TPL-001-5.1 P5 Contingencies and Auditor Expectations

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Objective

- Background (FERC Orders No. 754 & 786)
- TPL-001-5.1 Footnote 13
- Differences between P4 and P5 Contingency
- Auditor’s Expectations
- Important Dates
- References

Background

NERC Advisory (March 30, 2009)

- A Single Point of Failure (SPF) issue caused three significant system disturbances in 5 years.
  - Westwing Outage — June 14, 2004 (Category 3 outage)
  - Broad River Disturbance — Aug. 25, 2007 (Category 2 outage)
  - PacifiCorp East Disturbance — Feb. 14, 2008 (Category 3 outage)

FERC Order No. 754

- FERC identified an issue concerning the study of the non-operation of non-redundant primary protection systems (i.e. SPF)
- "Direct Commission staff to meet with NERC and subject matter experts to explore this reliability concern, including where it can best be addressed…"

FERC Order No. 786

- FERC directed NERC to modify TPL-001-4 to address the concern that the six-month threshold could exclude planned maintenance outages of significant facilities from future planning assessments.

Order 786 Resulting Changes in TPL-001-5

Known outages selection moved from R1 to R2

- Stresses the assessment of known outages, rather than just the identification in System models in R1

Eliminated the specified six-month outage duration

- PCs and TPs must have either a documented outage coordination procedure, or technical rationale to select which known outages shall be assessed
- Limitation of known outages to be assessed cannot be based solely on outage duration alone
- Goal is to assess those outages that are expected to cause more severe System impacts

Similar language to steady-state analysis under Part 2.1.5 added to Part 2.4.5 for stability analysis

- Stability analysis performed for the outage of long lead time Elements

Order 754 Resulting Changes in TPL-001-5

Modified Category P5 event to include SPF

Modified “Table 1 - Steady State and Stability Performance Extreme Events”

Updates to Footnote 13 – describes the non-redundant Protection System components to consider for P5 contingencies.

P5 Event Modification

Category	Initial Condition	Event [1]	Fault Type [2]	BES Level [3]	Interruption of Firm Transmission Service Allowed [4]	Non-Consequential Load Loss Allowed
P5 Multiple Contingency *(Fault plus ~~relay~~non-redundant component of a Protection System failure to operate)*	Normal System	Delayed Fault Clearing due to the failure of a non-redundant ~~relay[13]~~component of a Protection System[13] protecting the Faulted element to operate as designed, for one of the following: 1. Generator 2. Transmission Circuit 3. Transformer[5] 4. Shunt Device[6] 5. Bus Section	SLG	EHV	No[9]	No
				HV	Yes	Yes

Revision to Table 1 – Steady State and Stability Performance Extreme Events

Steady State	Stability
1. Loss of a single generator, Transmission Circuit, single pole of a DC Line, shunt device, or transformer forced out of service followed by another single generator, Transmission Circuit, single pole of a different DC Line, shunt device, or transformer forced out of service prior to System adjustments. 2. Local area events affecting the Transmission System such as: a. Loss of a tower line with three or more circuits.[11] b. Loss of all Transmission lines on a common Right-of-Way[11]. c. Loss of a switching station or substation (loss of one voltage level plus transformers). d. Loss of all generating units at a generating station. e. Loss of a large Load or major Load center. 3. Wide area events affecting the Transmission System based on System topology such as: a. Loss of two generating stations resulting from conditions such as: i. Loss of a large gas pipeline into a region or multiple regions that have significant gas-fired generation.	1. With an initial condition of a single generator, Transmission circuit, single pole of a DC line, shunt device, or transformer forced out of service, apply a 3Ø fault on another single generator, Transmission circuit, single pole of a different DC line, shunt device, or transformer prior to System adjustments. 2. Local or wide area events affecting the Transmission System such as: a. 3Ø fault on generator with stuck breaker[10] ~~or a relay failure[13]~~ resulting in Delayed Fault Clearing. b. 3Ø fault on Transmission circuit with stuck breaker[10] ~~or a relay failure[13]~~ resulting in Delayed Fault Clearing. c. 3Ø fault on transformer with stuck breaker[10] ~~or a relay failure[13]~~ resulting in Delayed Fault Clearing. d. 3Ø fault on bus section with stuck breaker[10] ~~or a relay failure[13]~~ resulting in Delayed Fault Clearing. e. 3Ø fault on generator with failure of a non-redundant component of a Protection System[13] resulting in Delayed Fault Clearing. f. 3Ø fault on Transmission circuit with failure of a non-redundant component of a Protection System[13] resulting in Delayed Fault Clearing.

