

Designated Entity Design Standards Task Force (DEDSTF)

Minimum Design Requirements for FERC Order 1000 Projects

System Protection Subgroup

For any substation facility included in the scope of a transmission project subject to a Designated Entity Agreement (DEA), the following minimum system protection, ~~metering,~~ and control requirements apply.

1. System Protection Engineering and Design Requirements for Facilities that Interconnect to Existing Incumbent Transmission Owners (All Voltage Levels requiring the signing of a DEA)

For transmission circuits and other facilities with protective zones that are shared with existing incumbent Transmission Owners (i.e., facilities that represent ties between existing substations owned by incumbent Transmission Owners and Designated Entity substation facilities, etc.), the parties must coordinate to develop a protection system design that does not degrade the performance or reliability of the system, following the applicable technical requirements and standards of the Transmission Owner that are posted on PJM's website per Manual 14C Section 6.1.3.2., or other mutually agreed to solution for the items listed below. PJM Manual 07 will apply to all aspects of projects subject to the DEDSTF-requirements requirements. When interconnecting to multiple Transmission Owners systems, all parties must coordinate to achieve a mutually agreed upon solution.

The following are examples (including but not limited to) of design requirements that must be coordinated between parties.

- Line relay scheme (DCB, POTT, current diff, etc.)
- Line relay types/models
- Line protection communication media (Fiber, Power Line Carrier, etc.)
- Line protection communication scheme requirements – number of channels, channel types (POTT, DCB, DTT, etc.), and channel performance requirements
- Line Relay Setting and Trip Logic Design
 - Design must include sufficient test switches to allow isolation of protection system components and to provide adequate isolation to maintain protection system components and minimize trips caused by testing maintenance to be performed without taking any primary element out of service (e.g., line, transformer, bus)
- Reclosing method (HBDL, sync check, etc.) and associated timing must be coordinated with the local TO

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2. System Protection Requirements for Facilities That exist within a developers station and That Do Not Directly Interconnect with Existing Substations Owned by Incumbent Transmission Owners

Facilities with protective zones that are not shared with incumbent Transmission Owners or Generation Owners are not subject to DEA section 4.2 (i.e., facilities entirely within a Designated Entity substation or a facility that interconnects two Designated Entity substation facilities, etc. PJM Manual 07 will apply to the following Designated Entity equipment as minimum design standards for system protection, metering, and control:

- Substation Buses (Manual 07, Section 9)
- Breaker Failure Protection (Manual 07, Section 12)
- Transmission Substation Transformers (Manual 07, Section 8)
- Shunt Reactors and Capacitors (Manual 07, Section 10 and 11)
- Phase Angle Regulating and Voltage Regulating Transformers (Manual 07, Section 13)
- HVDC Transmission Circuits and Converters (No Coverage in Manual 07)

Note 1: Minimum system protection requirements for HVDC Transmission Circuits and associated converter equipment shall be determined on a case-by-case basis and included in the applicable PJM Problem Statement & Requirements Document. At a minimum, completely redundant protection systems will be required for these elements.

Note 2: For phase angle regulators (PAR) at a Designated Entity station that are electrically located at the terminal of a transmission line with a shared protection zone, design and relay setting coordination between the Designated Entity facility and the incumbent Transmission Owner facility is required. The required protection schemes on a PAR are inherently complex, and can adversely affect reliability of the incumbent Transmission Owner system. In these cases, agreement on scope of design and protection philosophy, relay settings and test methods may be required by the incumbent Transmission Owner.

Note 3: Breaker failure design, timing requirements and relay types must be coordinated between the Designated Entity and the Incumbent Transmission Owner prior to the design of the protection system for all breakers in the Designated Entity station. Where generator stability is a concern, the protection requirements must be fully understood by the Designated Entity prior to the selection of relay types and overall design of the breaker failure scheme.

