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NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Order 754 – Data Request

The study of Single Point of Failure

January 20, 2012

RELIABILITY | ACCOUNTABILITY




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Overview

- Summary of FERC Order 754
- October 24-25, 2011 FERC Technical Conference
- SPCS/TIS Joint Meeting Outcomes
  - Request for Data or Information
- RoP, Section 1600 background
  - Authority
  - Criteria
- Data Request
- Posted for Informal Comment
- Questions and Answers Session

Summary of Order 754

- Order 754[1]
  - Commission's approval of Project Interpretation of TPL-002-0b — PacifiCorp (Project 2009-14[2])
  - Commission has a concern (P19)
    - Study of a single point of failure on protection systems
  - Commission issued a directive (P20)
    - FERC staff to meet with NERC and appropriate SMEs
      - Explore the reliability concern
    - NERC to make an informational filing in six months (March 15, 2012)
      - Explain whether there is a further system protection issue and, if so:
      - What forum to address the issue?
      - What priority based on current initiatives?

[1] http://www.ferc.gov/whats-new/comm-meet/2011/091511/E-4.pdf

[2] http://www.nerc.com/filez/standards/Project2009-14_Interpretation_TPL-002-0_PacifiCorp.html

Technical Conference

- FERC Technical Conference (October 24-25, 2011)
  - Well attended by industry
    - Stakeholders, NERC and FERC staff
  - Discussions were open and helpful
    - 8 presentations
  - Outcomes
    - 4 Consensus Points
    - Problem Statement
    - 3 potential approaches for addressing the issue

Consensus Points

- Performance based issue, not full redundancy issue
- Existing approved standards address requirements to assess single point of failure
- Assessments of single point of failure of non-redundant primary protection (including backup) systems need to be sufficiently comprehensive
- Lack of sufficiently comprehensive assessments of non-redundant primary protection systems is a reliability concern

Problem Statement

- *"The group perceives a reliability concern regarding the comprehensive assessment of potential protection system failures by registered entities. The group agrees on the need to study if a gap exists regarding the study and resolution of a single point of failure on protection systems."*

Approaches

- Data Request – A small group should develop a proposal to the joint SPCS/TIS committees December 6-7, 2011
- Interpretation Request – A small group should develop a proposal to be presented to the joint SPCS/TIS committees December 6-7, 2011
- Project 2009-07 – To be considered later after the review of the first two bullets above

Data Request Background

- RoP, Section 1600 – Request for Data or Information
  - Authority
    - FPA, Section 215
    - FERC, Section 39.2(d) regulations
  - Criteria
    - Describe why data is needed, its use and collection method
    - Identify the functional entity(ies)
    - Estimate of the burden on reporting entities
    - A schedule for reporting
    - Must not have a compliance use
  - Posting for Comment (45 days)
  - BOT Approval Required

SPCS/TIS Meeting Outcomes

- Data Request Goals
  - Meet the criteria of Order 754
  - Have clear expectations
  - Achieve the least burden on entities
  - Avoid “Compliance” space
  - Obtain quality data
    - Sufficient sample size
    - Data across all voltages > 100 kV
    - Define potential concern:
      - Potential impact on system performance
      - Risk based on attributes of “as-built” protection systems

Data Request Overview

- Purpose: Identify whether there is a reliability concern associated with the assessment of single points of failure on protection systems
- The data collected will enable NERC
  - To assess whether there is a reliability concern, and if so
  - Determine whether it is related to specific protection system components
- The data request covers the following subjects:
  - Method
  - Rationale
  - Schedule
  - Data Reporting

Responsibility

- Responsible Entities
  - Transmission Planners
  - Requires assistance from Generator Owners and Transmission Owners
- Data request will be sent to all registered entities in the United States and Canada
- The data request is mandatory for registered entities in the United States
  - FPA, Section 215
  - FERC, Section 39.2(d) regulations
- Registered entities in Canada are strongly encouraged to submit data so that decisions regarding this concern are based on complete data across North America