Revision to Table 1 – Steady State and Stability Performance Extreme Events (cont.)

ii. Loss of the use of a large body of water as the cooling source for generation. iii. Wildfires. iv. Severe weather, e.g., hurricanes, tornadoes, etc. v. A successful cyber attack. vi. Shutdown of a nuclear power plant(s) and related facilities for a day or more for common causes such as problems with similarly designed plants. b. Other events based upon operating experience that may result in wide area disturbances.	g. 3Ø fault on transformer with failure of a non-redundant component of a Protection System[13] resulting in Delayed Fault Clearing. h. 3Ø fault on bus section with failure of a non-redundant component of a Protection System[13] resulting in Delayed Fault Clearing. ~~e.~~i. 3Ø internal breaker fault. ~~f.~~i. Other events based upon operating experience, such as consideration of initiating events that experience suggests may result in wide area disturbances

TPL-001-5.1 Footnote 13

- For purposes of this standard, non-redundant components of a Protection System to consider are as follows:
  - a. A single protective relay which responds to electrical quantities, without an alternative (which may or may not respond to electrical quantities) that provides comparable Normal Clearing times;
  - b. A single communications system associated with protective functions, necessary for correct operation of a communication-aided protection scheme required for Normal Clearing (an exception is a single communications system that is both monitored and reported at a Control Center);
  - c. A single station dc supply associated with protective functions required for Normal Clearing (an exception is a single station dc supply that is both monitored and reported at a Control Center for both low voltage and open circuit);
  - d. A single control circuitry (including auxiliary relays and lockout relays) associated with protective functions, from the dc supply through and including the trip coil(s) of the circuit breakers or other interrupting devices, required for Normal Clearing (the trip coil may be excluded if it is both monitored and reported at a Control Center)

TPL-001-5.1 — Transmission System Planning Performance Requirements

Category	Initial Condition	Event [1]	Fault Type [2]
P5 Multiple Contingency *(Fault plus non-redundant component of a Protection System failure to operate)*	Normal System	Delayed Fault Clearing due to the failure of a non-redundant component of a Protection System[13] protecting the Faulted element to operate as designed, for one of the following: 1. Generator 2. Transmission Circuit 3. Transformer[5] 4. Shunt Device[6] 5. Bus Section	SLG

TPL-001-4 Footnote 13: Applies to the following relay functions or types: pilot (#85), distance (#21), differential (#87), current (#50, 51, and 67), voltage (#27 & 59), directional (#32, & 67), and tripping (#86, & 94)

TPL-001-5.1 Footnote 13 (Cont'd)

Does Footnote 13 prescribe redundancy?

Why is monitored and reported to a Control Center used in parts of Footnote 13?

Why are relays that respond to electrical quantities addressed?

What is comparable and what is not comparable for purposes of Footnote 13?

Are separate Normal Clearing times comparable?

Why are communication-aided Protection Systems addressed?

Why are DC supplies addressed?

What differentiates a single station DC supply (Footnote 13c) from a single control circuitry (Footnote 13d)?

Is a battery charging system appropriate redundancy for the battery?

Why is control circuitry addressed?

Does Footnote 13 prescribe redundancy?

