Information Document
Generator Relay Loadability
ID #2017-002RS

Information Documents are not authoritative. Information Documents are for information purposes only and are intended to provide guidance. In the event of any discrepancy between an Information Document and any Authoritative Document(s) in effect, the Authoritative Document(s) governs.

1 Purpose

This Information Document relates to the following Authoritative Document[1]:

- Alberta Reliability Standard PRC-025-AB-2, *Generator Relay Loadability* ("PRC-025-AB-2")

The purpose of this Information Document is to assist market participants in correctly addressing the generator relay loadability requirements contained in PRC-025-AB-2.

2 Background

The North American Electricity Reliability Council (NERC) has analyzed many of the major disturbances in the last 25 years on the North American interconnected power system, and has determined that generating units have tripped for conditions that did not pose a direct risk to those generating units and associated equipment within the time period where the tripping occurred. This tripping has often been determined to have resulted in either one or both of expanding the scope or extending the duration of the disturbances. This was noted to be a serious issue in the August 2003 "blackout" in the northeastern North American continent.[2]

During the recoverable phase of a disturbance, the disturbance may exhibit a "voltage disturbance" behavior pattern, where system voltage may be widely depressed and may fluctuate. In order to support the system during this transient phase of a disturbance, PRC-025-AB-2 establishes criteria for setting load-responsive protective relays such that individual generating units and aggregated generating facilities may provide reactive power within their dynamic capability during transient time periods to help the system recover from the voltage disturbance. The premature or unnecessary tripping of generating units and aggregated generating facilities resulting in the removal of dynamic reactive power exacerbates the severity of the voltage disturbance, and as a result changes the character of the system disturbance. In addition, the loss of real power could initiate or exacerbate a frequency disturbance.

3 Overview of Applicability

3.1 Protective Functions

PRC-025-AB-2 does not require the legal owner of a generating unit, aggregated generating facility, or transmission facility to use any of the protective functions listed in Table 2. Each legal owner of a generating unit, aggregated generating facility and transmission facility that applies load-responsive protective relays in their respective facilities described in the applicability section, selects applicable options in Table 2, *Relay Loadability Evaluation Criteria*, to set each load-responsive protective relay element according to its application and relay type.

[1] "Authoritative Documents" is the general name given by the AESO to categories of documents made by the AESO under the authority of the *Electric Utilities Act* and regulations, and that contain binding legal requirements for either market participants or the AESO, or both. AESO Authoritative Documents include: the ISO rules, the Alberta reliability standards, and the ISO tariff.

[2] Interim Report: Causes of the August 14th Blackout in the United States and Canada, U.S.-Canada Power System Outage Task Force, November 2003 (https://www.nerc.com/docs/docs/blackout/814BlackoutReport.pdf)

3.2 System Elements

Subsection 2.1 of PRC-025-AB-2 sets out those system elements covered by the applicability of PRC-025-AB-2. The intent of this section is to capture all the system elements that would apply to PRC-025-AB-2.

3.3 Exclusions

Appendix 2 of PRC-025-AB-2 captures the protection systems that are excluded from the application of PRC-025-AB-2. The following are a few examples of the protection systems excluded in Appendix 2:

(i) In respect of subsection (b), an example may include, but not limited to, overcurrent relays used in conjunction with inadvertent energization schemes and open breaker flashover schemes.

(ii) In respect of subsection (c), an example may include, but not limited, to protective relay elements installed to prevent false operation in the event of a loss of potential.

(iii) In respect of subsection (d), an example may include, but not limited, to overcurrent elements that are only enabled during loss of potential conditions.

Note that “Full-load current” in Appendix 2 (f) means rated armature current.

4 Requirement R1

The phrase “while maintaining reliable fault protection” in requirement R1 means that the responsible entity is to comply with PRC-025-AB-2 while achieving its desired fault protection goals. Refer to the “Guidelines and Technical Basis” section in NERC’s PRC-025-2, Introduction, for more information. The AESO generally agrees with the information contained within the “Guidelines and Technical Basis” section in NERC’s PRC-025-2 and recognizes that it may be a useful reference for market participants as they implement PRC-025-AB-2.

5 Generating Units and Aggregated Generating Facilities

Synchronous generating unit relay pickup setting criteria values (including aggregated generating facilities consisting of several synchronous generating units) are derived from the generating unit’s maximum authorized real power and the generating unit’s reactive power capability.

