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NPCC, Inc.

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Bulk Power System Protection Criteria

Adopted by the Members of the Northeast Power Coordinating Council Inc., this May 21, 2007, based on recommendation by the Reliability Coordinating Committee, in accordance with Section VIII of the NPCC Inc. Bylaws dated May 18, 2006 as amended to date.

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Note:

Terms in bold typeface are defined in the *NPCC Glossary of Terms* (Document A-7)

1.0 Introduction

This document establishes the **protection** criteria, for **protection** of the NPCC **bulk power system**. It is not a design specification. It is recognized that certain **Areas** or member systems may choose to apply more rigid criteria because of local considerations. Guidance for consideration in the implementation of these criteria is provided in Document B-5.

Compliance with these criteria will be reviewed by TFSP in accordance with NPCC *Procedure for Reporting and Reviewing Proposed Protection Systems for the Bulk Power System* (Document C-22).

1.1 Applicability

1.1.1 New Facilities

These criteria shall apply to all new **Bulk Power System** facilities.

1.1.2 Existing Facilities

It is the responsibility of individual companies to assess the **protection systems** at existing facilities and to make modifications which are required to meet the intent of these criteria as follows:

1.1.2.1 Planned Renewal or Upgrade to Existing Facilities

It is recognized that there may be portions of the **bulk power system,** which existed prior to each member's adoption of the *Bulk Power System Protection Criteria* (Document A-5) that do not meet these criteria. If any **protection systems** or sub-systems of these facilities are replaced as part of a planned renewal or upgrade to the facility and do not meet all of these criteria, then an assessment shall be conducted for those criteria that are not met. The result of this assessment shall be reported on the appropriate C22 forms.

1.1.2.2 Facility Classification Upgraded to **Bulk Power System**

These criteria apply to all existing facilities which become classified as **bulk power system**. A

mitigation plan shall be required to bring such a facility into compliance with these criteria

1.1.2.3 Additions to **Bulk Power System** Facilities

If a **bulk power system element** is added to an existing **bulk power system** facility that is recognized under section 1.1.2.1, Planned Renewal or Upgrade to Existing Facilities, these criteria apply to the **protection systems** for the new **element**.

1.1.2.4 "In-kind" Replacement of **Bulk Power System** Equipment

If a **bulk power system element** (e.g., breaker, transformer, capacitor bank, reactor, etc.) or a **protective relay** is replaced "in-kind" as a result of an unplanned event, then it is not required to upgrade the associated protection system to comply with these criteria.

1.2 Responsibility

Whenever changes are anticipated in generating sources, transmission facilities, or operating conditions, members shall review those **protection system** applications (i.e., settings, ac and dc supplies) which can reasonably be expected to be impacted by those changes.

2.0 General Criteria

Due consideration shall be given to dependability and security. For those **protective relays** intended for removal of **faults** from the **bulk power system**, dependability is paramount, and the redundancy provisions of the criteria shall apply. For **Protective relays** installed for reasons other than **fault** sensing such as overload, etc., security is paramount, and the redundancy provisions of the criteria do not apply. The relative effect on the **bulk power system** of a failure of a **protection system** to operate when desired versus an unintended operation shall be weighed carefully in selecting design parameters as follows:

2.1 Issues Affecting Dependability

2.1.1 Except as identified otherwise in these criteria, all **elements** of the **bulk power system** shall be protected by two **protection**

groups, each of which is independently capable of performing the specified protective function for that **element**. This requirement also applies during energization of the **element**.

2.1.2 Except as identified otherwise in these criteria, the two **protection groups** shall not share the same component.

2.1.3 Means shall be provided to trip all necessary local and remote breakers in the event that a breaker fails to clear a **fault**. This **protection** need not be duplicated.

2.2 Issues Affecting Security

2.2.1 **Protection systems** shall be designed to isolate only the faulted **element**, except in those circumstances where additional **elements** are tripped intentionally to preserve system integrity, or where isolating additional **elements** has no impact outside the local area.

2.3 Issues Affecting Dependability and Security

2.3.1 The thermal capability of all **protection system** components shall be adequate to withstand rated maximum short time and continuous loading of the associated **protected elements**.

2.3.2 Communication link availability, critical switch positions, and trip circuit integrity, shall be monitored to allow prompt attention by appropriate operating authorities.

2.3.3 When remote access to **protection systems** is possible, the design shall include security measures to minimize the probability of unauthorized access to the **protection systems**.

2.3.4 Short Circuit Models used to assess **protection** scheme design and to develop **protection** settings shall take into account minimum and maximum fault levels and mutual effects of parallel transmission lines. Details of neighboring systems shall be modeled wherever they can affect results significantly.

2.4 Operating Time

Bulk power system protection shall take corrective action within times determined by studies with due regard to security, dependability and selectivity.