Does not prescribe any level of redundancy

Gives those non-redundant components of a Protection System that consideration for simulation of the Table 1 Planning Event P5 and Table 1 Extreme Events Stability column 2e-2h

If, after proper consideration and simulation, required System performance is achieved, then there may be no need to make non-redundant components of a Protection System redundant

If, after proper consideration and simulation it is demonstrated that required System performance is not achieved, making non-redundant components of a Protection System redundant may be but one of many alternatives for corrective actions to obtain required System performance.

Why is monitored and reported to a Control Center used in parts of Footnote 13?

- Components that may be SPF but are monitored and reported to a Control Center exhibited lower risk on par with being redundant, and therefore do not warrant P5 Event simulation.

Why are relays that respond to electrical quantities addressed?

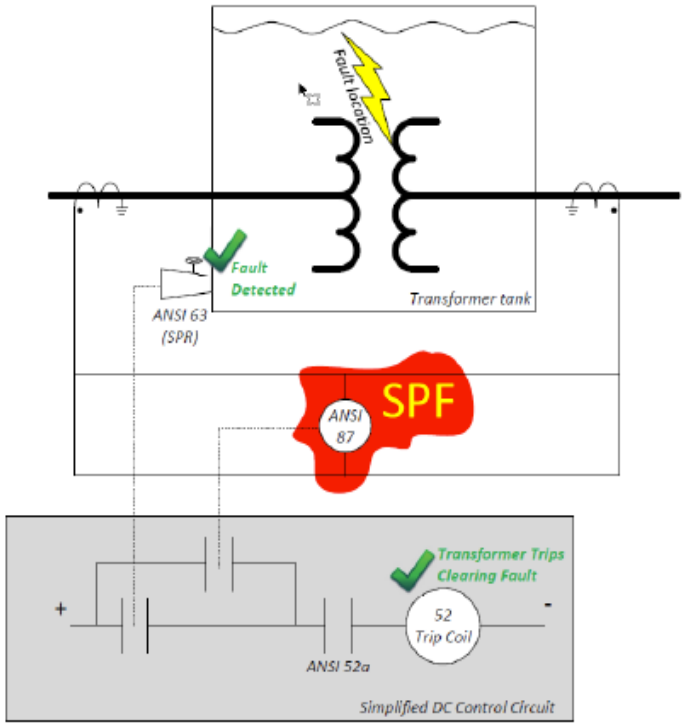


Figure 1: Internal Transformer Tank Fault with Sudden Pressure Protection and failed Transformer Differential Relay

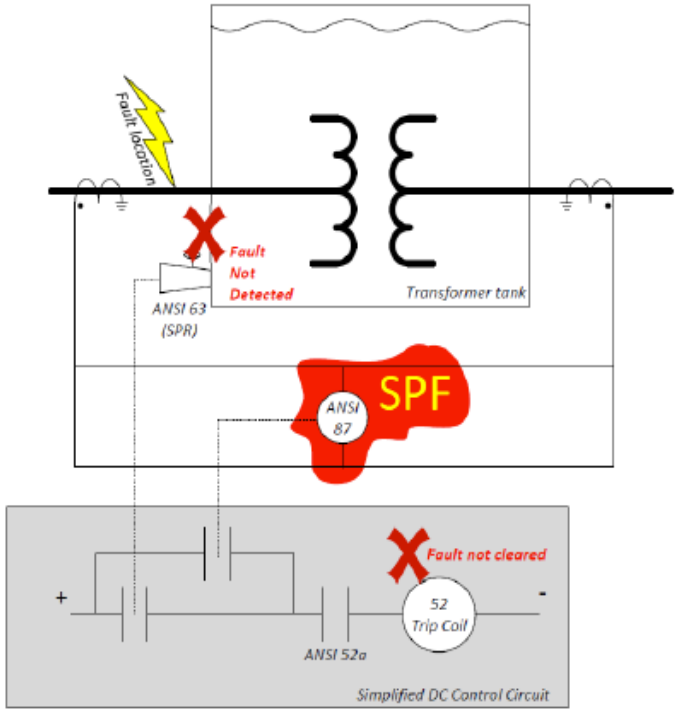


Figure 2: External Transformer Tank Fault with Sudden Pressure Protection and failed Transformer Differential Relay

What is comparable and what is not comparable for purposes of Footnote 13?

