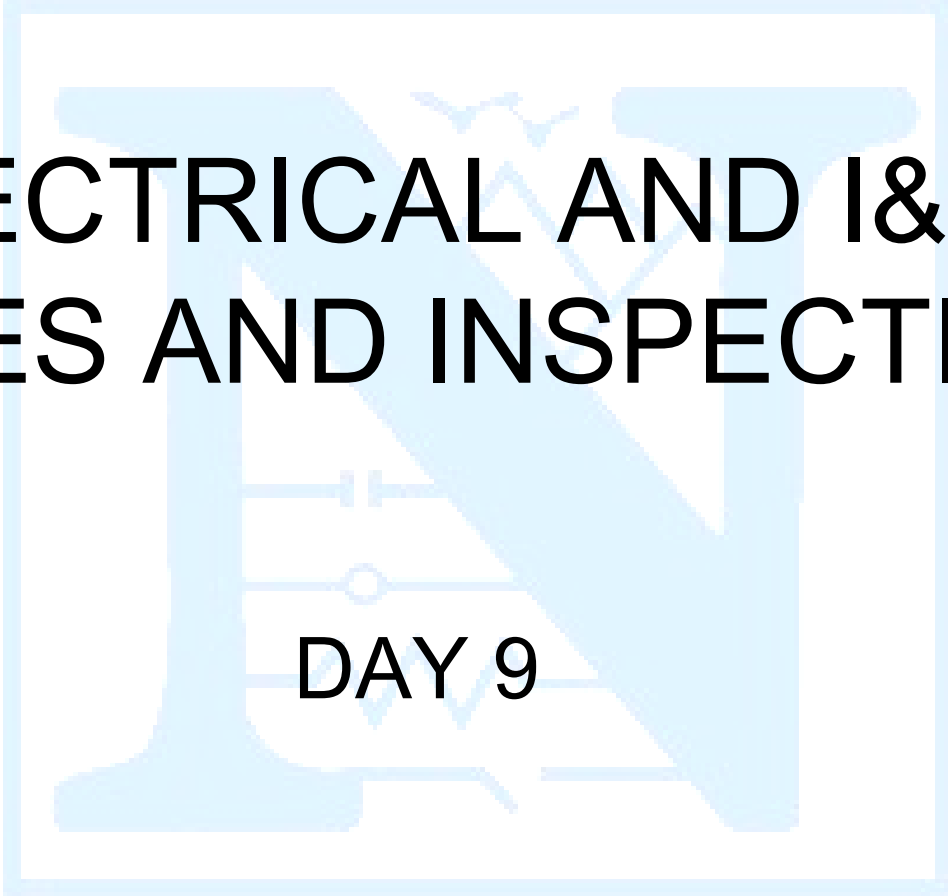




ELECTRICAL AND I&C CODES AND INSPECTION



DAY 9

DAY 9

Sessions:

- 20. Overview of Industry Guidance
- 21. Regulatory Guides
- Student Activity: Standards vs. Regulatory Guides Matrix**
- 22. NRC Inspection Procedures

20. Overview of Industry Guidance



20. Overview of Industry Guidance Objectives

- Identify the major sources of industry guidance
- Provide a general overview of these guidance documents
- Discuss how this guidance relates to new reactor inspection

20. Overview of Industry Guidance

- Regulatory Guides
- Generic Communication
- NUREGs
- NERC Reliability Standards
- NUMARC 87-00
- NEI

Regulatory Guides

Division 1 Power Reactors

<http://www.nrc.gov/reading-rm/doc-collections/reg-guides/power-reactors/active/>

Regulatory Guides

Division **1** Power Reactors

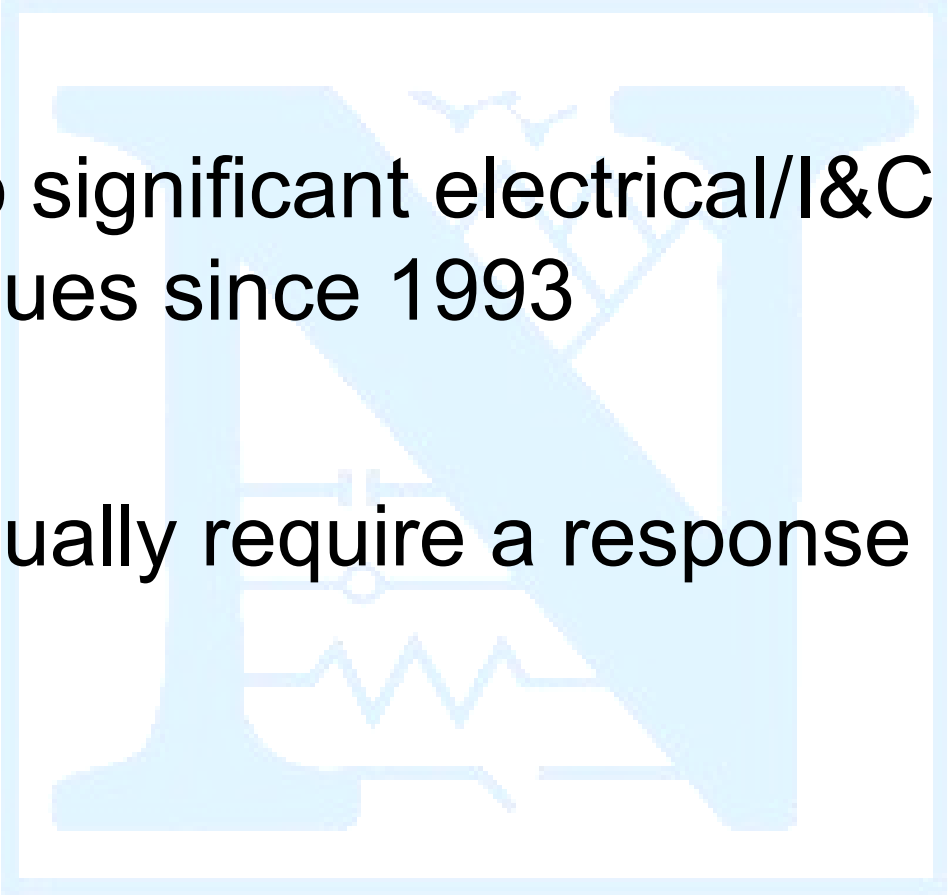
Reg Guides RG **1**.xxx

Draft Reg Guides DG **1**yyy

Generic Communication

- 
- 
- Bulletins
 - Generic Letters
 - Regulatory Issue Summaries
 - Information Notices

Bulletins

- 
- 
- No significant electrical/I&C issues since 1993
 - Usually require a response

Bulletins

BL 93-03, “Reactor Vessel Water Level Instrumentation in BWRs”

BL 92-01, “Failure of Thermal Lag Fire Barrier System”

BL 90-01, “Loss of Fill Oil in Rosemount Transmitters”

BL 88-10, “Nonconforming Molded-Case Circuit Breakers”

Generic Letters

- Information transfer
- Usually require a response

Generic Letters

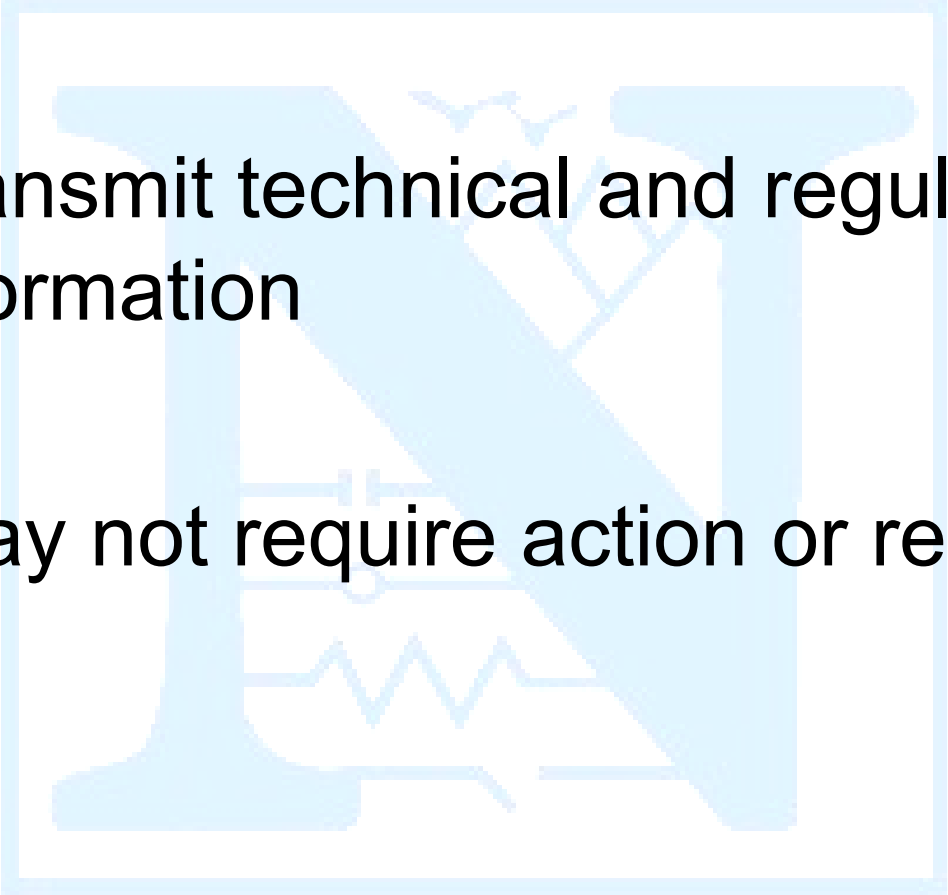
GL 2006-02, “Operability of Offsite Power”