Method

- Assessment for a cross-section of system elements operated at > 100 kV
  - Provide representative sample without testing all elements
- 9-step process to assess concern
  - Transmission Planner assesses potential system performance associated with a protection system single-point-of-failure
  - Generator Owners and Transmission Owners assess exposure to single-points-of-failure where a system performance concern is identified
- Utilizes existing analysis where possible

Step 1

1. Each Transmission Planner will meet with Transmission Owners and Generator Owners in its transmission planning area to identify the following:
   - Any bus from Table A, “Buses to be Tested,” that can be excluded from testing on the basis that the protection system(s) for all elements connected to the bus and for the physical bus(es), if any, meet the attributes for all categories in Table B, “Protection System Attributes to be Evaluated,” based on the Transmission Owner’s or Generator Owner’s “as-built” knowledge of the protection system(s).
   - Transformers with through-fault protection and at least one winding connected at a bus to be tested.

Buses To Be Tested

- For the purposes of this testing, all bus configurations will be treated as a straight bus (single-breaker) configuration
  - Considers all elements at one voltage in a substation to be connected to the bus (unless electrically separated)
- Testing is based on a fault on the bus
  - Minimizes burden on registered entities
  - Representative of a close-in fault on any element connected to the bus

List of Buses to be Tested

- The purpose of Step 1 is to develop a list of buses to be evaluated by the Transmission Planner
  - Initial list based on Table A
  - List reduced based on TO/GO input
    - Exclude buses when all elements meet the attributes for all categories in Table B based on TO/GO “as-built” knowledge of the protection systems

Note: This clarification will be added in the final data request

Table A

Table A: Buses to be Tested
Buses operated at 200 kV or higher with 4 or more circuits
Buses operated at 100 kV to 200 kV with 6 or more circuits
Buses operated at 100 kV or greater with 4 or more circuits and at which a bus fault and tripping of all connected elements at the remote terminals will result in 300 MW or more of consequential load loss as a result of remote clearing
Buses with aggregate generation of 1,000 MW or higher
Buses directly supplying off-site power to a nuclear generating station
Any additional buses the Transmission Planner believes are necessary for the reliable operation of the BES

***Note**: For purposes of applying Table A, circuits include transmission lines, transmission transformers with the primary terminal and at least one secondary terminal operated at 100 kV or higher, and generator step-up transformers.*