3. System Protection Requirements for Facilities ~~less than~~below 200kV

For protection systems in the substation subject to a Designated Entity Agreement that do not meet the applicability of PJM Manual 07 ~~because they are less than 200kV~~, Appendix A lists the minimum requirements for those protection systems.

Appendix A

This appendix outlines the protection requirements for the protection of greenfield project facilities ~~at system voltages at or above 46kV and below 200kV~~ but limited to 46kV.

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Comment [P1]: RS 5/18

Generator Protection

For generating units less than 100 MVA and connected below 200 kV, see PJM M07 Appendix D

Unit Power Transformer and Lead Protection

PJM Manual 07 Section 4 applies for unit power transformers and associated high-side leads where the transformers are (1) rated less than 100 MVA, or (2) are connected to utility systems at transmission system voltages below 200kV.

Unit Auxiliary Transformer and Lead Protection

PJM Manual 07 Section 5 applies for unit-connected auxiliary transformers and associated high-side leads where the transformers are (1) rated less than 100 MVA, or (2) are connected to utility systems at transmission system voltages below 200kV.

Start-up Station Service Transformer and Lead Protection

PJM Manual 07 Section 6 applies for start-up station service transformers and associated high and low-side leads connected to transmission systems at system voltages below 200kV.

Line Protection

PJM Manual 07 Section 7 applies for the protection of lines at system voltages below 200kV except for following requirements:

Primary Protection

- For transmission lines below 200kV, pilot protection may be required to meet coordination requirements of the interconnected Transmission Owner.

Restricted Ground Fault Protection

Comment [MJH2]: Dominion: It is a better practice to have pilot in all networked lines. I would ass a statement that mentions lines 200 kV below but limited to 69kV should be required to have pilot protection

Comment [MJH3]: BGE: Are you trying to say that high speed simultaneous clearing of all line terminals is not required, unless it is needed to meet coordination requirements?

Comment [MJH4]: BGE: Would prefer a stronger statement that requires pilot as-needed for high speed simultaneous clearing of all terminals and possibly redundant pilot if miscoordination can result from a fault during a communication failure.

Comment [P5]: RS (5/18) – No revision. Remains unchanged

- Not required for transmission lines below 200kV. For transmission lines <200kV, restricted ground fault protection may be required to meet coordination requirements of the interconnected Transmission Owner.

Close-in Multi-Phase Fault Protection (Switch-Onto-Fault Protection)

- Not required for transmission lines below 100kV

Comment [MJH6]: DEDSTF: Maybe replace "Not Required" with "Must Consider"

Comment [MJH7]: BGE: At lower voltages you are much more likely to have a restricted ground fault

Comment [P8]: RS (5/18)

Comment [MJH9]: DEDSTF: Maybe replace "Not Required" with "Must Consider"

Comment [MJH10]: BGE: If you are only applying impedance based protection it is defeated by SOTF conditions and you would have a full loss of protection. How is that acceptable?

Comment [P11]: RS (5/18) removed – all TOs req SOTF >46kV

Substation Transformer Protection

PJM Manual 07 Section 8 applies for the protection of substation transformers with high-side voltages of below 200kV except for following requirements:

Current Differential Zone Considerations

- M07 applies except, separate restraint windings in the differential relays are not required for substation transformers with high-side voltages below 200kV

Isolation of a Faulted Transformer Tapped to a Line

- PJM Manual 07 Section 8.2 applies since bulk power lines operated below 300 kV may be tapped with the concurrence of the transmission line owner(s).

Protection Scheme Requirements

- A device failure scheme for the fault interrupting device is not required for substation transformers with high-side voltages below 200kV.

Comment [MJH12]: BGE: I think this means to say that section 8.1 applies but that current-based schemes need not be differential below XXX kV. If so I think that's a clearer statement and less subject to misinterpretation

Comment [P13]: RS 5/18

Transformer Leads Protection

- High and low side leads of transformers with high-side voltages below 100kV must be protected by two independent schemes, only one of which must be high-speed. If the leads are included in a line protection zone, transformer lead protection is not required.