GL 2007-01, “Inaccessible Power Cable Failures”

GL 96-01, “Testing of Safety-Related Circuits”

GL 94-01, “Removal of Accelerated Testing for Emergency Diesel Generators”

Regulatory Issue Summaries

- 
- 
- Transmit technical and regulatory information
 - May not require action or response

Regulatory Issue Summaries

RIS 2008-05, “Lessons to Improve ITAACs”

RIS 2007-24, “Crossflow Ultrasonic Flow Meter”

RIS 2004-05, “Grid Reliability and Plant Risk”

RIS 2003-09, “EQ of Low-Voltage I&C Cables”

RIS 2002-22, “EPRI/NEI Guidance for Licensing of Digital Upgrades”

NUREGs

- 
- 
- Regulatory decisions
 - Results of research
 - Results of incident investigations

NUREGs

- NUREG
- NUREG/BR
- NUREG/CR
- NUREG/CP
- NUREG/IA

NERC Reliability Standards

- NUC-001 Nuclear Plant Interface Coordination

ftp://www.nerc.com/pub/sys/all_updl/standards/rs/NUC-001-2.pdf

NERC Reliability Standard NUC-001-02

- Nuclear Plant Interface Coordination
 - Requirements
 - Measures
 - Compliance

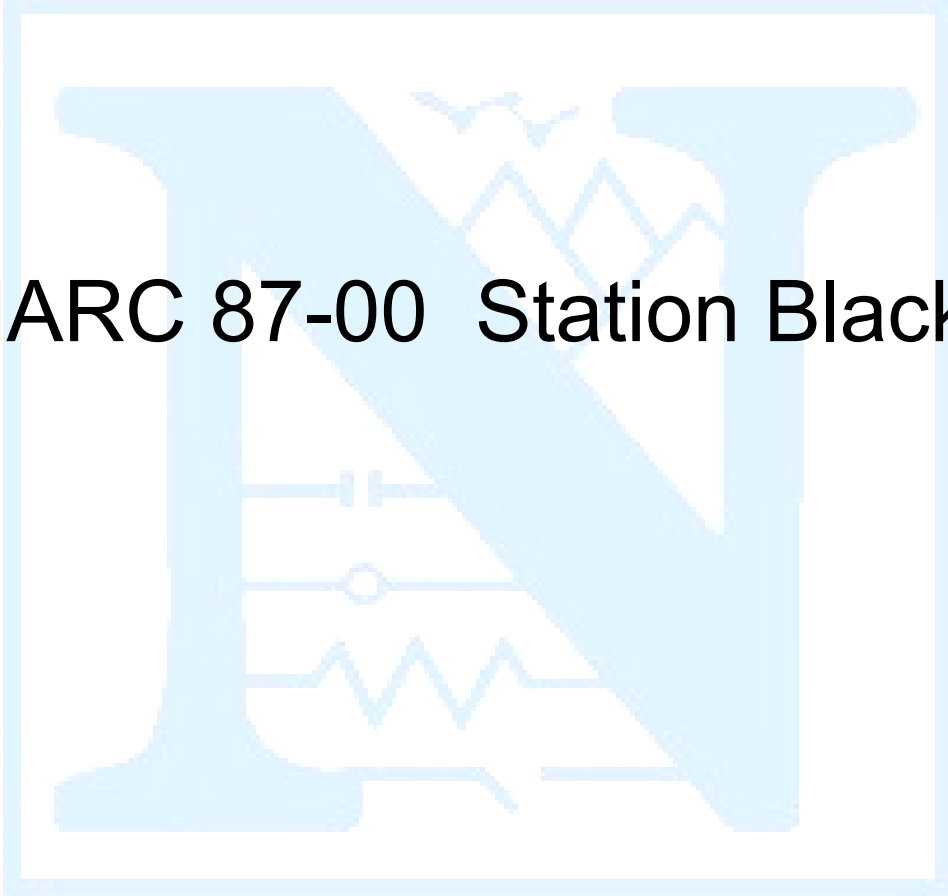
NERC Reliability Standards

- VAR-001 Voltage and Reactive Control
- TPL-002 Loss of a Single System Element
- TPL-003 Loss of Two or More Elements
- TOP-002 Normal Operating Planning
- TOP-007 System Operating Limits and Interregional Reliability Operating Limits

NERC Reliability Standards

- EOP-005, System Restoration Plans
- EOP-008, Plans for Loss of Control Center Functionality
- BAL-005, Automatic Generation Control
- MOD-014, Development of Interconnection Specific Steady-State System Models
- MOD-015, Development of Interconnection Specific Dynamic System Models

Nuclear Management and Resources Council



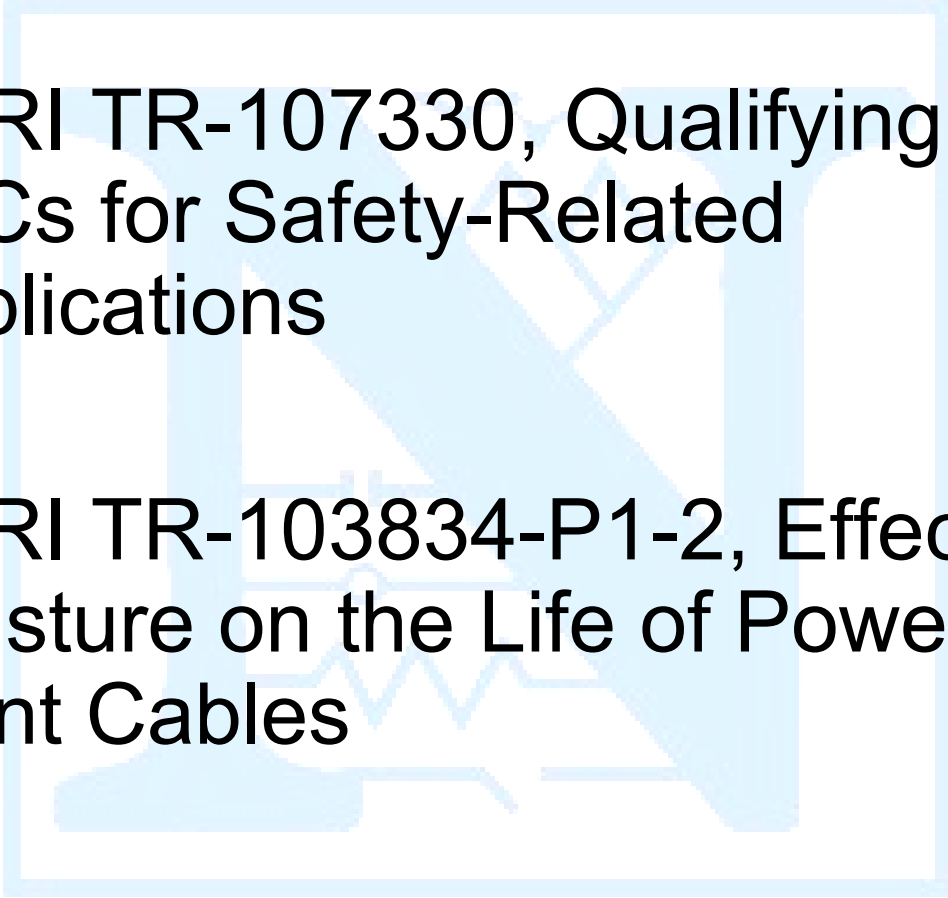
NUMARC 87-00 Station Blackout

Nuclear Energy Institute

- NEI 06-09, Risk-Informed Technical Specifications
- NEI 04-10, Risk Informed Surveillance Frequencies
- NEI 95-10, License Renewal



Electric Power Research Institute

- 
- EPRI TR-107330, Qualifying PLCs for Safety-Related Applications
 - EPRI TR-103834-P1-2, Effects of Moisture on the Life of Power Plant Cables

