

Document Preparation Profile (DPP)

1. IDENTIFICATION

Document Category: Safety Guide

Working ID: DS 430

Proposed Title: Design of Electric Power Systems for NPPs

Proposed Action: Expand Scope of and update NS-G-1.8 into a new Safety Guide

Published Title/Date: NS-G-1.8: Design of Emergency Power Systems for NPPs (2004)

Safety Series No.: NS-G-1.8

SS Committee(s): NUSSC

Technical Officer(s): Gary Johnson

2. BACKGROUND

NS-G-1.8 provides recommendations regarding the implementation of NS-R-1 requirements for Emergency Power Systems (EPS). The Safety Guide makes recommendations and gives guidance on the provisions necessary for both new and operating nuclear power plants to meet the requirements relating to the functions of EPS. The existing guide also includes an Appendix containing guidance on normal and off-site power supplies, but this guidance focuses on their role in supporting reliability of EPS.

Functions of electrical power systems important to safety are not limited to emergency power supply or to support of EPS. For example, normal power supplies must be designed to minimize challenges to emergency systems, and to limit the effects of fire and other internal events on power supply for other, otherwise unaffected systems. With the advent of computer-based technology there must also be increased emphasis on electrical system design to both minimize and mitigate the effects of electromagnetic interference. Furthermore, many topics, such as raceway and cable system design, are important to the entire plant electrical power system, but in the existing guide are discussed only in the context of emergency power supplies.

3. OBJECTIVE AND JUSTIFICATION

The objective of this work is to develop a safety guide addressing all electrical power systems important to safety. The existing guide does not contain sufficient guidance about non-emergency portions of plant electric power systems and many recommendations of the existing guide apply to more than just the emergency power functions of the electrical system. Furthermore, the new guide should include update the recommendations for electrical systems to reflect consensus that has emerged in several areas, such as computer security and interactions between the NPP and the grid, since the original publication of NS-G-1.3 and NS-G-1.

The existing guide also contains guidance on non-electrical emergency power supply, e.g., compressed air. This guidance should be relocated into the proposed safety guide dealing with auxiliary systems.

4. POSITION IN THE OVERALL STRUCTURE OF THE RELEVANT SERIES AND INTERFACES WITH EXISTING AND/OR PLANNED PUBLICATIONS

The new guide would be one of the design safety guides providing recommendations for the implementation of NS-R-1, “Safety of Nuclear Power Plants: Design.” and would have interfaces with the following Safety Guides:

- NS-G-1.2: Safety Assessment and Verification for Nuclear Power Plants¹.
- NS-G-1.3: Instrumentation and Control Systems Important to Safety in Nuclear Power Plants²
- NS-G-2.2: Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants³
- NS-G-2.14 Conduct of Operations at Nuclear Power Plants⁴

The new guide must avoid conflicts with the following guides that guide the development of design inputs for the electrical power systems or give guidance on engineering methods that ensure operability of systems and components:

- NS-G-1.5: External Events Excluding Earthquakes in the Design of Nuclear Power Plants
- NS-G-1.6: Seismic Design and Qualification for Nuclear Power Plants
- NS-G-1.7: Protection against Internal Fires and Explosions in the Design of Nuclear Power Plants
- NS-G-1.11: Protection against Internal Hazards other than Fires and Explosions in the Design of Nuclear Power Plants

The new guide must also consider new and revised IAEA safety standards that are currently under development, such as the revision to NS-R-1, and the new guide on safety classification. These will be considered as they near completion.

5. OVERVIEW

Summary of proposed scope

This Safety Guide will provide recommendations for design and implementation of electrical power systems important to safety. The guidance will be broadly applicable to nuclear power plants and are intended for application to both the design of new electrical power systems and

¹ Relative to guidance on implementing NS-R-1 requirements on engineering aspects important to safety

² Relative to requirements for instrumentation and control of the power systems and to support services that electric power systems provide to the I&C systems. Note that the support services include functions beyond just power supply, e.g., cabling, cable separation, and protection against electromagnetic noise.

³ Relative to guidance on implementing NS-R-1 and NS-R-2 requirements for limiting safety system settings

⁴ Relative to operational conduct that must be supported by the Electrical Systems.

the modernization of existing systems. Guidance will be provided for classifying electrical power systems by their importance to safety and on the application of design requirements to systems and components of different safety classification.

Draft Outline

The top level outline for the safety guide is given below. A tentative outline giving more detail about specific topics to be covered is given in the appendix. The specifics of the detailed outline may evolve as the document is prepared.

