

**PJM Designated Entity Design Standards Task Force
Substation Standards Subgroup**

Outline Requirements

I. Introduction - Technical Requirements & Design Philosophy

II. Transmission System Design Criteria

A. Environmental Lines and Substations

1. Ambient Temperature
2. Wind loading Substations (no ice)
3. Ice load substations (no wind) 25mm radial ice
4. Wind coincident with 13mm radial ice 40mph (64km/h)
5. Seismic Substations
6. Flood Plain

B. Substations General

1. AC Station Service
 - Required Number Independent Sources
 - Quality of Sources
 - Need for Back up Generation
2. DC Supply
 - Required Number of Independent Batteries and Chargers
 - Capacity/Duty Cycle
 - Fusing/Protection
 - Quality/independence of Charger AC Supplies
3. Ground Grid Resistance

C. Substation Electrical

1. Line Terminal and Equipment Continuous Current
2. Short Circuit Current
3. Operating Voltage
4. RIV
5. Lightning Impulse Withstand Voltage (with and without arresters)
6. Switching Impulse Withstand
7. Surge arresters
8. Breaker Line closing Switching Surge Factor
9. System Grounding
10. Lightning trip out Performance (station)
11. Fault performance (circuit failure, including momentary) all other causes

III. Substation Bus Configuration & Substation Design Requirements

A. Introduction

B. Functional Criteria

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- C. Substation Arrangement
 - 1. Accessibility and Layout
 - 2. Grounding and Fence
 - Ground Grid Potential (< 1 ohm)
 - Fence & Gate Grounding Techniques
 - Structure & Equipment Grounding Techniques
 - Transformers
 - Other Equipment
 - Ground Rod Criteria
 - Station Stone
 - 3. Lighting
 - 4. Lightning/Surge/Noise Protection
 - 5. Raceways
 - 6. Security
 - 7. Relay/Control House
 - 8. Auxiliary Facilities
 - Fire Prevention/Protection/Mitigation
 - Station Security
 - Substation Signs
 - Spill Prevention
 - Storm Water Management

IV. Spare Equipment Philosophy

V. Design, Application, Maintenance & Operation Technical Requirements

- A. Overhead Transmission Lines
- B. Power Cables
- C. Large Power Transformers
- D. Circuit Breakers
- E. Load Interrupting Switches (Circuit Switches)
- F. Disconnects & Switches
- G. Shunt Capacitors
- H. Instrument Transformers
- I. AC Station Service
- J. Substation Batteries & Chargers
- K. DC Substation Service
- L. Substation Operation & Maintenance

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Outline Requirements

- M. Carrier Current Line Traps
- N. Insulation Coordination & Surge Protection
- O. Relay and Control Building Requirements
- P. Bus Design
- Q. SVC's
- R. Series Capacitors
- S. Gas Insulated Substations
- T. DC Inverters
- U. HVDC Transmission

VI. Rating Guides

- A. Bare Overhead Transmission Conductor Ratings
- B. Power Transformers
- C. Circuit Breakers
- D. Air Disconnect Switches
- E. Outdoor Substation Conductor Ratings
- F. Current Transformers
- G. Line Traps
- H. Underground and Submarine Transmission Cable Rating Methodology

VII. Installation & Commissioning

VIII. Inspection, Testing & Acceptance

Open questions:

Inclusion of other voltage standard verbiage/ criteria. 69kV, 115kV, 138kV, 161kV, 765kV

List of future requirements which must be considered in the design.