Applies only to alternatives for a single protective relay that responds to electrical quantities

Comparable alternative to a single protective relay that responds to electrical quantities must result in fault clearing within the expected Normal Clearing time period and isolate the fault by tripping similar System Elements

Are separate Normal Clearing times comparable?

Implicit in the principle of comparable Normal Clearing times

- In some cases, multiple layers of protection may overlap towards achieving a common System protective objective: to provide Normal Clearing.

It depends…

Why are communication-aided Protection Systems addressed?

Communication-aided Protection Systems

- Pilot protection schemes,
- Direct transfer tripping (DTT) schemes,
- Permissive transfer tripping schemes,
- Line differential relaying schemes
- Etc.,

Proper operation of the communication system must be considered when considering potential SPF components of Protection Systems

Communication-aided Protection System that may experience a SPF, causing it to operate improperly or not at all, must be considered as part of non-redundancy

Why are DC supplies addressed?

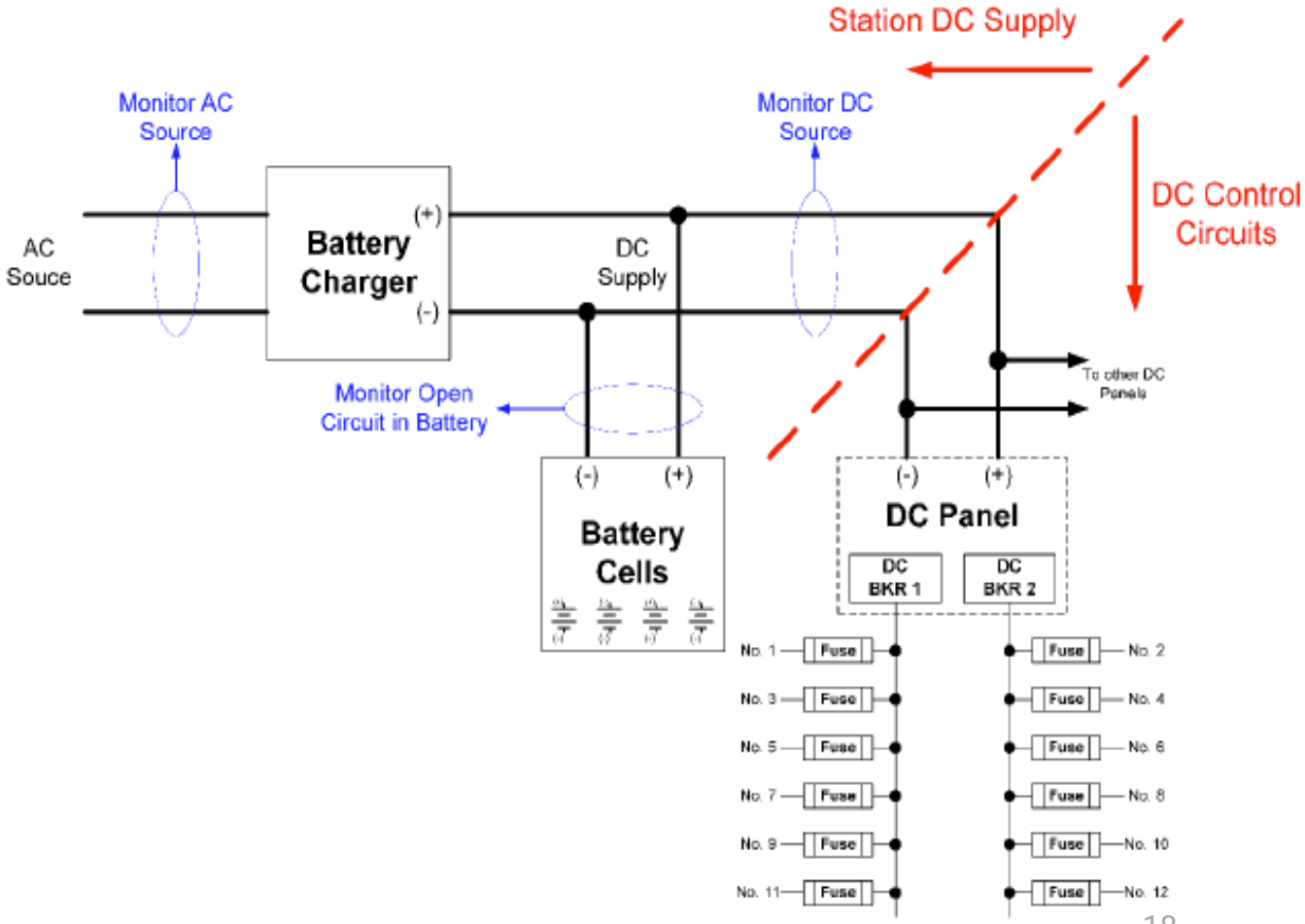
Failure of a single station Protection System DC supply is a significant point of failure