1. INTRODUCTION

Background

Objective

Scope

Structure

2. ELECTRICAL POWER SYSTEMS IMPORTANT TO SAFETY

3. SAFETY CLASSIFICATION

4. DESIGN BASIS

5. DESIGN GUIDELINES FOR OFFSITE POWER SYSTEMS

6. DESIGN GUIDELINES FOR ONSITE POWER SYSTEMS

7. ELECTROMAGNETIC COMPATABILITY AND LIGHTNING PROTECTION

8. RACEWAY AND CABLE SYSTEMS

9. DESIGN CONFIRMATION AND DOCUMENTATION

REFERENCES

GLOSSARY

6. PRODUCTION: Provisional schedule for preparation of the document, outlining expected dates for:

Approval of DPP by the Coordination Committee	March 2009
Approval of DPP by the Safety Standards Committees*	June 2009
Approval of DPP by the CSS*	October 2009
Approval of draft by the Coordination Committee	April 2010
Approval by the Safety Standards Committees for submission to Member States for comments*	June 2010
Approval of the revised draft by the Coordination Committee*	March 2011
Review in NS-SSCS*	March 2011
Approval by the Safety Standards Committees for submission to the CSS*	June 2011
Endorsement by the CSS*	October 2011

Approval by the Publications Committee

November
2011

Target publication date

Early 2012:

note: * is necessary only for the Safety Standards.

7. RESOURCES

It is estimated that development of the new guide would involve approximately 40 weeks of effort by member states experts. This is based upon assuming 4 one-week expert meetings involving no more than 5 experts and an average of one week of work per expert between meetings.

Secretariat resources involved are estimated at 10 weeks of effort by agency staff plus support for expert travel and honoraria for experts whose effort is not otherwise funded.

NEW SAFETY GUIDE
POWER SYSTEMS IMPORTANT TO SAFETY IN NPP
ANNOTATED OUTLINE

2009.08.12

1. INTRODUCTION

1.1. Background

1.2. Objective

1.3. Scope

2. ELECTRICAL POWER SYSTEMS IMPORTANT TO SAFETY

3. SAFETY CLASSIFICATION

4. DESIGN BASIS

4.1. General

4.2. Reliability, form and arrangement)

4.3. Single failure criterion and equipment outages

4.4. Common cause failures

4.5. Combinations of events

4.6. Station blackout)

5. GUIDELINES FOR OFFSITE POWER SYSTEMS

5.1. Normal power supplies

5.2. Grid stability

5.3. Transmission lines

5.4. Switchyard

5.5. Reliability assessment

5.6. On-site measures

6. DESIGN GUIDELINES FOR ONSITE POWER SYSTEMS

6.1. General design guidelines

6.1.1. Performance requirements)

6.1.2. Design for reliability

6.1.2.1. Single failure criterion

6.1.2.1.1. The criterion

6.1.2.1.2. Application of the single failure criterion to I&C systems important to safety

6.1.2.2. Redundancy)

6.1.2.3. Diversity)

6.1.2.4. Reliability assessment

6.1.2.5. Independence

6.1.2.5.1. Connection between redundant divisions

6.1.2.5.2. Isolation of instrumentation and control systems

6.1.2.5.3. Loads other than safety system loads

6.1.2.6. Failure modes

6.1.2.7. Control of access to equipment

6.1.2.8. Operating limits

6.1.3. Human-machine interface

6.1.4. Equipment qualification

6.1.4.1. Equipment qualification programme

6.1.4.2. Methods of qualification

6.1.5. Quality

6.1.6. Design for electromagnetic compatibility

6.1.7. Testing and testability

6.1.7.1. Test programme

6.1.7.2. Test provisions

6.1.7.2.1. Fault detection

6.1.7.2.2. Demonstration of system performance

6.1.7.2.3. Removal from service

6.1.7.2.4. Control and conduct of tests

- 6.1.8. Maintainability*
- 6.1.9. Documentation*
- 6.1.10. Identification of items important to safety*
- 6.1.11. Sharing of components in multiunit plants*
- 6.2. AC power sources**
 - 6.2.1. Diesel generators*
- 6.3. DC power sources**
 - 6.3.1. Battery*
 - 6.3.2. Battery charge*
 - 6.3.3. Battery capability*
 - 6.3.4. Non-interruptible AC sources*
- 6.4. Distribution systems**
 - 6.4.1. Capability*
 - 6.4.2. Support system equipment*
 - 6.4.3. Protective devices of the main and branch circuits*
- 6.5. Controls and Monitoring)**
 - 6.5.1. Monitoring*
- 6.6. Grounding**
- 6.7. Alternative Power Supplies (Old I.5)**
- 7. LIGHTNING AND SURGE PROTECTION**
 - 7.1. Lightning protection (Old 4.1.14)**
 - 7.2. Surge voltage protection**
- 8. RACEWAY AND CABLE SYSTEMS**
 - 8.1. Buses and cables (Old 4.1.2)**
 - 8.1.1. Insulation*
 - 8.1.2. Rating and sizing*
 - 8.1.3. Installation*

8.1.4. Connectors, terminations and splices

8.1.5. Separation by classes

8.1.6. Independence

8.1.7. Physical protection

8.2. Electrical penetrations (Old 4.1.13)

8.3. Fire protection

9. DESIGN CONFIRMATION AND DOCUMENTATION

9.1. Quality assurance

9.2. Qualification

9.2.1. Qualification methods

9.2.1.1. Qualification by type testing

9.2.1.2. Qualification by operating experience

9.2.1.3. Qualification by analysis

9.3. Verification of design

9.4. Documentation

ANNEX I. REFERENCES

ANNEX II. GLOSSARY

ANNEX III. CONTRIBUTORS TO DRAFTING AND REVIEW

ANNEX IV. BODIES FOR THE ENDORSEMENT OF SAFETY STANDARDS