

# Order 754 – System Protection Reliability Issues

A Review of the NERC Planning Standards

October 24, 2011

**RELIABILITY | ACCOUNTABILITY**



- The NERC Planning Standards established fundamental requirements for planning reliable interconnected bulk electric systems
- The Planning Standards were based on the following general format:
  - Introduction — Background and reason(s) for the Standard(s)
  - Standard — Statement of the specifics requiring compliance
  - Measurement — Measure(s) of performance relative to the Standard
  - Guides — Good planning practices and considerations that may vary for local conditions

- Approved by the NERC Board of Trustees in September 1997, the NERC Reliability Standards were divided into four sections:
  - I. System Adequacy and Security
  - II. System Modeling Data Requirements
  - III. System Protection and Control
  - IV. System Restoration
- The subject of protection system reliability was addressed in the III.A. standards (III. System Protection and Control – A. Transmission Protection Systems)

- The Planning Standards established an important principle by taking a reliability-based approach to addressing protection system single points of failure by linking the need for “redundancy” to the impact of a protection system component failure on system performance
- Discussion in Section III, System Protection and Control, stated:
  - The need for redundancy in protection systems should be based on an evaluation of the system consequences of the failure or misoperation of the protection system and the need to maintain overall system reliability

- Standard III.A.S2 established that evaluation of the system consequences of the failure or misoperation of the protection system would be based on the ability to meet system performance requirements specified for transmission planning studies
  - Transmission protection systems shall provide redundancy such that no single protection system component failure would prevent the interconnected transmission systems from meeting the system performance requirements of the I.A. Standards on Transmission Systems and associated Table I

- The I.A. Standards on Transmission Systems and associated Table I were the forerunner of the existing Transmission Planning standards, TPL-001 through TPL-004, and included four standards
  - S1: Addressed Category A – No contingencies with “All Facilities in Service”
  - S2: Addressed Category B – Event resulting in the loss of a single component
  - S3: Addressed Category C – Event(s) resulting in the loss of two or more (multiple) components
  - S4: Addressed Category D – Extreme event resulting in two or more (multiple) components removed or cascading out of service

- The contingencies in each Category were defined in Table 1 and were similar to the existing Transmission Planning standards
- Category C contingencies included single-line-to-ground faults on a generator, transmission circuit, transformer, or bus section, with delayed clearing
- Category D contingencies included three-phase faults on a generator, transmission circuit, transformer, or bus section, with delayed clearing
- Delayed clearing included breaker failure or protection system failure

- For Category A, B, and C the measurements required:
  - Loadings within applicable thermal ratings
  - Voltage levels within applicable limits
  - Stability of the network
  - Supply of all customer demand and maintenance of all contracted firm (non-recallable reserved) transfers<sup>1</sup>
  - Avoidance of cascading outages
- For Category D the measurements required entities to:
  - Assess the risks and system responses
  - Document measures/procedures to mitigate/eliminate the extent and effects of those events where such events could lead to uncontrolled cascading outages or system instability
  - Implement such measures and procedures at their discretion

<sup>1</sup> Table 1 allowed the controlled interruption of electric supply to customers (load shedding), the planned removal from service of certain generators, or the curtailment of contracted firm (non-recallable reserved) electric power transfers for Category C contingencies



- The Measurements for the III.A. Standards specified:
  - Where redundancy in the protection systems due to single protection system component failures is necessary to meet the system performance requirements of the I.A. Standards and associated Table I, the transmission or protection system owners shall provide, as a minimum, separate ac current inputs and separately fused dc control voltage with new or upgraded protection system installations
  - Breaker failure protections need not be duplicated
  - Each Region shall also develop a plan for reviewing the need for redundancy in its existing transmission protection systems and for implementing any required redundancy

- The NERC Reliability Standards also included Guides describing “good planning practices and considerations” that the Regions and their members were encouraged to consider and follow
- The Guides for the III.A. Standards noted that:
  - Physical and electrical separation should be maintained between redundant protection systems, where practical, to reduce the possibility of both systems being disabled by a single event or condition

- During 2001 through 2002 the NERC Planning Standards and Measurements were revised and Compliance Templates developed
- The approach to address protection system reliability was modified to address this within standard I.A.S3
- Table 1 was modified to include footnote (f) which defined delayed clearing as
  - “Delayed clearing of a fault is due to failure of any protection system component such as a relay, circuit breaker, or current transformer (CT), and not because of an intentional design delay.”

- This approach allowed entities to consider other effective and efficient approaches to meeting the standards in addition to providing protection system redundancy
- The revised planning standards were subsequently translated into the NERC Version 0 Planning Standards