Prevent the operation of all local protection, including back-up protection

What differentiates a single station DC supply (Footnote 13c) from a single control circuitry (Footnote 13d)?

DC supply includes station battery, battery chargers and non-battery-based dc supply

Control circuitry includes everything from where the station DC supply terminates through and including the trip coils, including the wiring, as well as auxiliary and lockout relays



Is a battery charging system appropriate redundancy for the battery?

- A battery charger cannot take the place of a redundant battery DC supply.

Why is control circuitry addressed?

Failure of a Protection System single control circuitry is a significant point of failure

Prevent proper tripping and, depending upon its design and mode of failure, may also prevent the initiation of breaker failure protection

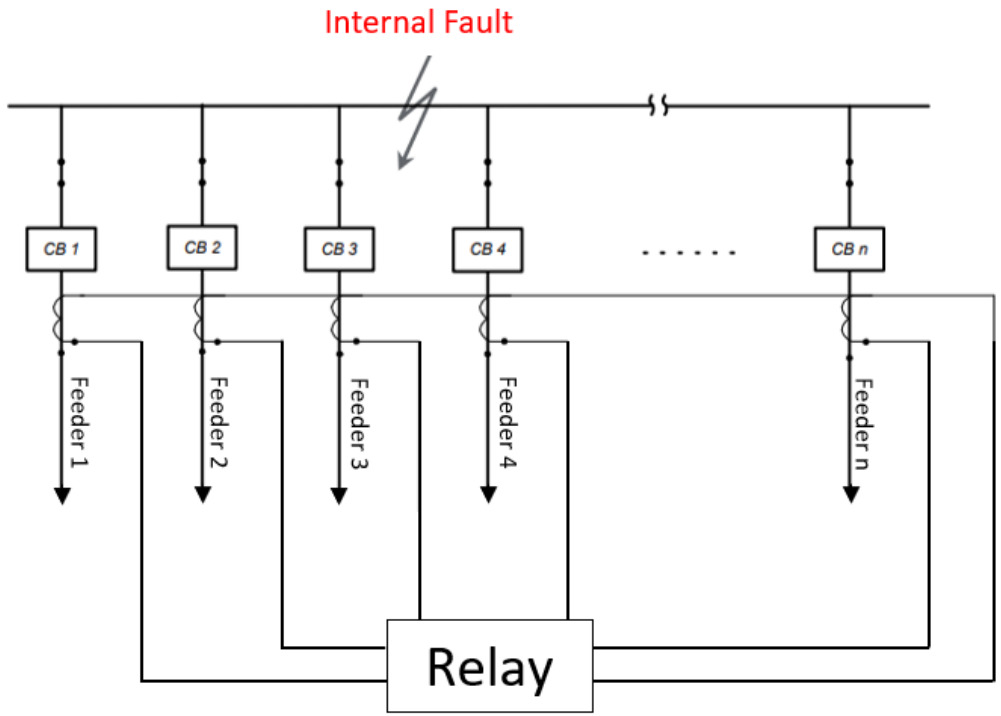
Parts of the control circuitry are generally unmonitored