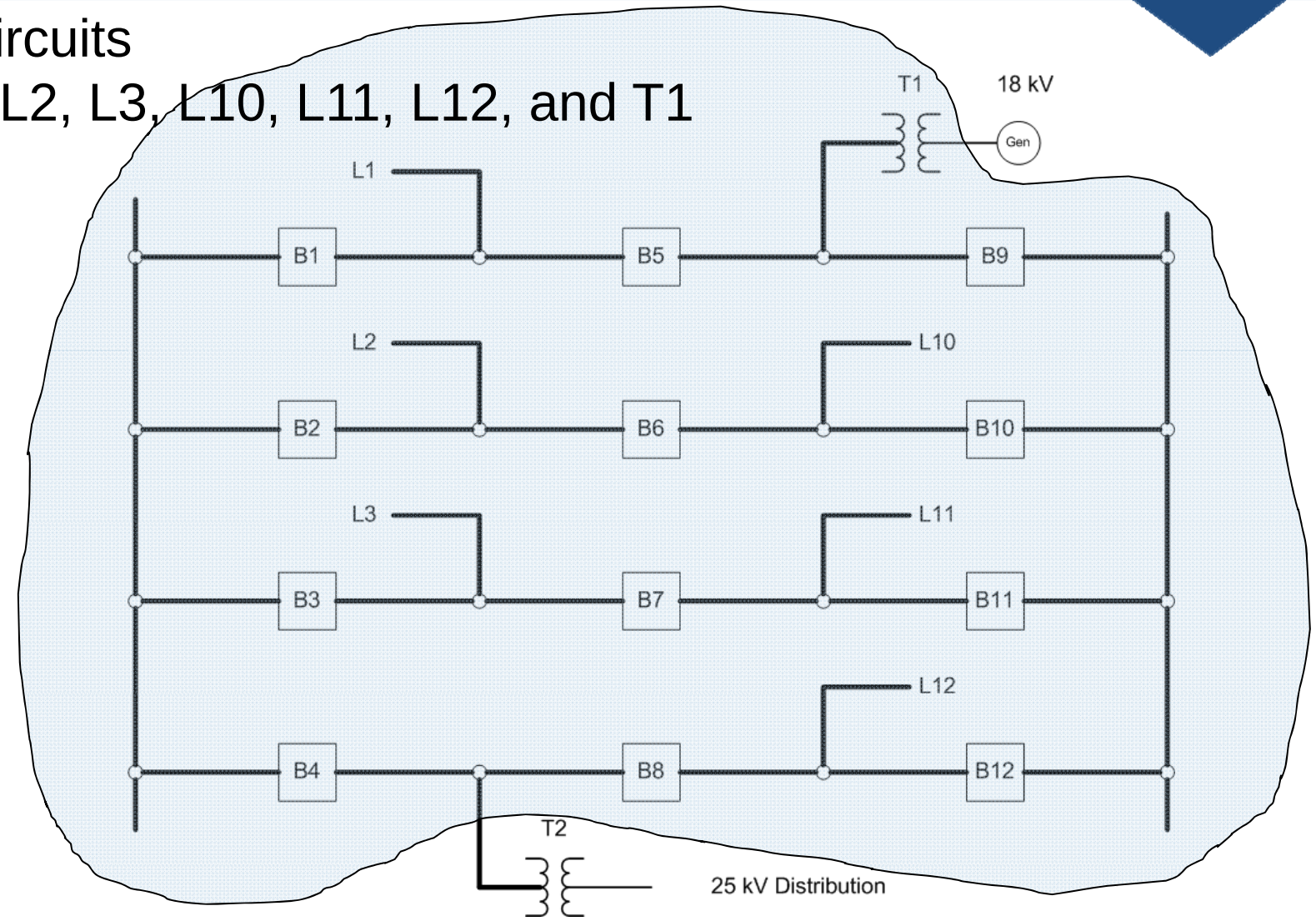
Table B

Table B: Protection System Attributes to be Evaluated
Protective Relays: The protection system for the element includes two independent protective relays that are used to measure electrical quantities, sense an abnormal condition such as a fault, and respond to the abnormal condition.
Communications Systems: The protection system for the element includes two independent communication channels and associated communication equipment when such communication between protective relays is needed to satisfy BES performance required in the TPL standards.
AC Current and Voltage Inputs: The protection system includes two independent ac current sources and related inputs and two independent ac voltage sources and related inputs, except that the two ac current sources may have a common primary current transformer (CT) winding and the two ac voltage inputs may have common capacitance coupled voltage transformer (CCVT), voltage transformer (VT), or similar device primary windings.
DC Control Circuitry: The protection system includes two independent dc control circuits with no common dc control circuitry, auxiliary relays, or circuit breaker trip coils.

Note: *Physical separation of protection system components is not necessary for protection system components to be reported as independent.*