20. Overview of Industry Guidance Objectives Review

- Identified the major sources of industry guidance
- Provided a general overview of these guidance documents
- Discussed how this guidance relates to new reactor inspection

21. Regulatory Guides

<http://www.nrc.gov/reading-rm/doc-collections/reg-guides/power-reactors/active/>



21. Regulatory Guides Objectives

- Identify the Reg Guides applicable to electrical and I&C activities
- Provide a general overview of the purpose of these Reg Guides
- Discuss how these Reg Guides relate to new reactor inspection

21. Regulatory Guides

- Electrical Reg Guides
- I&C Reg Guides



21. Electrical Power Regulatory Guides

RG 1.6	Independence Between Redundant Power Sources
RG 1.9	Emergency Diesel-Generator Units
RG 1.32	Criteria for Safety-Related Electric Power Systems
RG 1.47	Bypassed and Inoperable Status Indication
RG 1.53	Application of the Single-Failure Criterion

21. Electrical Power Regulatory Guides



RG 1.63	Electric Penetration Assemblies
RG 1.75	Physical Independence of Electric Systems
RG 1.81	Shared Emergency and Shutdown Electric Systems
RG 1.89	Environmental Qualification of Equipment Important to Safety
RG 1.100	Seismic Qualification of Electric and Mechanical Equipment

21. Electrical Power Regulatory Guides

- RG 1.106 Thermal Overload Protection for MOVs
- RG 1.118 Periodic Testing of Electric Power and Protection Systems
- RG 1.155 Station Blackout
- RG 1.204 Guidelines for Lightning Protection
- RG 1.210 Qualification of Safety-Related Battery Chargers and Inverters

21. Electrical Power Regulatory Guides

- RG 1.211 Qualification of Safety-Related Cables and Field Splices
- RG 1.212 Sizing of Large Lead-Acid Storage Batteries
- RG 1.213 Qualification of Safety-Related Motor Control Centers

21. I&C Regulatory Guides



RG 1.6	Electrical Independence
RG 1.11	Instrument Lines Penetrating Containment
RG 1.30	Installation, Inspection, and Testing of I&C Equipment
RG 1.47	Bypassed and Inoperable Status Indication
RG 1.53	The Single-Failure Criterion
RG 1.75	Physical Independence

21. I&C Regulatory Guides



RG 1.68	Initial Test Programs
RG 1.79	Preoperational Testing of ECCS
RG 1.81	Shared Emergency and Shutdown Systems
RG 1.89	Qualification of Class 1E Equipment

21. I&C Regulatory Guides

- RG 1.97 Accident Monitoring Instrumentation
- RG 1.100 Seismic Qualification
- RG 1.105 Instrument Setpoints
- RG 1.131 Qualification Cables, Field Splices, and Connections (see RG 1.211)
- RG 1.151 Instrument Sensing Lines

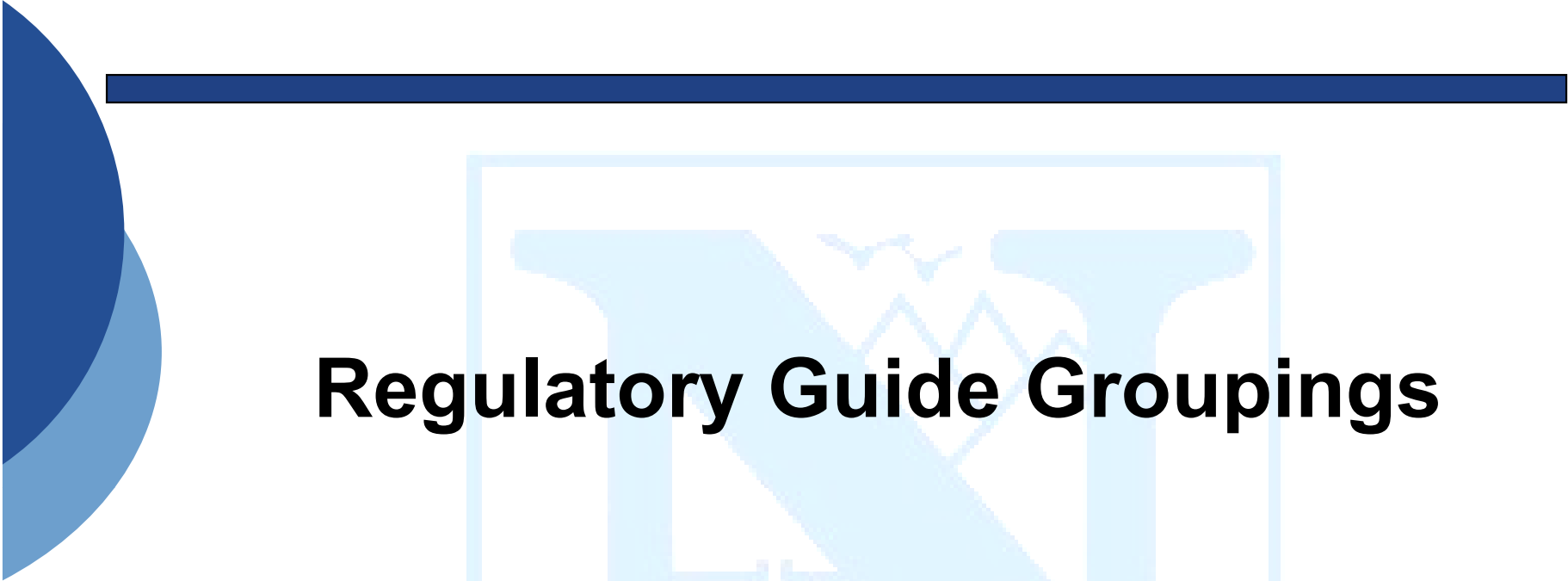
21. I&C Regulatory Guides

- RG 1.153 Criteria for Safety Systems
- RG 1.180 Evaluating EMI/RFI in Safety-Related I&C
- RG 1.209 EQ of Safety-Related Computer-Based Instrumentation and Control Systems
- RG 1.211 Qualification of Safety-Related Cables and Field Splices for Nuclear Power Plants

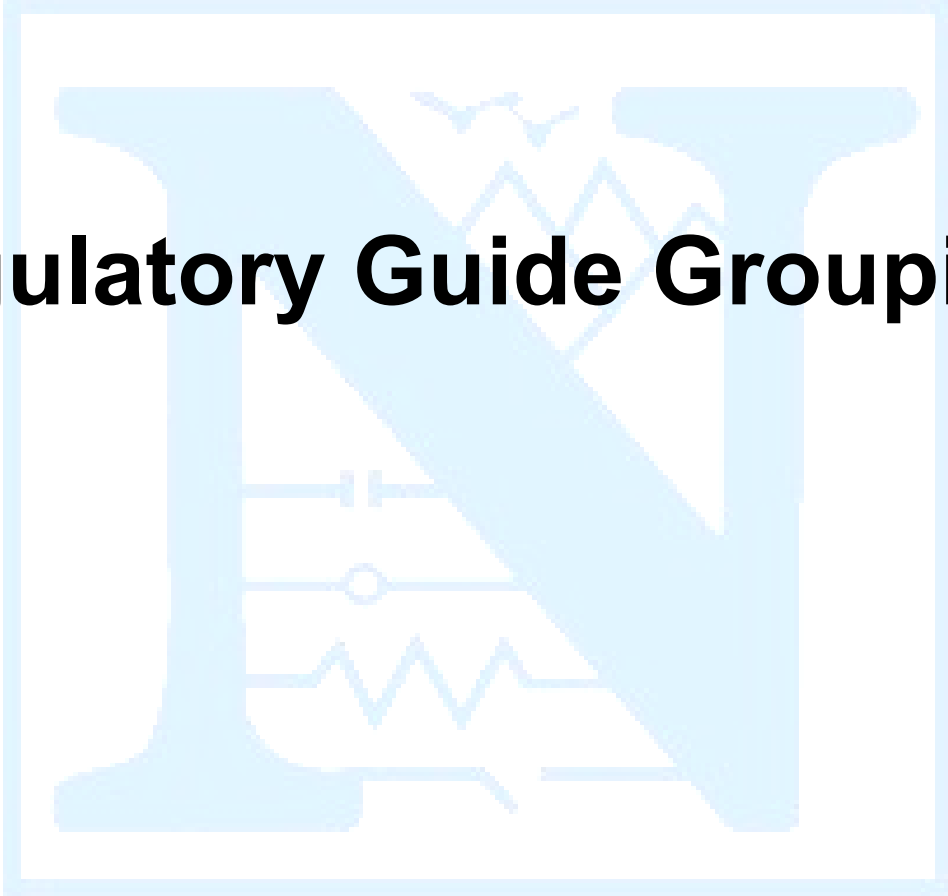
21. I&C Regulatory Guides



RG 1.168	V&V Reviews and Audits
RG 1.169	Configuration Management
RG 1.170	Test Documentation
RG 1.171	Software Unit Testing
RG 1.172	Software Requirements
RG 1.173	Software Life Cycle