Failed control circuity may remain undetected until periodic testing is conducted

Differences between P4 and P5 Contingency

Category	Initial Condition	Event [1]	Fault Type [2]
P4 Multiple Contingency *(Fault plus stuck breaker[10])*	Normal System	Loss of multiple elements caused by a stuck breaker[10](non-Bus-tie Breaker) attempting to clear a Fault on one of the following: 1. Generator 2. Transmission Circuit 3. Transformer[5] 4. Shunt Device[6] 5. Bus Section	SLG
		6. Loss of multiple elements caused by a stuck breaker[10] (Bus-tie Breaker) attempting to clear a Fault on the associated bus	SLG

Category	Initial Condition	Event [1]	Fault Type [2]
P5 Multiple Contingency *(Fault plus non-redundant component of a Protection System failure to operate)*	Normal System	Delayed Fault Clearing due to the failure of a non-redundant component of a Protection System[13] protecting the Faulted element to operate as designed, for one of the following: 1. Generator 2. Transmission Circuit 3. Transformer[5] 4. Shunt Device[6] 5. Bus Section	SLG



Bus Differential Protection

Auditor's Expectations

How does the entity consider Category P5 Contingencies for transmission circuits for all Contingency scenarios?

How does the entity identify non-redundant relays for its development of P5 Contingencies?

Review of documentation is expected to justify the clearing times studied under a P5 Contingency.

Sample the entity's Protection Systems to test the effectiveness of the entity's identification method for non-redundant component of a Protection System.

How is the list of non-redundant components of a Protection System for development of P5 Contingencies maintained?

How are the identified non-redundant components of a Protection System for the entity's development of P5 Contingencies coordinated?

Important Dates

January 23, 2020

- TPL-001-5 approved by FERC

July 1, 2023 – Effective Date

- Develop a procedure or technical rationale for selecting known outages of generation and Transmission Facilities
- Coordinate with protection engineers to obtain necessary data to perform the SPF analysis
- Complete first annual Planning Assessment in accordance with TPL-001-5

July 1, 2025 – 24 months after effective date

- Phased-in Compliance Dates for R2 Part 2.7 for the revised Category P5 Planning Event
- Entities required to identify Corrective Action Plans to address any Category P5 planning events involving SPFs in Protection Systems

July 1, 2029 – 72 months after effective date

- Comply with the bolded part of R2 Part 2.7 that states "Revisions to the Corrective Action Plan(s) are allowed in subsequent Planning Assessments **but the planned System shall continue to meet the performance requirements in Table 1.**"

References

NERC Industry Advisory – Protection System Single Point of Failure (March, 2009)

FERC Order No. 754 (Docket No. RM10-6-000; Order No. 754, September 2011)

Informational Filing of the North American Electric Reliability Corporation in Response to Order No. 754 (March, 2012)

Order No. 754 Assessment of Protection System Single Points of Failure Based on the Section 1600 Data Request (September, 2015)

Order No. 786 (Docket Nos. RM12-1-000 and RM13-9-000; Order No. 786, October 2013)

Project 2015-10 Technical Rationale for TPL-001-05 (October, 2018)

ERO Enterprise CMEP Practice Guide - Considerations for TPL-001-4 and TPL-001-5.1 Table 1 Contingencies (November, 2021)

Questions

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