

1. Purpose/Scope

This document specifies the processes used to collect, report and analyze information by the Relay Subcommittee.

2. Definitions

2.1 Protection System

Includes an assembly of interconnected devices designed to detect and initiate action to isolate a fault on a system facility. Schemes designed to automatically restore tripped facilities are also classified as protection systems.

Several redundant assemblies may be applied for the above functions on an individual facility—in such cases, each assembly is considered as a separate protection system.

A protection system consists of items such as relays, current transformers, potential transformers, communication interface equipment, communication links, breaker trip and close coils, switchgear auxiliary switches, and all associated connections.

2.2 Misoperation

An incorrect or improper operation of a protection system shall be known as a misoperation. Misoperations involve events in which a protective system operated unnecessarily, failed to operate, or operated outside of desired timing tolerances.

Misoperations of protective systems associated with all system facilities (networked or radial) operated at 200 kV and above, excluding capacitor banks, are required to be reported. Also, non-fault misoperations which occur during commissioning of new, or modified, protection systems not previously placed into service do not need to be reported.

Human error that is associated with facilities which are part of the protection system, and directly causes the protection system to operate unnecessarily, are classified as misoperations.

Human error that causes problems to facilities which are not part of the protection system, but indirectly causes the protection system to operate as expected, are not classified as misoperations.

For example:

Misoperations

- Protective system design error
- Protective system wiring error
- Incorrect setting on a protective system device
- Failure of a protective system device to function as designed including communication facilities
- Configuration of protective system left in improper state after changes made for testing (after testing is completed)
- A misoperation of the primary or backup system even though fault was properly cleared
- A failure of automatic reclosing controls to properly initiate closing of a breaker, even if the correct reclosing of an adjacent breaker restored the line terminal
- Relay bumped by personnel at the station
- Personnel error while testing, maintaining, or communicating with the protection system
- Rapid Pressure Rise, Fault Pressure, or Sudden Pressure Relay misoperations

Non-Misoperation

- Misoperation of scheme on lower voltage system causes 230 kV facility to trip
- Water leaked on system due to defective roof
- Operation due to mechanical problem such as low gas pressure, loss of cooling, etc., regardless of the cause of the mechanical problem
- Improper operation of system control facilities such as control switches, SCADA, capacitor controls, SVC controls, etc

2.3 Special Protection System Operations

The correct, incorrect, or inadvertent operation of a Special Protection System requires analysis and reporting as if a misoperation/Multiple Facility Trip. Special Protection System operations, which do not affect PJM Bulk Power Facilities 200 kV and higher (i.e., old MAAC Type III) are not required to be reported.

2.4 Underfrequency / Undervoltage Load Shedding Operations

- The correct, incorrect, or inadvertent operation of an underfrequency load shedding relay during a system underfrequency event requires analysis and reporting as if a misoperation/Multiple Facility Trip
- The correct, incorrect, or inadvertent operation of an undervoltage load shedding relay connected at 100 kV or higher during an undervoltage event requires analysis and reporting as if a misoperation/ Multiple Facility Trip
- A report will not be required for activation due to total loss of supply to a station

2.5 Multiple Facility Trip (MFT)

A reportable multiple facility trip (MFT) is defined as an operation that removes more than one bulk power facility from service for one fault or personnel error. A facility consists of all equipment designed to be deenergized to provide isolation of a single fault. Reportable bulk power facilities consist of generators and associated GSU's interconnected at 200 kV or above, transformers with both high and low side windings 200 kV or above, and 200 kV and above transmission lines and capacitor banks.

Multiple Facility Trip examples:

- A transmission line fault, which results in the loss of a second transmission line due to a relay misoperation, is a Multiple Facility Trip
- A fault that simultaneously involves and trips two or more transmission lines is a Multiple Facility Trip
- A simultaneous outage of multiple facilities caused by more than one fault at different locations is not considered as a Multiple Facility Trip
- A transformer fault, which also trips a transmission line, is a Multiple Facility Trip (provided both the transformer and transmission line are 'reportable facilities')
- The tripout of a line and a transformer when the transformer is directly connected to the line is not a Multiple Facility Trip, although two pieces of equipment are lost, this is not a Multiple Facility Trip since the system operators should anticipate this loss
- A transmission line fault, which also tripped equipment on the subtransmission or distribution system, would not be a Multiple Facility Trip
- A fault on the subtransmission or distribution system, which also tripped a bulk power facility, would not be a Multiple Facility Trip
- A breaker failure operation, or a circuit breaker fault, will typically trip more than one bulk power facility, and, when this is the case, are always considered to be a Multiple Facility Trip,

however, if one of the facilities is a bus that does not further affect network topology, a report is not required

- A bus fault that causes the loss of more than one bulk power system facility, excluding the bus itself, is a Multiple Facility Trip, all other bus faults are not Multiple Facility Trips

3. Responsibilities

3.1 Company Representative

- Submit timely accurate and complete reports in accordance with this document
- Review reports from other companies for implications on entire system

3.2 Misoperation Report Coordinator

- Collect Misoperation/Multiple Facility Trip reports
- Distribute Misoperation/Multiple Facility Trips
 - Issue periodic reports with a tabular summary of the Misoperations/Multiple Facility Trips, issue a report analyzing the previous year's Multiple Facility Trips including input from the Relay Testing Subcommittee

4. Procedure

4.1 Coordinators

The chairman shall assign a Misoperations reporting coordinator.