Regulatory Guide Groupings



GDC 17 Electric Power Supply

- RG 1.6 Independence of Power
- RG 1.9 Emergency Diesel Generators
- RG 1.32 Electric Power Systems
- RG 1.75 Physical Independence
- RG 1.128 Installation of Batteries

GDC 17 Electric Power Supply

RG 1.129 Maintenance of Batteries

RG 1.153 Safety Systems

RG 1.155 Station Blackout

RG 1.212. Sizing of Batteries

GDC 18 Inspection and Testing of Electric Power Systems



RG 1.128 Installation of Batteries

RG 1.129 Maintenance of Batteries

RG 1.153 Safety Systems

10 CFR 50.55a(h) Safety Systems

RG 1.53

Safety Systems

RG 1.75

Physical Independence

RG 1.118

Periodic Testing



10 CFR 50.49, GDC 2 & 4 Qualification

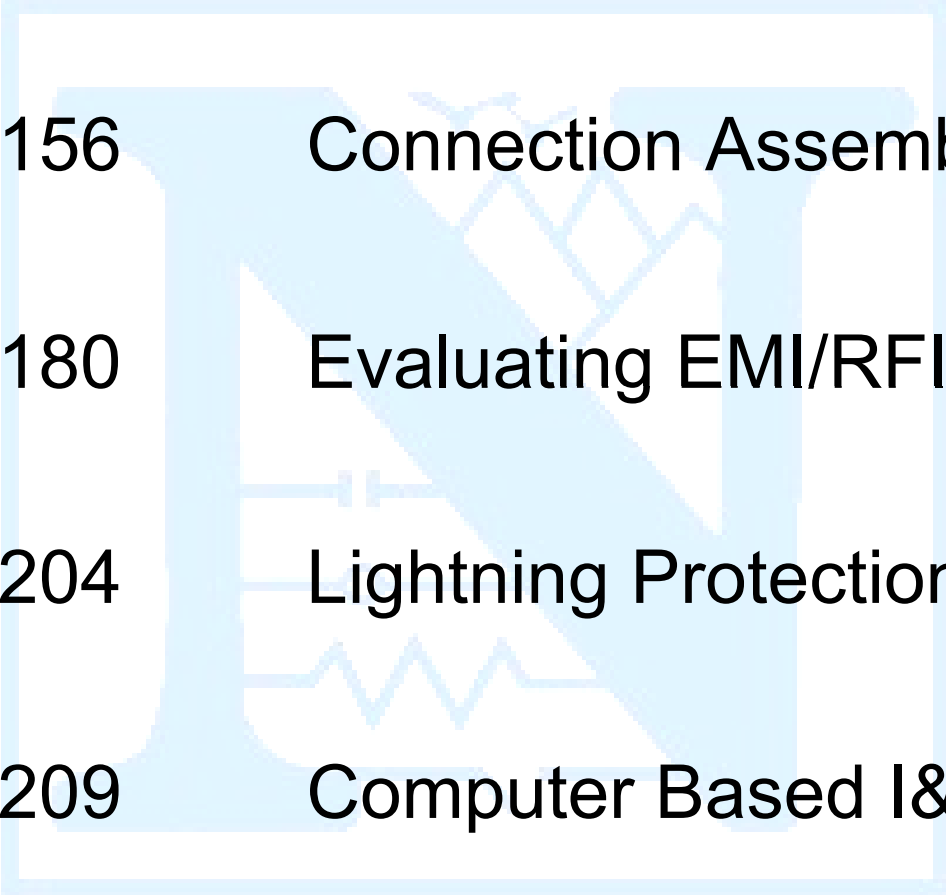
RG 1.40 Continuous Duty Motors

RG 1.63 Electrical Penetration Assemblies

RG 1.73 Valve Operators

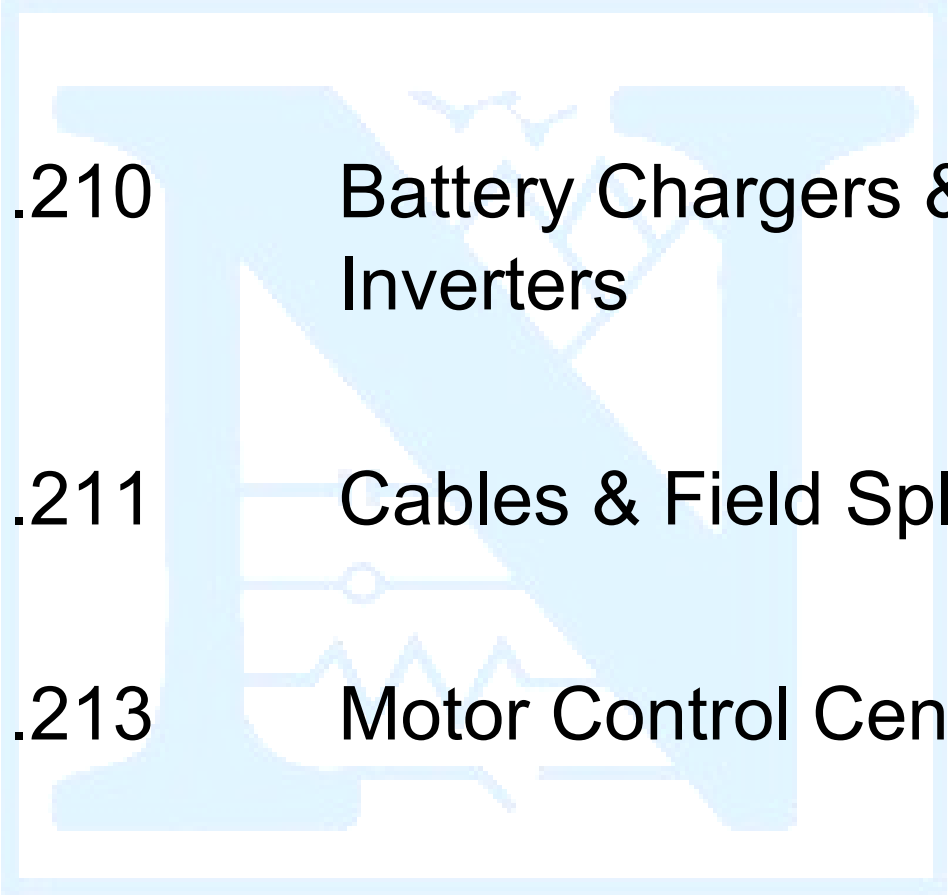
RG 1.89 Environmental Qualification

10 CFR 50.49, GDC 2 & 4 Qualification



RG 1.156	Connection Assemblies
RG 1.180	Evaluating EMI/RFI
RG 1.204	Lightning Protection
RG 1.209	Computer Based I&C

10 CFR 50.49, GDC 2 & 4 Qualification



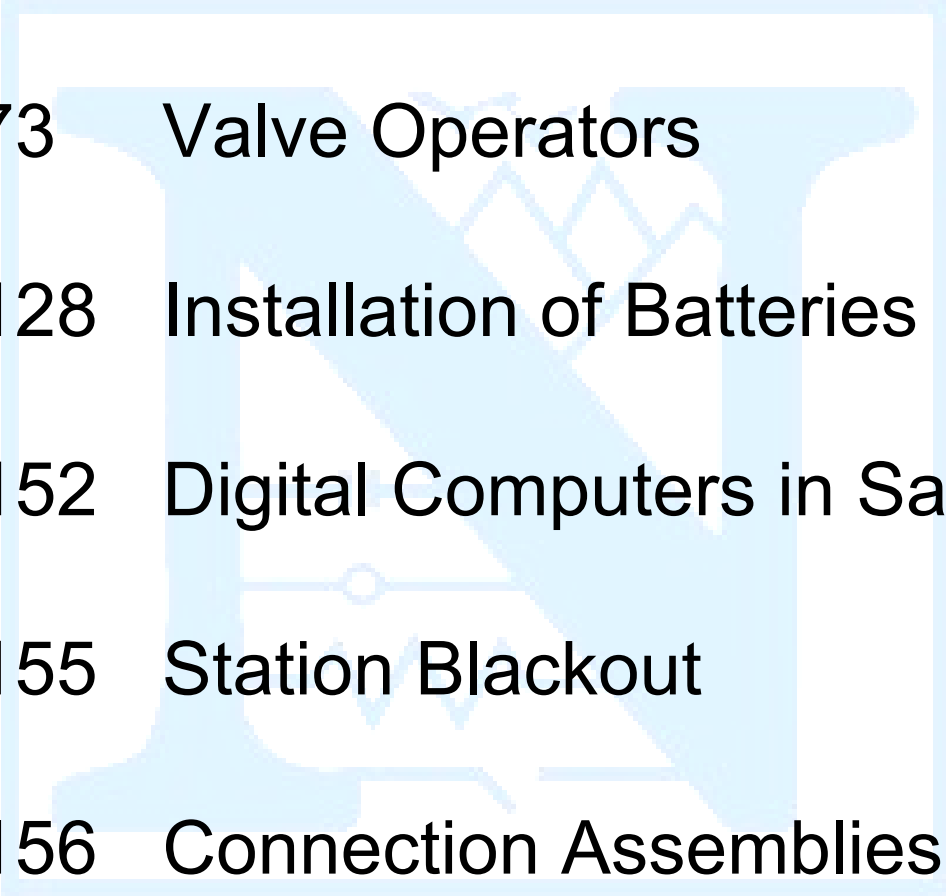
RG 1.210	Battery Chargers & Inverters
RG 1.211	Cables & Field Splices
RG 1.213	Motor Control Centers