Asynchronous generating unit relay pickup setting criteria values (including inverter-based installations or wind turbine generating units) are derived from the facility’s maximum authorized real power and the facility’s reactive power capability including the reactive power output of any static or dynamic reactive power devices.

6 Transmission System Step-Up Transformers

Calculations using the transmission system step-up transformer turns ratio is required to use the actual tap that is applied (i.e. in service) for transmission system step-up transformers with off-load tap changers. If on-load tap changers are used, the calculations are expected to reflect the tap that results in the lowest generating unit bus voltage. When the criterion specifies the use of the transmission system step-up transformer’s impedance, the nameplate impedance at the nominal ratio should be used.

Applications that use more complex topology, such as generating units connected to a multiple winding transformer, are not directly addressed by the criteria in Table 2. These topologies can result in complex power flows, and may require simulation to avoid overly conservative assumptions to simplify the calculations. The AESO recommends that entities with these topologies set their relays in such a way that they do not operate for the conditions being addressed in PRC-025-AB-2 using an appropriate option for the application from Table 2.

7 Unit Auxiliary Transformers

These transformers are variably referred to as station power, unit auxiliary transformers, or station service transformers used to provide overall auxiliary power to the generator station when the generating unit is running. Loss of these transformers will result in removing the generating unit from service. Refer to the "Guidelines and Technical Basis" section in NERC's PRC-025-2 for more detailed information concerning unit auxiliary transformers.

8 Multiple Lines

Applications that use more complex topology, such as multiple lines that connect the transmission system step-up transformers to the transmission system that are used to export energy directly from a bulk electric system generating unit or generating plant are not directly addressed by the criteria in Table 2. These topologies can result in complex power flows, and simulation may be required to avoid overly conservative assumptions to simplify the calculations. The AESO recommends that entities with these topologies set their relays in such a way that they do not operate for the conditions being addressed in PRC-025-AB-2 using an appropriate option for the application from Table 2. This includes elements that also supply generating plant loads.

9 Industrial Complexes

The loss of several generating units within an industrial complex would exacerbate the severity of the voltage disturbance on the transmission system within that area, and the loss of real power could initiate or exacerbate a frequency disturbance. As such, PRC-025-AB-2 is also applicable to a generating unit within an industrial complex or industrial service designation facilities. PRC-025-AB-2 is not intended to include system elements that connect a generating unit to an industrial complex's operating loads.

10 Table 2

10.1 Definitions and Criteria

The NERC language in Table 2 has been revised in order to align with or to avoid conflict with commonly used terms by the AESO or terms in the AESO's *Consolidated Authoritative Document Glossary*. Examples include:

(i) "100% of the gross MW capability reported to the Transmission Planner" has been changed to "100% of the maximum authorized real power";

(ii) "Dispersed power producing resources" has been changed to "aggregated generating facilities"; and

(iii) "Generator step-up transformer (GSU)" has been changed to "transmission system step-up transformer".

The criteria established in Table 2 represent short-duration conditions during which generating units and aggregated generating facilities are capable of providing system reactive resources, and for which generating units and aggregated generating facilities have been historically recorded to disconnect, causing events to become more severe.

10.2 Structure of Table 2

Table 2 in PRC-025-AB-2 is structured and formatted to assist the reader in identifying an option for a given load-responsive protective relay.

(a) The first column identifies the application, for example:

(i) synchronous or asynchronous generating units or aggregated generating facilities;

(ii) transmission system step-up transformers;

(iii) generating unit or aggregated generating facility auxiliary transformers; or

(iv) other equipment that connect the transmission system step-up transformers to the transmission system.

(b) The second column identifies the load-responsive protective relay (e.g., 21, 50, 51, 51V-C, 51V- R, or 67) according to the applied application in the first column.

(c) The third column uses numeric and alphabetic options to identify the available options for setting load-responsive protective relays according to the application and applied relay type.

See Figures 1 and 2 for guidance on the application of the options.

(d) The bus voltage column and pickup setting criteria columns provide the criteria for determining an appropriate setting.

11 Further Recommended Reading

As with every Alberta reliability standard, each responsible entity is responsible for determining, for its facilities, what actions are necessary to meet the requirements in PRC-025-AB-2.

The AESO generally agrees with the information contained within the following documents and recognizes that these documents may be a useful reference for market participants as they implement PRC-025-AB-2. In addition, the AESO may use the information contained within the following documents as reference material in assessing compliance with PRC-025-AB-2 where it determines that the guidance information is applicable.