Breaker-and-a-Half

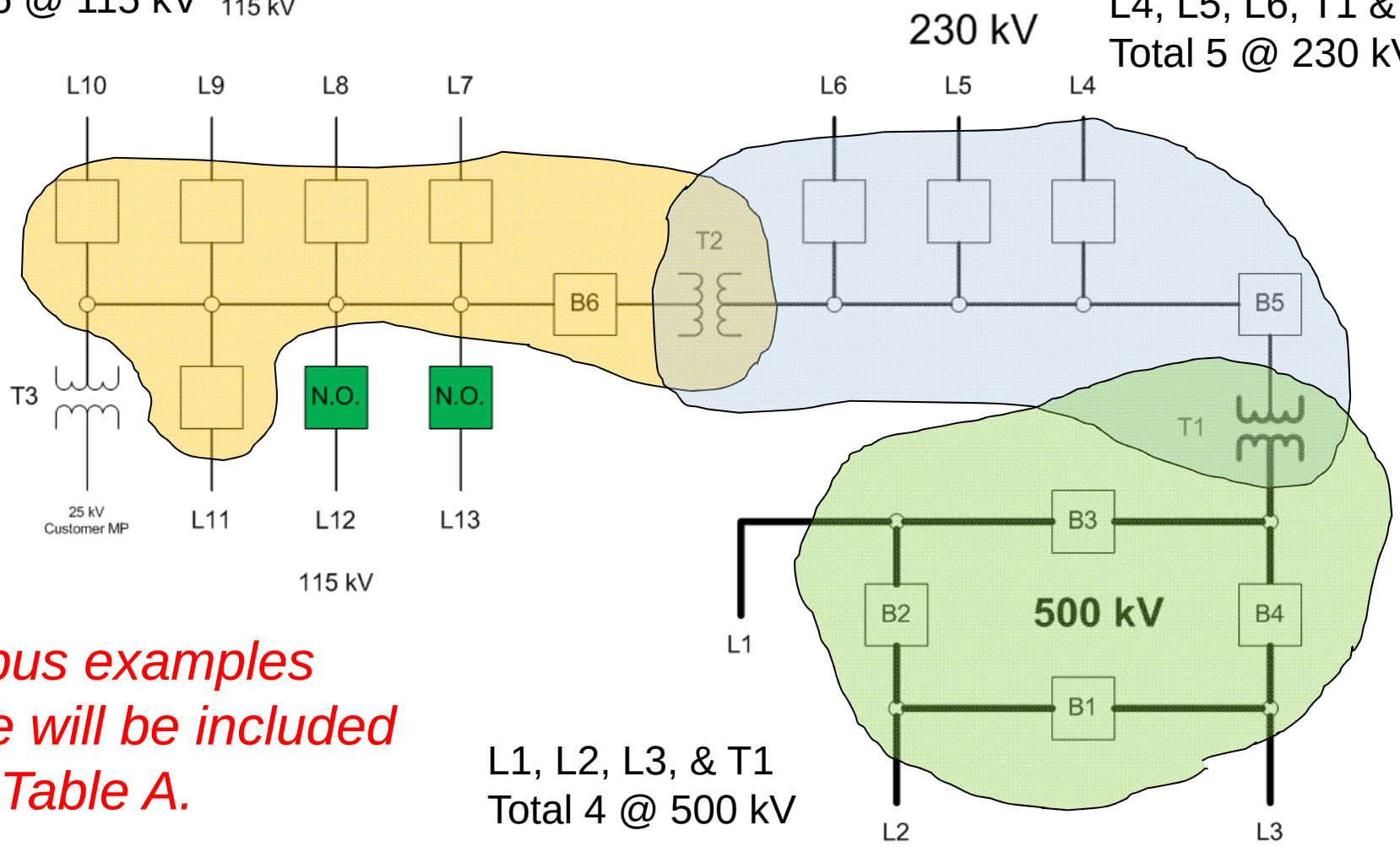
7 Circuits
L1, L2, L3, L10, L11, L12, and T1



Ring Bus

L7, L8, L9 , L10, L11, &T2
Total 6 @ 115 kV

L4, L5, L6, T1 & T2
Total 5 @ 230 kV



All bus examples here will be included per Table A.