10 CFR 50.63 Station Blackout

RG 1.155 Station Blackout

RG 1.212 Sizing Large Batteries

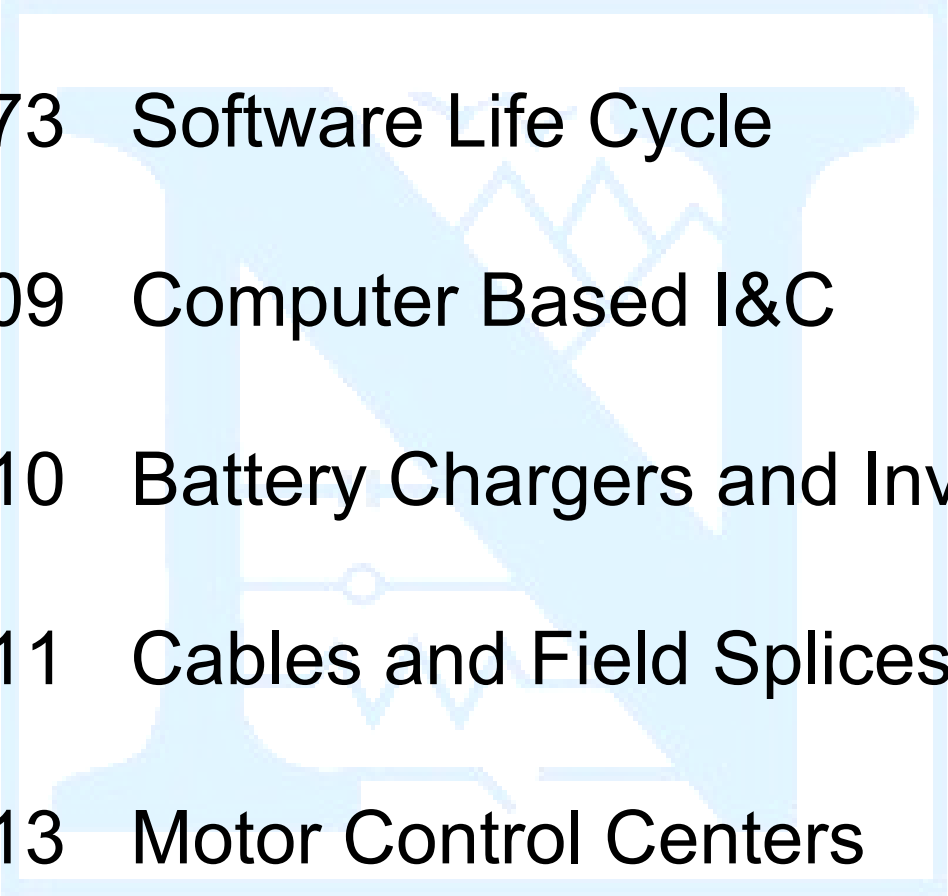
Criterion III Design Control

- 
- 
- RG 1.73 Valve Operators
 - RG 1.128 Installation of Batteries
 - RG 1.152 Digital Computers in Safety
 - RG 1.155 Station Blackout
 - RG 1.156 Connection Assemblies

Criterion III Design Control

- RG 1.168 Software V&V
- RG 1.169 Software Configuration Mgmt.
- RG 1.170 Software Test Documentation
- RG 1.171 Software Unit Testing
- RG 1.172 Software Requirements Spec.

Criterion III Design Control

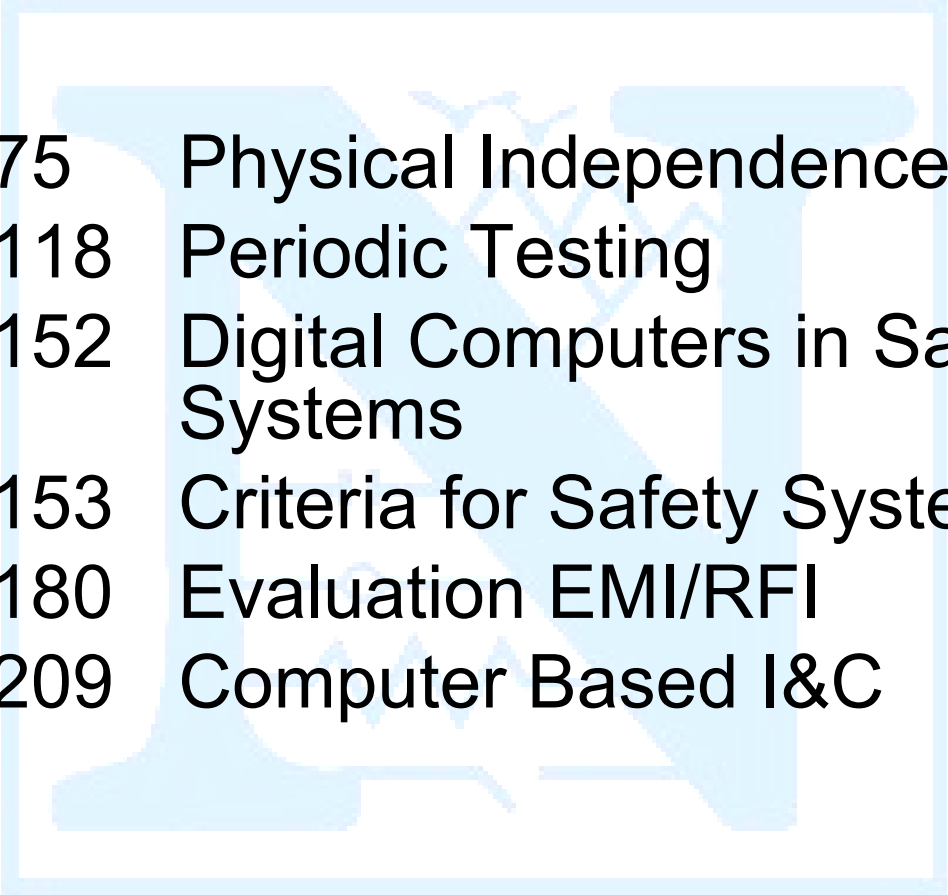
- 
- 
- RG 1.173 Software Life Cycle
 - RG 1.209 Computer Based I&C
 - RG 1.210 Battery Chargers and Inverters
 - RG 1.211 Cables and Field Splices
 - RG 1.213 Motor Control Centers