- NERC System Protection and Control Subcommittee, July 2015,"*Considerations for Power Plant and Transmission System Protection Coordination*".
- NERC PRC-025-2 sections:
  - Guidelines and Technical Basis
  - Table 1, Options
  - Example Calculations

Revision History

Posting Date	Description of Changes
2019-09-24	Initial release

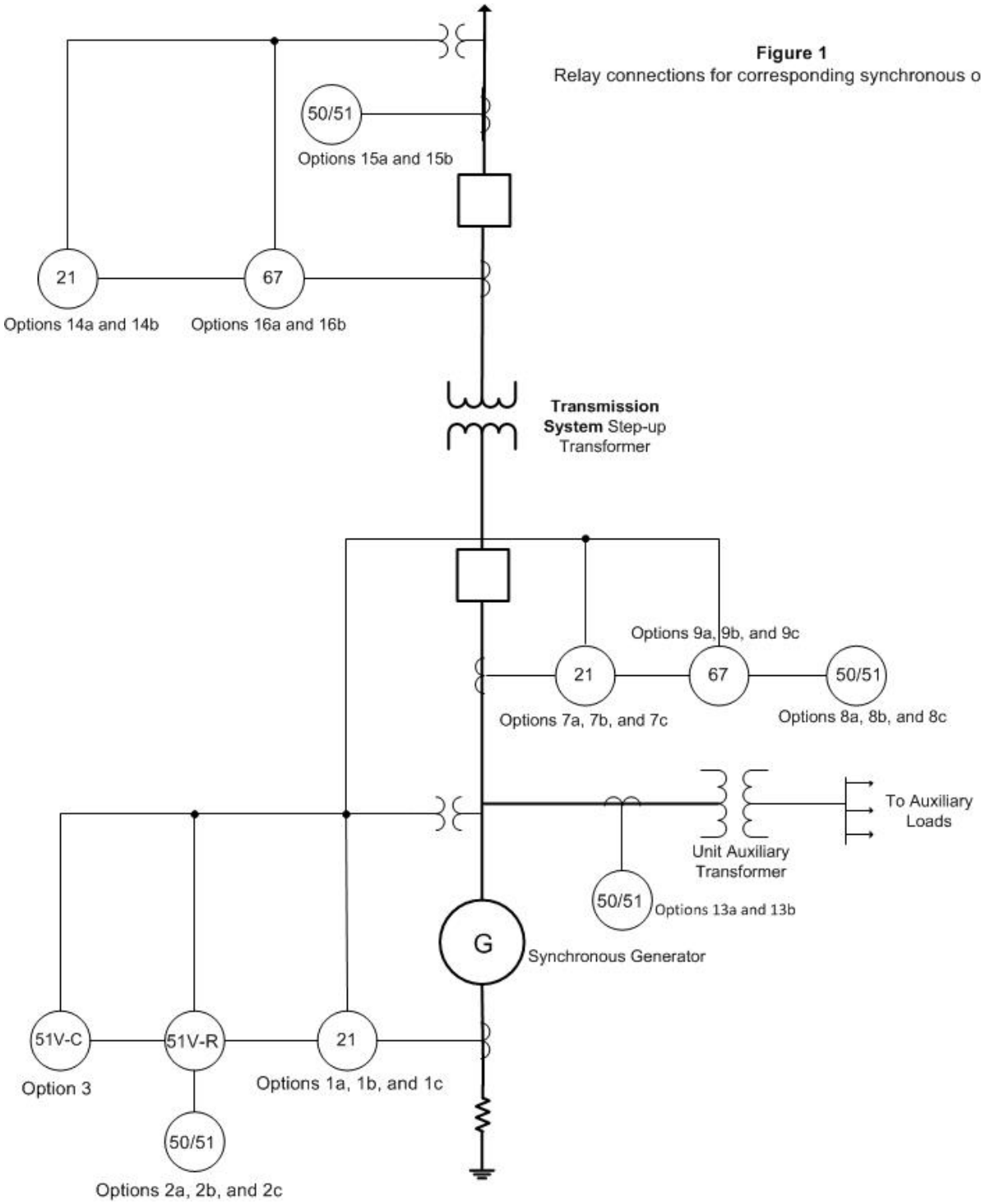

Figure 1
Relay connections for corresponding synchronous options

Figure 2
Relay connections for corresponding asynchronous options including inverter based installations