2.5 This section is intentionally left blank.

2.6 **Protection System** Testing and Maintenance

2.6.1 **Protection systems** shall be maintained in accordance with the *Maintenance Criteria for Bulk Power System Protection* (Document A-4).

2.6.2 The design of **protection systems** both in terms of circuitry and physical arrangement shall facilitate periodic testing and maintenance.

2.6.3 Each **protection group** shall be functionally tested to verify the dependability and security aspects of the design, when initially placed in service and when modifications are made.

2.7 Analysis of **Protection** Performance

2.7.1 **Bulk power system** automatic operations shall be analyzed to determine proper **protection system** performance. Corrective measures shall be taken promptly if a **protection group** fails to operate or operates incorrectly.

2.7.2 Event and fault recording capability shall be provided to permit analysis of system disturbances and **protection system** performance.

2.7.3 Internal clocks in event and **fault** recording equipment shall be time synchronized to within 2 milliseconds or less of Universal Coordinated Time scale. The time zone shall be clearly identified as either universal time zone or local time zone.

2.7.4 Each **protective relay** which trips **Bulk Power System** equipment shall provide separate target indication.

3.0 Equipment and Design Considerations

3.1 Current Transformers

Current transformers (CTs) associated with **protection systems** shall have adequate steady-state and transient characteristics for their intended function as follows:

3.1.1 The output of each current transformer secondary winding shall be designed to remain within acceptable limits for the connected burdens under all anticipated **fault** currents to ensure correct operation of the **protection system**.

3.1.2 The thermal and mechanical capabilities of the CT at the operating tap shall be adequate to prevent damage under maximum **fault** conditions and normal or **emergency** system loading conditions.

3.1.3 For **protection groups** to be independent, they shall be supplied from separate current transformer secondary windings.

3.1.4 Interconnected current transformer secondary wiring shall be grounded at only one point.

3.1.5 Current transformers shall be connected so that adjacent **protection** zones overlap.

3.2 Voltage Transformers and Potential Devices

Voltage transformers and potential devices associated with **protection systems** shall have adequate steady-state and transient characteristics for their intended functions as follows:

3.2.1 Voltage transformers and potential devices shall have adequate volt-ampere capacity to supply the connected burden while maintaining their **relay** accuracy over their specified primary voltage range.

3.2.2 The two **protection groups** protecting an **element** shall be supplied from separate voltage sources. The two **protection groups** may be supplied from separate secondary windings on one transformer or potential device, provided all of the following requirements are met:

- Complete loss of one or more phase voltages does not prevent all tripping of the protected **element**;
- Each secondary winding has sufficient capacity to permit fuse **protection** of the circuit;
- Each secondary winding circuit is adequately fuse protected.

3.2.3 The wiring from each voltage transformer secondary winding shall not be grounded at more than one point.

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3.4 This section is intentionally left blank.

3.5 Batteries and Direct Current (dc) Supply

DC supplies associated with **protection** shall be designed to have a high degree of dependability as follows:

3.5.1 No single battery or dc power supply failure shall prevent both independent **protection groups** from performing the intended function. Each battery shall be provided with its own charger.

3.5.2 Each station battery shall have sufficient capacity to permit operation of the station, in the event of a loss of its battery charger or the ac supply source, for the period of time necessary to transfer the **load** to the other station battery or re-establish the supply source. Each station battery and its associated charger shall have sufficient capacity to supply the total dc **load** of the station.

3.5.3 A transfer arrangement shall be provided to permit connecting the total **load** to either station battery without creating areas where, prior to failure of either a station battery or a charger, a single event can disable both dc supplies.

3.5.4 The battery chargers and all dc circuits shall be protected against short circuits. All protective devices shall be coordinated to minimize the number of dc circuits interrupted.

3.5.5 Dc systems shall be continuously monitored to detect abnormal voltage levels (both high and low), dc grounds, and loss of ac to the battery chargers, in order to allow prompt attention by the appropriate operating authorities.

3.5.6 **Protection groups** dc sources shall be continuously monitored to detect loss of voltage in order to allow prompt attention by the appropriate operating authorities.

3.6 Station Service ac Supply

On **bulk power system** facilities, there shall be two sources of station service ac supply, each capable of carrying at least all the critical **loads** associated with **protection systems**.

3.7 Circuit Breakers

No single trip coil failure shall prevent both independent **protection groups** from performing the intended function. The design of a breaker with two trip coils shall be such that the breaker will operate if both trip coils are energized simultaneously. The correct operation of this design shall be verified by tests.