Criterion XI Test Control

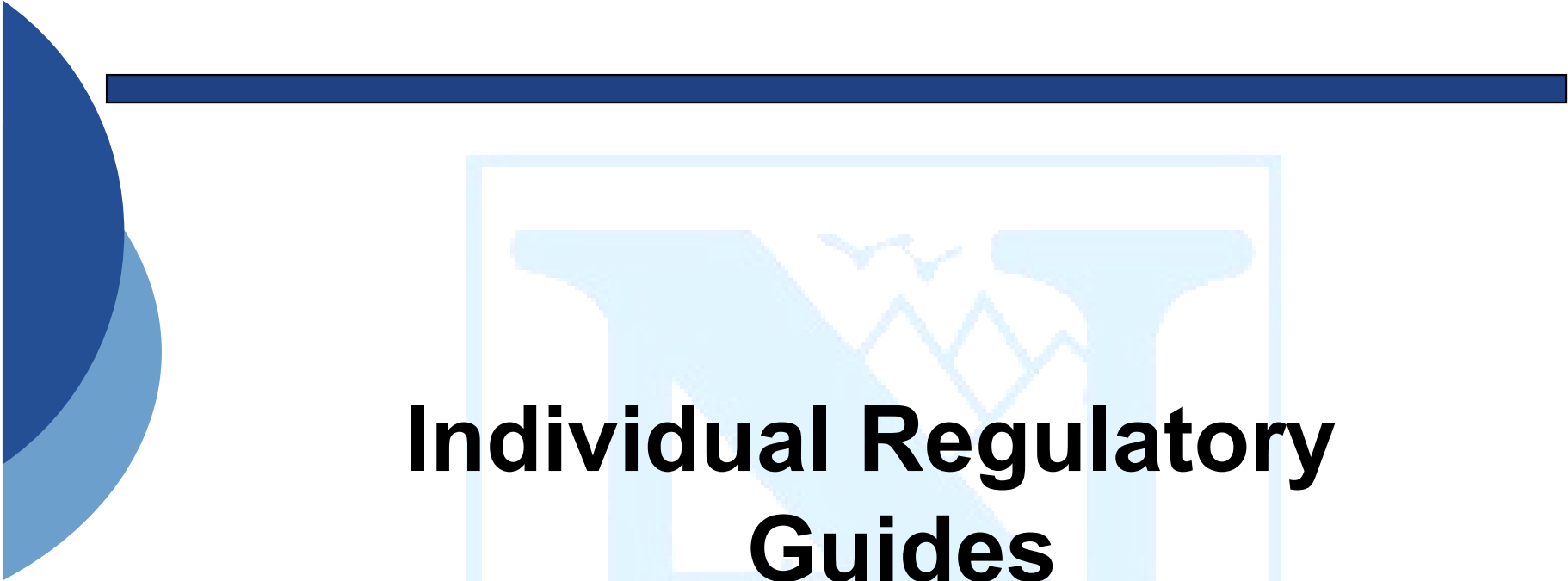


RG 1.106	MOV Thermal Overloads
RG 1.129	Maintenance of Batteries
RG 1.168	Software V&V
RG 1.170	Software Test Documentation
RG 1.171	Software Unit Testing
RG 1.209	Computer Based I&C

GDC 21-26 Protection Systems



RG 1.75	Physical Independence
RG 1.118	Periodic Testing
RG 1.152	Digital Computers in Safety Systems
RG 1.153	Criteria for Safety Systems
RG 1.180	Evaluation EMI/RFI
RG 1.209	Computer Based I&C



Individual Regulatory Guides



RG 1.6 Independence between Redundant Power Supplies

Requirements:

GDC 17 Independence

Standards:

None

RG 1.9 Application and Testing of EDGs

Requirements:

GDC 17 Capacity

Standards:

IEEE Std 387

RG 1.32 Electrical Power Systems

Requirements:

GDC 17 Redundancy

Standards:

IEEE Std 308

RG 1.40 Qualification of Continuous Duty Motors

Requirements:

10 CFR 50.49,
GDC 2, 4, 23 Environmental

Standards:

IEEE Std 334

RG 1.47 Bypass and Inoperable Status Indication

Requirements:

10 CFR 50.34(f)(2)(v),
GDC 13 Bypass I&C

Standards:

IEEE Std 603

RG 1.53 Application of the Single Failure Criterion

Requirements:

10 CFR 50.55a(h)

Standards:

IEEE Std 379

RG 1.63 Electrical Penetration Assemblies

Requirements:

10 CFR 50.49

GDC 50

Standards:

IEEE Std 317

RG 1.73 Qualification of Valve Operators

Requirements:

Criterion III Design Control

Standards:

IEEE Std 382

RG 1.75 Physical Independence

Requirements:

10 CFR 50.55a(h)

GDC 17, 21, 22

Standards:

IEEE Std 384

RG 1.81 Shared Power Supplies in Multi-Unit Stations

Requirements:

GDC 5 Sharing in Multi-unit Stations

Standards:
(IEEE 308)

RG 1.89 Environmental Qualification

Requirements:

GDC 2, 4 Qualification

Standards:

IEEE Std 323

RG 1.100 Seismic Qualification of Elec and Mech Equipment

Requirements:

GDC 2 Natural Phenomenon

Standards:

IEEE Std 344

RG 1.106 MOV Thermal Overload Protection

Requirements:

GDC 4, 13

Criterion XI Test Control

Standards:

(IEEE 741, Appendix B)

RG 1.108

(Withdrawn - See RG 1.9)

RG 1.118 Periodic Testing

Requirements:

10 CFR 50.55a(h),
GDC 18, 21, Criterion XI

Standards:

IEEE Std 279 (Superseded by IEEE
Std 603)
IEEE 308

RG 1.128 Installation of Large Lead Acid Batteries

Requirements:

GDC 17, 18, Criterion III Design Control

Standards:

IEEE Std 484

RG 1.129 Maintenance of Large Lead Acid Batteries

Requirements:

GDC 17,18, Criterion XI Test Control

Standards:

IEEE Std 450

RG 1.131

(Withdrawn - See RG 1.211)

RG 1.152 Digital Computers in Safety Systems



Requirements:

GDC 21, Criterion III Design Control

Standards:

IEEE Std 7-4.3.2

RG 1.153 Criteria for Safety Systems

Requirements:

GDC 13,17,18,20,21,22,23,24,25,26

Standards:

IEEE Std 603



RG 1.155 Station Blackout

Requirements:

10 CFR 50.63, GDC 17, Criterion III

Standards:

NUMARC 87-00

RG 1.156 Qualification of Connector Assemblies

Requirements:

10 CFR 50.49, Criterion III

Standards:

IEEE Std 572

RG 1.168 V&V Reviews and Audits

Requirements:

Criteria III, XI, XVII

Standards:

IEEE Std 1012 and IEEE Std 1028

RG 1.169 Configuration Management



Requirements:
Criteria III, VI

Standards:
IEEE Std 828 and IEEE Std 1042

RG 1.170 Test Documentation

Requirements:

Criteria I,II,III,V,XI, XVII

Standards:

IEEE Std 829

RG 1.171 Software Unit Testing

Requirements:

Criteria I,II,III,V,XI, XVII

Standards:

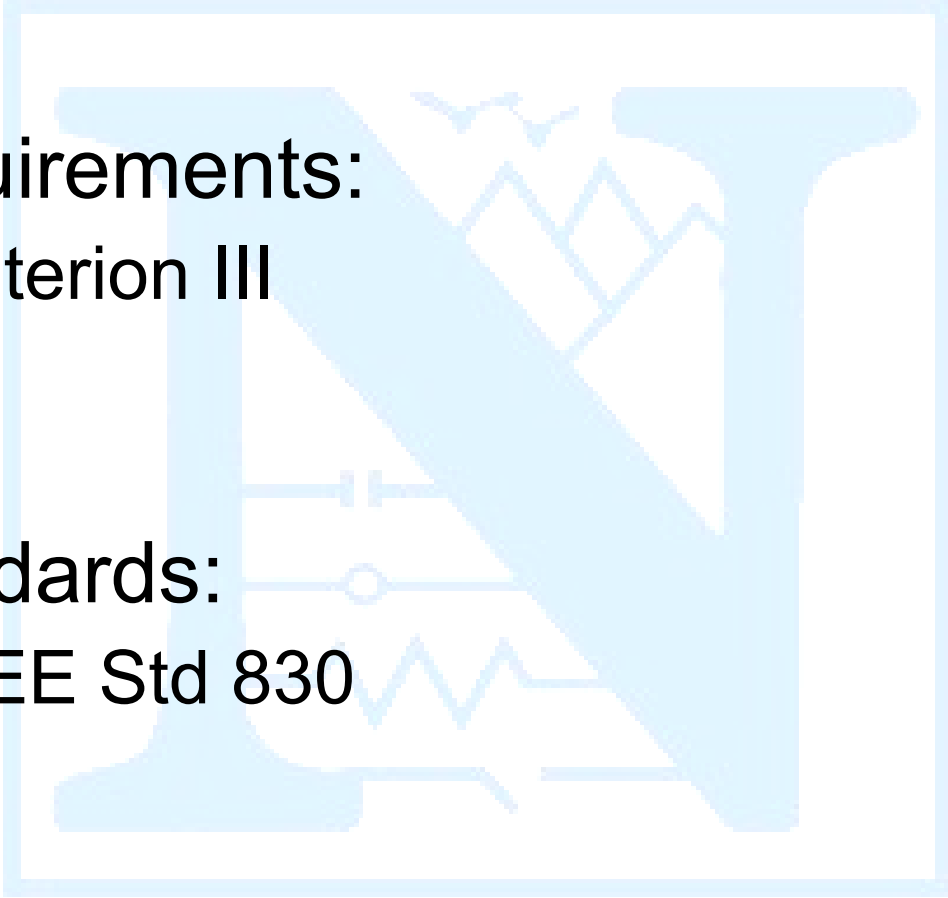
IEEE Std 1008

RG 1.172 Software Requirements



Requirements:
Criterion III

Standards:
IEEE Std 830



RG 1.173 Software Life Cycle

Requirements:
Criteria III, VI

Standards:
IEEE Std 1074

RG 1.180 Evaluating EMI/RFI

Requirements:

GDC 1,2,4,13,21,22,23

Standards:

IEEE Std 603, IEC 61000

RG 1.204 Lightning Protection

Requirements:

GDC 2 Natural Phenomenon

Standards:

NFPA 780, UL 96A,

IEEE Std 665, 666, 1050

ANSI C62.23

RG 1.209 Qualification of Computer Based I&C

Requirements:

GDC 2, 4, 13, 21, 22, 23,
Criterion III, XI, XVII

Standards:

IEEE Std 323

RG 1.210 Qualification of Battery Chargers and Inverters

Requirements:

10 CFR 50.49, GDC 2, 4,
Criterion III

Standards:

IEEE Std 650

RG 1.211 Qualification of Cables and Field Splices

Requirements:

10 CFR 50.49, GDC 2, 4,
Criterion III

Standards:

IEEE Std 383

RG 1.212 Sizing of Large Lead Acid Batteries

Requirements:

10 CFR 50.63(a)(2),
GDC 17, Criterion III

Standards:

IEEE Std 450

RG 1.213 Qualification of Motor Control Centers

Requirements:

10 CFR 50.49, GDC 2,4
Criterion III

Standards:

IEEE Std 649

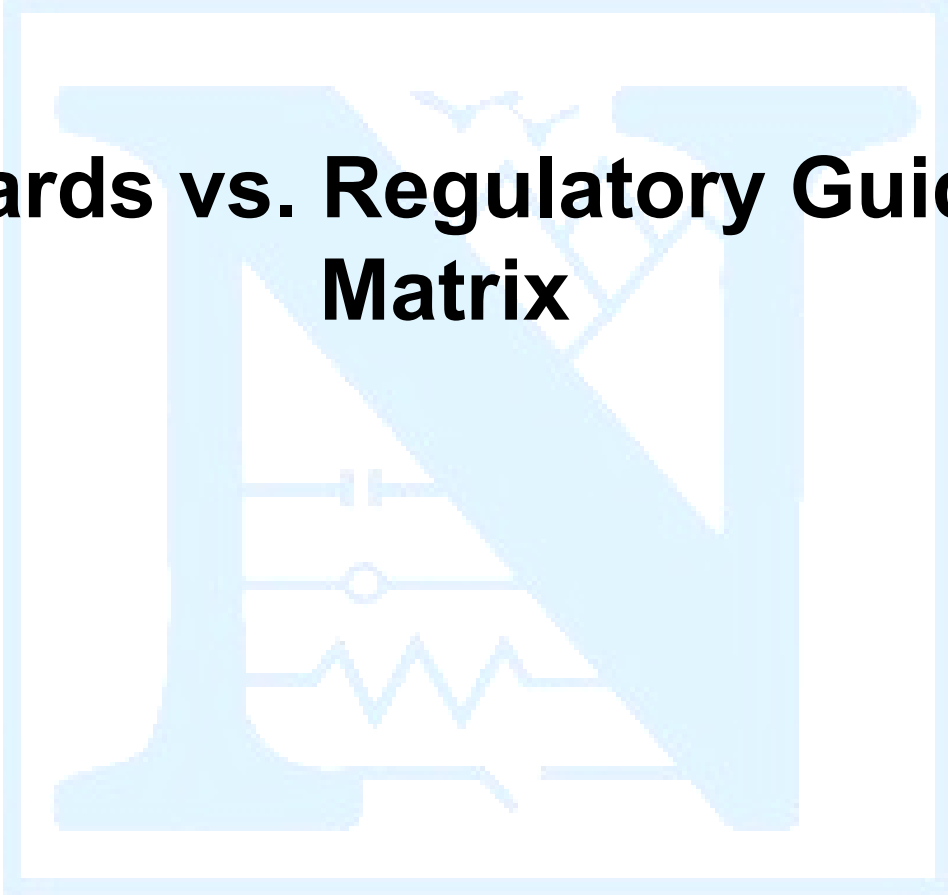
21. Regulatory Guides Objectives Review

- Identified the major I&C and electrical Reg Guides
- Provided a general overview of these Reg Guides
- Discussed how these Reg Guides relate to new reactor inspection

Student Activity



Standards vs. Regulatory Guides Matrix



22. NRC Construction Inspection Procedures



22. NRC Inspection Procedures Objectives

- Identify the major construction inspection procedures
- Provide a general overview of the purpose of these inspection procedures
- Discuss how these inspection procedures relate to new reactor inspection



22. NRC Inspection Procedures

MANUAL CHAPTER 2503

CONSTRUCTION INSPECTION
PROGRAM: INSPECTIONS OF
INSPECTIONS, TESTS,
ANALYSES, AND ACCEPTANCE
CRITERIA (ITAAC)

22. NRC Inspection Procedures

Construction Procedure 65001

Appendix:

65001.08

65001.09

65001.10

65001.11

Inspection Procedures:

