
<td>301</td>
<td>Manual on quality assurance for installation and commissioning of instrumentation, control and electrical equipment in nuclear power plants</td>
<td>1989</td>
</tr>
<tr>
<td>306</td>
<td>Guidebook on the education and training of technicians for nuclear power</td>
<td>1989</td>
</tr>
</tbody>
</table>

81
307  Management of abnormal radioactive wastes at nuclear power plants 1989
327  Planning for cleanup of large areas contaminated as a result of a nuclear accident 1991
328  Grading of quality assurance requirements: A manual 1991
330  Disposal of waste from the cleanup of large areas contaminated as a result of a nuclear accident 1992
334  Monitoring programmes for unrestricted release related to decommissioning of nuclear facilities 1992
338  Methodology for the management of ageing of nuclear power plant components important to safety 1992

IAEA-TECDOC SERIES

276  Management of radioactive waste from nuclear power plants 1983
294  International experience in the implementation of the lessons learned from the Three Mile Island accident 1983
303  Manual on the selection of appropriate quality assurance programmes for items and services of a nuclear power plant 1984
308  Survey of probabilistic methods in safety and risk assessment for nuclear power plant licensing 1984
332  Safety aspects of station blackout at nuclear power plants 1985
341  Developments in the preparation of operating procedures for emergency conditions of nuclear power plants 1985
348  Earthquake resistant design of nuclear facilities with limited radioactive inventory 1985
355  Comparison of high efficiency particulate filter testing methods 1985
377  Safety aspects of unplanned shutdowns and trips 1986
379  Atmospheric dispersion models for application in relation to radionuclide releases 1986
387  Combining risk analysis and operating experience 1986
390  Safety assessment of emergency electric power systems for nuclear power plants 1986
416  Manual on quality assurance for the survey, evaluation and confirmation of nuclear power plant sites 1987

82
Identification of failure sequences sensitive to human error 1987
Simulation of a loss of coolant accident 1987
Experience with simulator training for emergency conditions 1987
Improving nuclear power plant safety through operator aids 1987
Dose assessments in nuclear power plant siting 1988
Some practical implications of source term reassessment 1988
OSART results 1988
OSART results II 1989
Good practices for improved nuclear power plant performance 1989
Models and data requirements for human reliability analysis 1989
Survey of ranges of component reliability data for use in probabilistic safety assessment 1989
Status of advanced technology and design for water cooled reactors: Heavy water reactors 1989
A probabilistic safety assessment peer review: Case study on the use of probabilistic safety assessment for safety decisions 1989
Probabilistic safety criteria at the safety function/system level 1989
Guidebook on training to establish and maintain the qualification and competence of nuclear power plant operations personnel 1989
User requirements for decision support systems used for nuclear power plant accident prevention and mitigation 1989
Safety aspects of nuclear power plant ageing 1990
Use of expert systems in nuclear safety 1990
Procedures for conducting independent peer reviews of probabilistic safety assessment 1990
The use of probabilistic safety assessment in the relicensing of nuclear power plants for extended lifetimes 1990

83
Safety of nuclear installations: Future direction 1990
Computer codes for Level 1 probabilistic safety assessment 1990
Reviewing computer capabilities in nuclear power plants 1990
Safety implications of computerized process control in nuclear power plants 1991
Simulation of a loss of coolant accident with rupture in the steam generator hot collector 1991
Case study on the use of PSA methods: Determining safety importance of systems and components at nuclear power plants 1991
Case study on the use of PSA methods: Backfitting decisions 1991
Case study on the use of PSA methods: Human reliability analysis 1991
Case study on the use of PSA methods: Station blackout risk at Millstone Unit 3 1991
Use of probabilistic safety assessment to evaluate nuclear power plant technical specifications 1991
Numerical indicators of nuclear power plant safety performance 1991
Use of plant specific PSA to evaluate incidents at nuclear power plants 1991
Human reliability data collection and modelling 1991
Reviewing reactor engineering and fuel handling: Supplementary guidance and reference material for IAEA OSARTs 1992
Ranking of safety issues for WWER-440 model 230 nuclear power plants 1992
Procedures for conducting common cause failure analysis in probabilistic safety assessment 1992
658 Safety related maintenance in the framework of the reliability centered maintenance concept 1992
659 Reactor pressure vessel embrittlement 1992