Comment [MJH14]: BGE: Then this isn't an exception ... unless this is a lead in to the protection system requirements exception. If that's the case the two should be linked with "however, in the protection system requirements subsection..."

Comment [MJH15]: BGE: A transformer tapped to a networked transmission line that has a required fault interrupting device will be left to cook if the device fails to operate.

The common application would be to operate a circuit switcher bottle and blade independently so that if the bottle fails to open the switch blade opens, creating a fault that can be cleared by the source relays

Comment [P16]: RS 5/18 No revision

Bus Protection

- For the protection of substation buses at system voltages below 100kV, one high speed protection scheme is required for protecting the bus. Remote or local protection is required as a backup. The schemes must utilize independent current and/or voltage sources and independently protected DC control circuits.

Shunt Reactor Protection

PJM Manual 07 Section 10 applies for the protection of shunt reactors at system voltages below 200kV.

Shunt Capacitor Protection

PJM Manual 07 Section 11 applies for the protection of shunt capacitors at system voltages below 200kV with the following exception:

Unbalance Detection Scheme

- For facilities below 200kV, one capacitor bank unbalance detection scheme must be installed.

Breaker Failure Protection

PJM Manual 07 Section 12 applies for breaker failure protection at system voltages below 200kV with the following exception:

Local breaker failure protection requirements

- For facilities below 100kV, a dedicated breaker failure scheme shall be used for each fault-interrupting device and shall initiate tripping of all local sources of fault current only if the remote backup protection is inadequate.

Comment [P17]: RS 5/18

Comment [MJH18]: BGE: The wording is odd and seems to prohibit local breaker failure protection if remote backup protection is sufficiently sensitive to clear the fault. I suspect it means there is requirement for local breaker failure protection in cases where remote backup is not sensitive to the fault. "Remote backup protection is acceptable for facilities below 100 kV. If this cannot be achieved, a dedicated breaker failure scheme..."

Phase Angle Regulator Protection

PJM Manual 07 Section 13 applies for the protection of phase angle regulating transformers connected at system voltages below 200kV.

Transmission Line Reclosing

PJM Manual 07 Section 14 applies for automatic reclosing schemes for fault interrupting devices at system voltages below 200kV.

Supervision and Alarming of Relaying and Control Circuits

PJM Manual 07 Section 15 applies for supervision and alarming of relaying and control circuits applied to protect equipment at system voltages below 200kV.

Comment [MJH19]: BGE: Looking at Manual 7 Section 15, its clear enough, despite terse title, that protection communication circuits are also included. Because this is a separate document it would help the reader to provide a more explicit statement here.

Comment [MJH20]: BGE: Would there be load shedding applied for 46 kV to 200 kV?

Underfrequency Load Shedding

PJM Manual 07 Section 16 applies for underfrequency load shedding schemes at system voltages below 200kV.

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~~Special Protection Schemes~~ Special Protection Schemes or Remedial Action Schemes

PJM Manual 07 Section 17 applies for ~~Special Protection Schemes~~ Special Protection Schemes (SPS) or Remedial Action Schemes (SPSRASs) at system voltages below 200kV.

Comment [P21]: RS 5/18. M07 lists both terms in the SPS section

Use of Dual Trip Coils

The use of dual trip coils in circuit breakers are not required at system voltages below 100kV

Direct Transfer Trip Requirements

PJM Manual 07 Appendix B applies for facilities below 200kV.

Dual Pilot Channels for Protective Relaying

PJM Manual 07 Appendix C applies for facilities below 200kV.

Small Generator Protection Requirements

PJM Appendix D applies for generating units less than 100 MVA and connected below 200kV.

Acceptable Three Terminal Line Applications

PJM Manual 07 Appendix E applies for facilities below 200kV with the following exception:

Protection Requirements

- For facilities below 200kV, directional comparison blocking (DCB) or unblocking scheme (DCUB) operating over power line carrier to a third terminal is acceptable for primary or backup line protection.