3.8 **Teleprotection**

Communication facilities required for **teleprotection** shall be designed to have a level of performance consistent with that required of the **protection system,** and shall meet the following:

3.8.1 Where each of the two **protection groups** protecting the same **bulk power system element** requires a communication channel, the equipment and channel for each group shall be separated physically and designed to minimize the risk of both **protection groups** being disabled simultaneously by a single event or condition.

3.8.2 **Teleprotection** equipment shall be monitored to detect loss of equipment and/or channel to allow prompt attention by the appropriate operating authorities.

3.8.3 **Teleprotection** systems shall be provided with means to test for proper signal adequacy.

3.8.4 **Teleprotection** equipment shall be powered by the substation batteries or other sources independent from the power system.

3.8.5 Except as identified otherwise in these criteria, the two **teleprotection** groups shall not share the same component.

3.8.5.1 The use of a single communication tower for the radio communication systems used by the two groups protecting a single **element**, is permitted.

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3.10 Environment

3.10.1 Each separate **protection group** and **Teleprotection** protecting the same system **element** shall be on different non-adjacent vertical mounting assemblies or enclosures.

3.10.2 In the event a common raceway is used, cabling for separate groups protecting the same system **element** shall be separated by a fire barrier.

3.11 Grounding

Station grounding is critical to the correct operation of **protection systems**. The design of the ground grid directly impacts proper **protection system** operation and the probability of false operation from **fault** currents or transient voltages.

3.11.1 Each member shall have established as part of its substation design procedures or specifications, a mandatory method of designing the substation ground grid, which:

- Can be traced to a recognized calculation methodology
- Considers cable shielding
- Considers equipment grounding

4.0 Specific Application Considerations

4.1 Transmission Line **Protection**

4.1.1 **Protection system** settings shall not constitute a loading limitation as per NERC requirement/standard. In cases where NERC approved exceptions are used the limits thus imposed shall be adhered to as system operating constraints.

4.1.2 A **pilot protection** shall be so designed that its failure or misoperation will not affect the operation of any other **pilot protection** on that same **element**.

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4.3 Breaker Failure **Protection**

Means shall be provided to trip all necessary local and remote breakers in the event that a breaker fails to clear a **fault** as follows:

4.3.1 Breaker failure **protection** shall be initiated by each of the **protection groups** which trip the breaker, with the optional exception of a breaker failure **protection** in an adjacent zone.

4.3.2 Fault current detectors shall be used to determine if a breaker has failed to interrupt a fault.

4.4 Generating Station **Protection**

All under- and over-frequency **protection systems** designed to disconnect generators from the power system shall be coordinated with automatic underfrequency **load shedding** programs, in accordance with the *Emergency Operation Criteria* (Document A-3).

4.5 Automatic Underfrequency **Load Shedding Protection Systems**

The criteria for the operation of these **Protection Systems** are detailed in the *Emergency Operation Criteria* (Document A-3) and the *Automatic Underfrequency Load Shedding Program Relaying Guide* (Document B-7).

4.6 HVdc Systems **Protection**

4.6.1 The ac portion of an HVdc converter station, up to the valve-side terminals of the converter transformers, shall be protected in accordance with these criteria.

4.6.2 Multiple commutation failures, unordered power reversals, and **faults** in the converter bridges and the dc portion of the HVdc link which are severe enough to disturb the **bulk power system** shall be detected by more than one independent control or **protection group** and appropriate corrective action shall be taken, in accordance with the considerations in these criteria.

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4.8 This section is intentionally left blank.

5.0 Reporting of Protection Systems

5.1 Each member shall provide the Task Force on System Protection (TFSP) with advance notification of any of the member's new **bulk power system protection** facilities, or significant changes in the member's existing **bulk power system protection** facilities.

5.2 Each member shall also provide the TFSP with advance notification of non-member **protection** facilities as required per NPCC Inc. Bylaws Section IX A (2) (c).

5.3 Each new or revised **protection system** shall be reported to the TFSP in accordance with the *Procedure for Reporting and Reviewing Proposed Protection Systems for the Bulk Power System* (Document C-22).

Prepared by:	Task Force on System Protection
Review frequency:	3 years
References:	*Bulk Power System Protection Guide (Document B-5)*
	Basic Criteria for the Design and Operation of the Interconnected Power Systems (Document A-2)
	Emergency Operation Criteria (Document A-3)
	Maintenance Criteria for Bulk Power System Protection (Document A-4)
	NPCC Glossary of Terms (Document A-7)
	Special Protection Systems Criteria (Document A-11)
	Automatic Underfrequency Load Shedding Program Relaying Guide (Document B-7)
	Procedure for Reporting and Reviewing Proposed Protection Systems for the Bulk Power System (Document C-22)
	Security Guidelines for Protection Systems IEDs (Document B-24)

For Information:	NPCC Working Group Report entitled, "Telecommunications for Bulk Power System Protection" dated March 1992