Electrical Components &
Systems

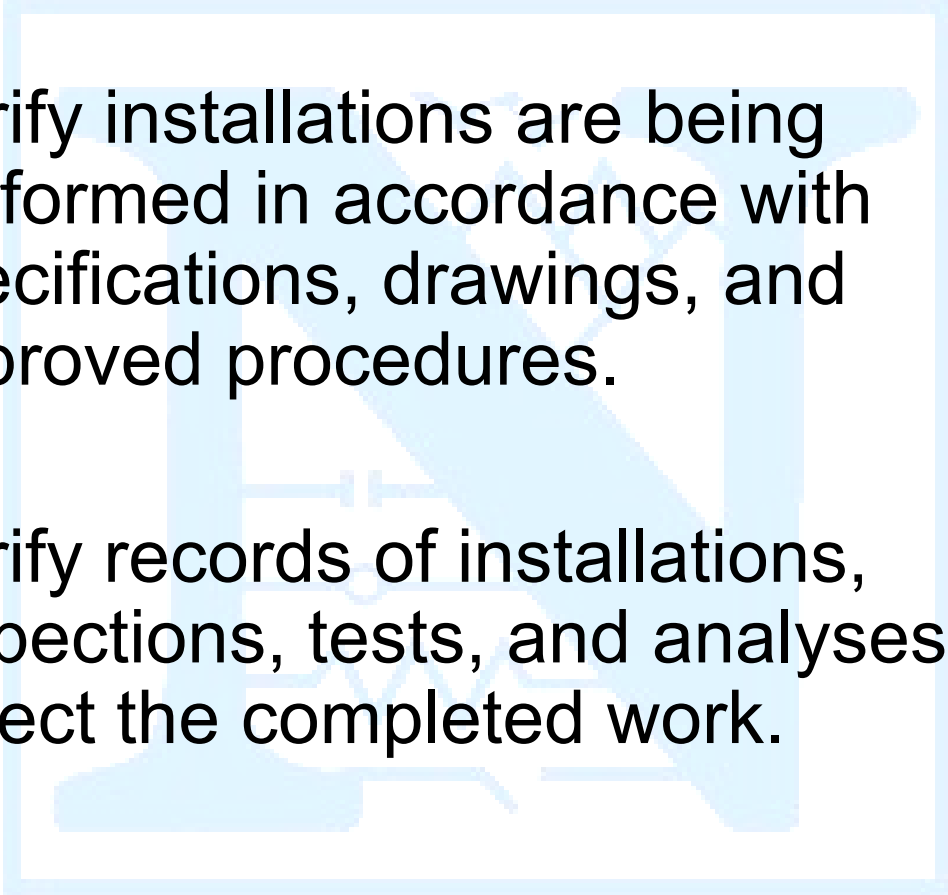
Cables

I&C

Containment Integrity &
Penetrations



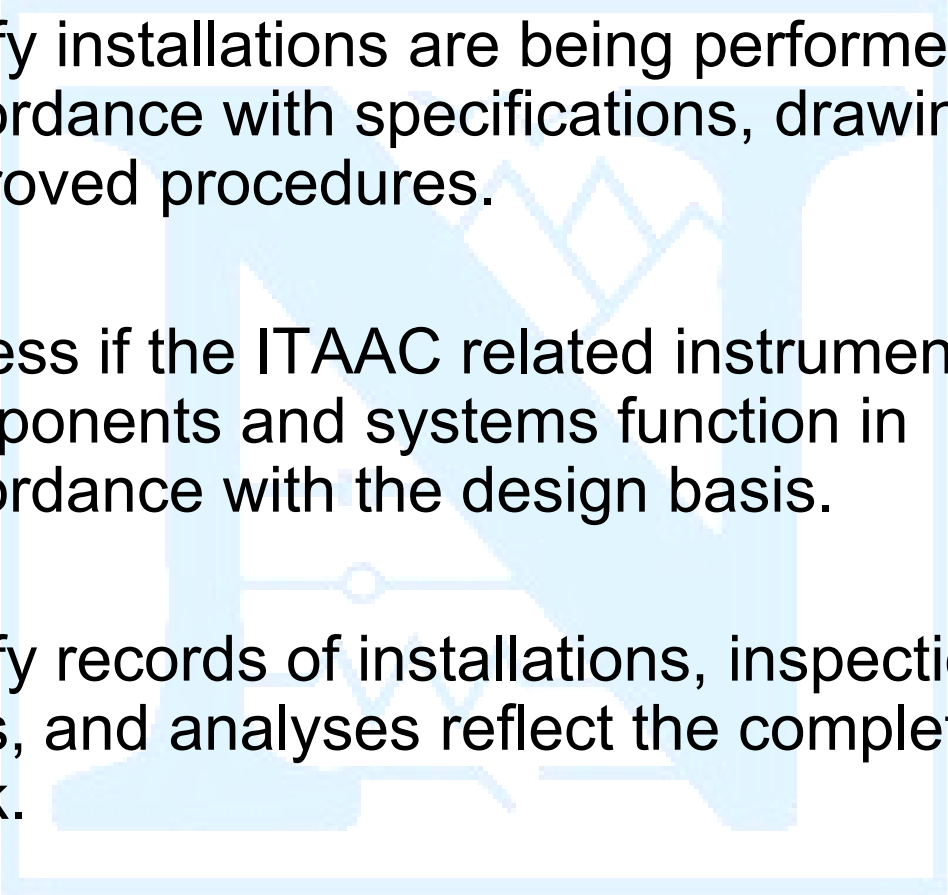
65001.08 Electrical Components and Systems

- 
1. Verify installations are being performed in accordance with specifications, drawings, and approved procedures.
 2. Verify records of installations, inspections, tests, and analyses reflect the completed work.

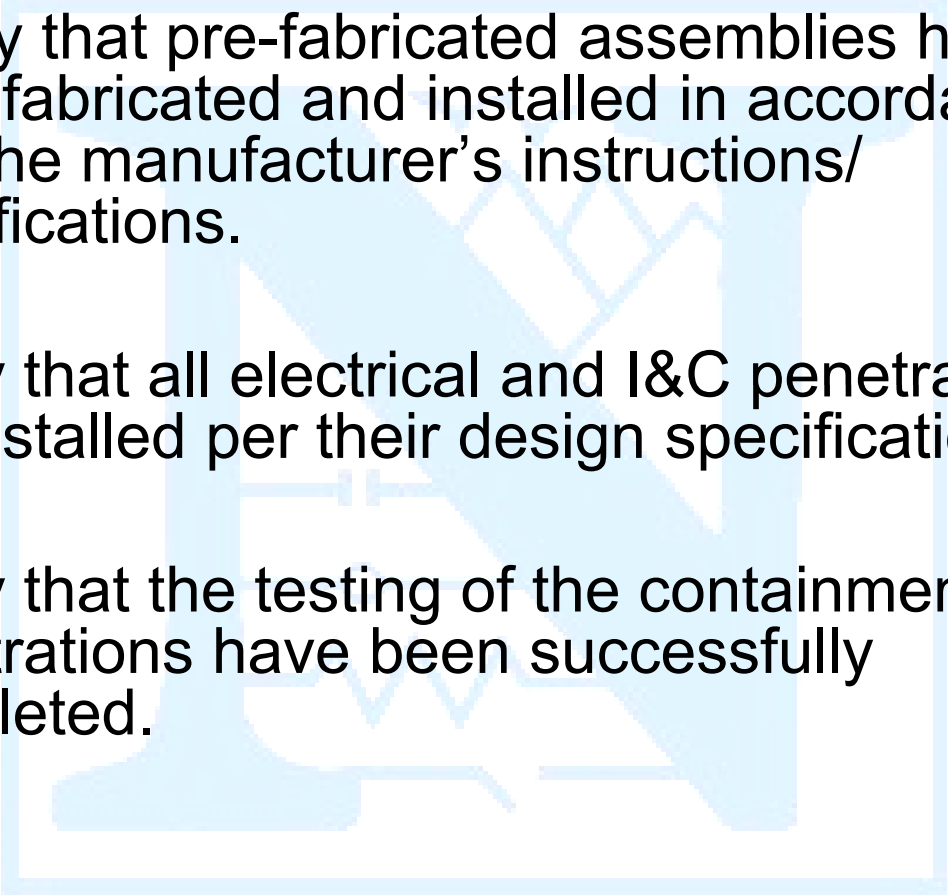
65001.09 Cables

1. Verify installations are being performed in accordance with specifications, drawings, and approved procedures.
2. Verify cables are properly installed in accordance with industry standards and the requirements described in the licensee's electrical installation specifications.
3. Verify records of installations, inspections, tests, and analyses reflect the completed work.

65001.10 I&C

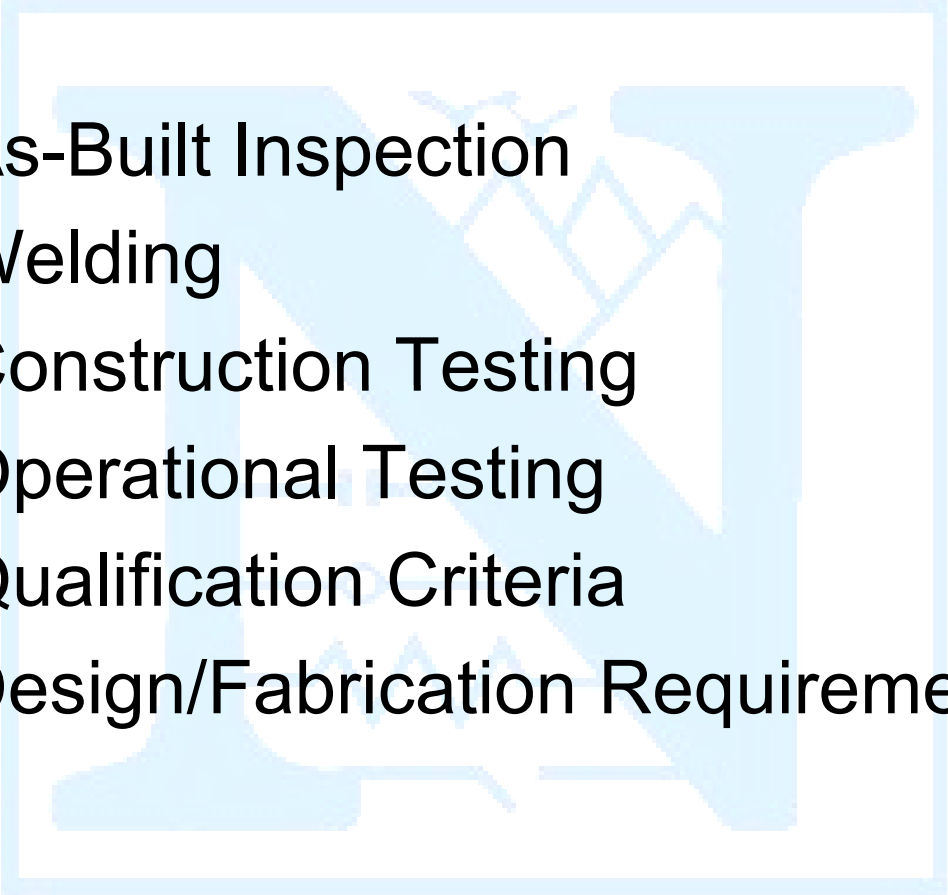
- 
- 
1. Verify installations are being performed in accordance with specifications, drawings, and approved procedures.
 2. Assess if the ITAAC related instrument components and systems function in accordance with the design basis.
 3. Verify records of installations, inspections, tests, and analyses reflect the completed work.

65001.11 Containment Penetrations

- 
- 
7. Verify that pre-fabricated assemblies have been fabricated and installed in accordance with the manufacturer's instructions/specifications.
 8. Verify that all electrical and I&C penetrations are installed per their design specifications.
 10. Verify that the testing of the containment and penetrations have been successfully completed.



ITAAC Matrix Column Classification

- 
- A As-Built Inspection
 - B Welding
 - C Construction Testing
 - D Operational Testing
 - E Qualification Criteria
 - F Design/Fabrication Requirements

22. NRC Inspection Procedures Objectives Review

- Identified the major I&C and electrical construction inspection procedures
- Provided a general overview of the purpose of these inspection procedures
- Discussed how these inspection procedures relate to new reactor inspection