PROCEEDINGS SERIES

STI/PUB/593 Quality assurance for nuclear power plants 1982
STI/PUB/628 Nuclear power plant control and instrumentation 1983
STI/PUB/645 Reliability of reactor pressure components 1983
STI/PUB/673 IAEA safety codes and guides (NUSS) in the light of current safety issues 1985
STI/PUB/700 Source term evaluation for accident conditions 1986
STI/PUB/701 Emergency planning and preparedness for nuclear facilities 1986
STI/PUB/716 Optimization of radiation protection 1986
STI/PUB/759 Safety aspects of the ageing and maintenance of nuclear power plants 1988
STI/PUB/761 Nuclear power performance and safety 1988
STI/PUB/782 Severe accidents in nuclear power plants 1988
STI/PUB/783 Radiation protection in nuclear energy 1988
STI/PUB/785 Feedback of operational safety experience from nuclear power plants 1989
STI/PUB/803 Regulatory practices and safety standards for nuclear power plants 1989
STI/PUB/824 Fire protection and fire fighting in nuclear installations 1989
STI/PUB/825 Environmental contamination following a major nuclear accident 1990
STI/PUB/826 Recovery operations in the event of a nuclear accident or radiological emergency 1990
STI/PUB/843 Balancing automation and human action in nuclear power plants 1991
STI/PUB/880 The safety of nuclear power: Strategy for the future 1992
This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
HOW TO ORDER IAEA PUBLICATIONS

An exclusive sales agent for IAEA publications, to whom all orders and inquiries should be addressed, has been appointed for the following countries:

CANADA
UNITED STATES OF AMERICA
UNIPUB, 4611-F Assembly Drive, Lanham, MD 20706-4391, USA

In the following countries IAEA publications may be purchased from the sales agents or booksellers listed or through major local booksellers. Payment can be made in local currency or with UNESCO coupons.

ARGENTINA
Comisión Nacional de Energía Atómica, Avenida del Libertador 8250, RA-1429 Buenos Aires

AUSTRALIA
Hunter Publications, 58 A Gipps Street, Collingwood, Victoria 3066

BELGIUM
Service Courrier UNESCO, 202, Avenue du Roi, B-1060 Brussels

CHILE
Comisión Chilena de Energía Nuclear, Venta de Publicaciones, Amunátegui 95, Casilla 188-D, Santiago

CHINA
IAEA Publications in Chinese:
China Nuclear Energy Industry Corporation, Translation Section, P.O. Box 2103, Beijing
IAEA Publications other than in Chinese:
China National Publications Import & Export Corporation, Deutsche Abteilung, P.O. Box 88, Beijing

CZECHOSLOVAKIA
S N T L, Spálená 51, CS-113 02 Prague 1

FRANCE
Office International de Documentation et Librairie, 48, rue Gay-Lussac, F-75240 Paris Cedex 05

HUNGARY
Kultura, Hungarian Foreign Trading Company, P.O. Box 149, H-1389 Budapest 62

INDIA
Oxford Book and Stationery Co., 17, Park Street, Calcutta-700 016
Oxford Book and Stationery Co., Scindia House, New Delhi-110 001

ISRAEL
YOZMOT Literature Ltd., P.O. Box 56055, IL-61560 Tel Aviv

ITALY
Libreria Scientifica Dott. Lucio di Biasio "AEIOU", Via Coronelli 6, I-20146 Milan

JAPAN
Maruzen Company, Ltd, P.O. Box 5050, 100-31 Tokyo International

PAKISTAN
Mirza Book Agency, 65, Shahrah Quaid-e-Azam, P.O. Box 729, Lahore 3

POLAND
Ars Polons, Foreign Trade Enterprise, Krakowskie Przedmieście 7, PL-00-068 Warsaw

ROMANIA
Ilexim, P.O. Box 136-137, Bucharest

RUSSIAN FEDERATION
Mezhdunarodnaya Kniga, Sovinkniga-EA, Dimitrova 39, SU-113 095 Moscow

SOUTH AFRICA
Van Schaik Bookstore (Pty) Ltd, P.O. Box 724, Pretoria 0001

SPAIN
Díaz de Santos, Legazpi 95, E-28006 Madrid
Díaz de Santos, Balines 417, E-08022 Barcelona

SWEDEN
AB Fritzes Kungl. Hovbokhandel, Fredsgatan 2, P.O. Box 16356, S-103 27 Stockholm

UNITED KINGDOM
HMSO, Publications Centre, Agency Section, 51 Nine Elms Lane, London SW8 5DR

YUGOSLAVIA
 Jugoslovenska Knjiga, Terazije 27, P.O. Box 36, YU-11001 Belgrade

Orders from countries where sales agents have not yet been appointed and requests for information should be addressed directly to:

Division of Publications
International Atomic Energy Agency
Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria

This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
This publication is no longer valid
Please see http://www-ns.iaea.org/standards/
This publication is no longer valid
Please see http://www-ns.iaea.org/standards/