4.2 Event Reporting

- Each company representative shall assure that all events are identified and analyzed
- Reports shall be submitted in a timely manner for 200 kV and above Misoperations and Multiple Facility Trips
- Misoperations shall be reported using the spreadsheet shown in Appendix A. This spreadsheet is based upon the RFC Misoperation reporting spreadsheet with additional columns added to facilitate PJM reporting requirements, this spreadsheet shall be posted on the PJM Sharepoint website
- Company representatives are also encouraged to submit misoperation reports similar to Appendix B, including a diagram when appropriate. This report format provides a greater level of detail that will facilitate discussion among the committee members. A copy of the report should be distributed electronically to all Relay Subcommittee and Relay Testing Subcommittee members. The subcommittees shall review the report and provide comments. The reporting member should incorporate the comments and forward the revised report to all Relay Subcommittee members and post the final report on the PJM Sharepoint website.

4.3 Summary Reporting

The Misoperation Report coordinator shall provide an annual analysis including input from the Relay Testing Subcommittee of the previous year's misoperation and Multiple Facility Trip reports for the chairman to distribute in accordance with Appendix C. The Summary Report for the previous year's misoperations and Multiple Facility Trips will be distributed in September. The report includes statistical comparisons and comments relating to trends or other items of interest.

4.4 Attachments

Appendix



- A - Misoperation Spreadsheet
- B - Detailed Misoperation Report
- C - Distribution

5. Other Relay Subcommittee Reporting Responsibilities

5.1 Review and report on 500 kV and 765 kV additions and changes, New Type I and II Special Protection Systems

Ensure that the associated protective relaying is compatible with current PJM Protection Standards, developed by the PJM Relay Subcommittee. Results of the review, including any non-conforming designs, should be noted in the Relay Subcommittee meeting minutes.

Lower voltage bulk facilities only require review if there is a question to compliance with the standards at the discretion of the associated Relay Subcommittee Member.

APPENDIX B

PJM RELAY SUBCOMMITTEE BULK POWER PROTECTION SYSTEM MISOPERATION REPORT

Date: December 19th, 1999

Time: 0357 hours

Location: Fairfield, Hurstville 2343 Circuit (230kV)

Weather: NA

Equipment Tripped and Relay Operations:

At Fairfield: 2343 bus OCB
#1 Generator inadvertent energizing protection
#1 Generator/2343 tie OCB stuck breaker timer

At Hurstville: 2343 bus and tie breakers
2343 circuit received transfer trip target from Fairfield

System Conditions:

Fairfield Unit #1 was paralleled and being trip-tested from the Plant.

Report:

A normal unit shutdown was initiated in the Plant, and the generator began its sequential tripping sequence, for which following closure of the steam valves, the unit began to motor. The primary reverse-power relay then initiated tripping of the two associated 230kV OCBs and the generator field breaker. The OCBs are of the independent pole type. The #1 Generator bus OCB opened properly, but the A-phase pole of the #1 Generator/2343 tie OCB failed to open due to a defective A-phase primary trip coil. Note: the primary reverse power relay is supervised by valve position switches and only operates the primary set of trip coils. Breaker failure is not intentionally initiated for this condition. The backup reverse power relay is unsupervised, but is set with a substantially greater time delay and had no chance to operate for this event.

With the generator field collapsing, but with the generator still synchronized through one pole, the unit began to draw vars from the system. The resulting current allowed the generator inadvertent energizing protection to operate (field breaker open with current flow in the step-up transformer). This protection initiates breaker failure. The breaker failure re-trip feature attempted to energize the backup set of trip coils, but was inoperative in this case because the three coils and associated 52a switches are connected in series, and two poles of the stuck OCB had opened properly, well beforehand. Breaker failure therefore resulted, tripping the opposite 2343 bus OCB and sending direct transfer trip to Hurstville.



Note: The reasonably prompt isolation of the generator and the defective breaker was a fortunate but unintended result of the design of the generator inadvertent energizing protection scheme.

Equipment returned to service:

The breaker was repaired and returned to service on 12-21-99.

Auto Reclosing:

Auto-reclosing of all associated breakers is defeated by design for the conditions that caused them to open.

Planned Corrective Action:

(1) Install “cross-tripping” circuitry that will (nearly) simultaneously energize both the primary and backup trip paths of all breakers with series trip coils and 52a contacts. Cross-tripping in this case would have prevented the stuck breaker operation and the consequent tripping of 2343 circuit.

(2) Implement a change in design requiring that not only manual but also automatic generator field breaker tripping via reverse power relay be supervised by an “OPEN” indication from all three poles of both synchronizing breakers (“AND” logic).

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Reporting Company: BSP&L
Date: 12-23-99
Revision No: 1



APPENDIX C

Distribution

Summaries and Analysis Reports should be issued to the following distribution:

- PJM Planning Committee Chairman
- PJM Planning Committee Secretary
- PJM Relay Subcommittee Members
- PJM Relay Subcommittee Staff Representative
- PJM Relay Testing Subcommittee Members
- Chairman of System Operations Subcommittee
- Chairman of Transmission and Substation Subcommittee
- Manager of PJM Operations Planning Department