L1, L2, L3, & T1
Total 4 @ 500 kV

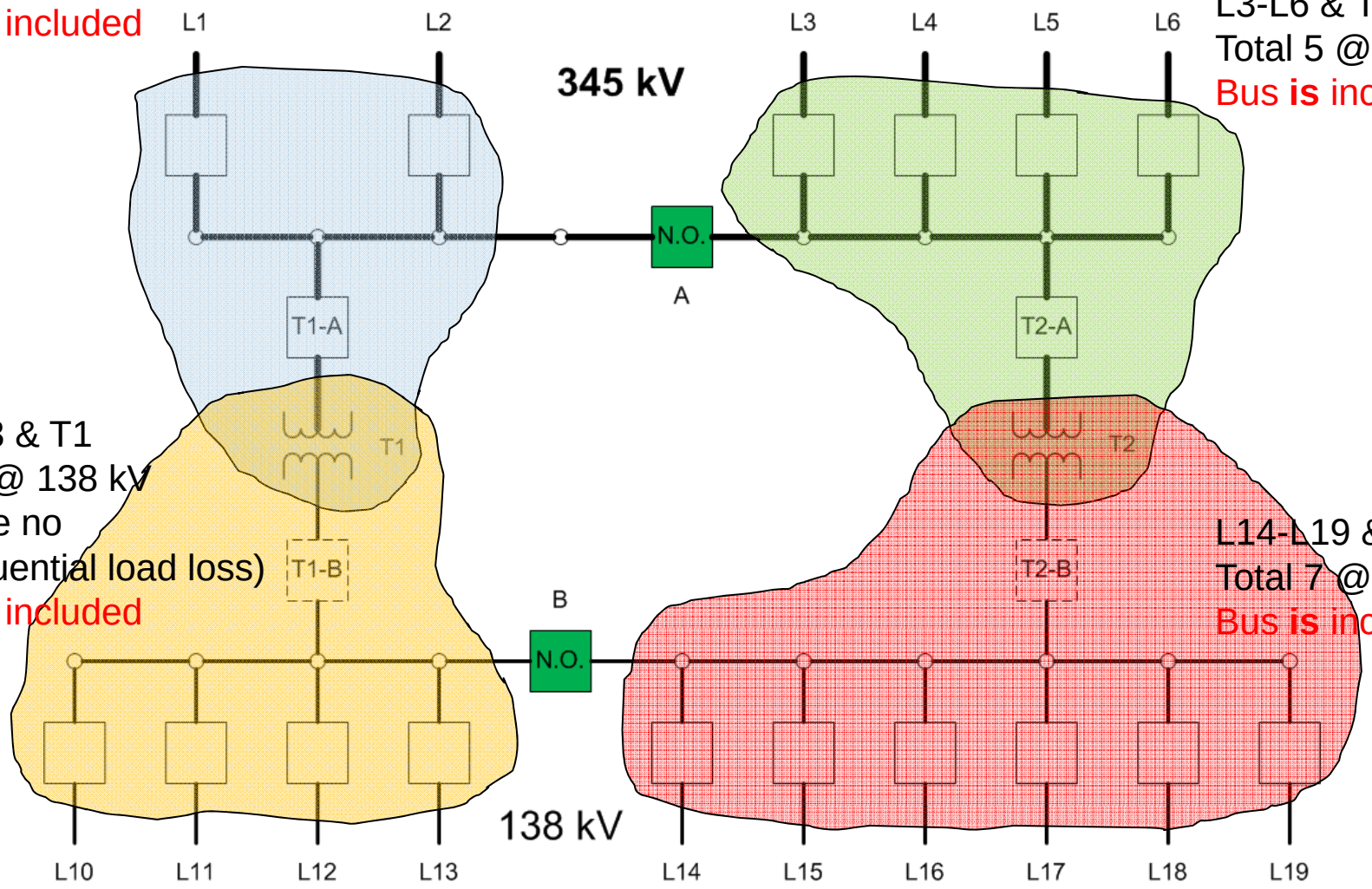
Additional Buses

L1, L2 & T1
Total 3 @ 345 kV
Bus not included

L3-L6 & T2
Total 5 @ 345 kV
Bus **is** included

L10-L13 & T1
Total 5 @ 138 kV
(assume no consequential load loss)
Bus not included

L14-L19 & T2
Total 7 @ 138 kV
Bus **is** included

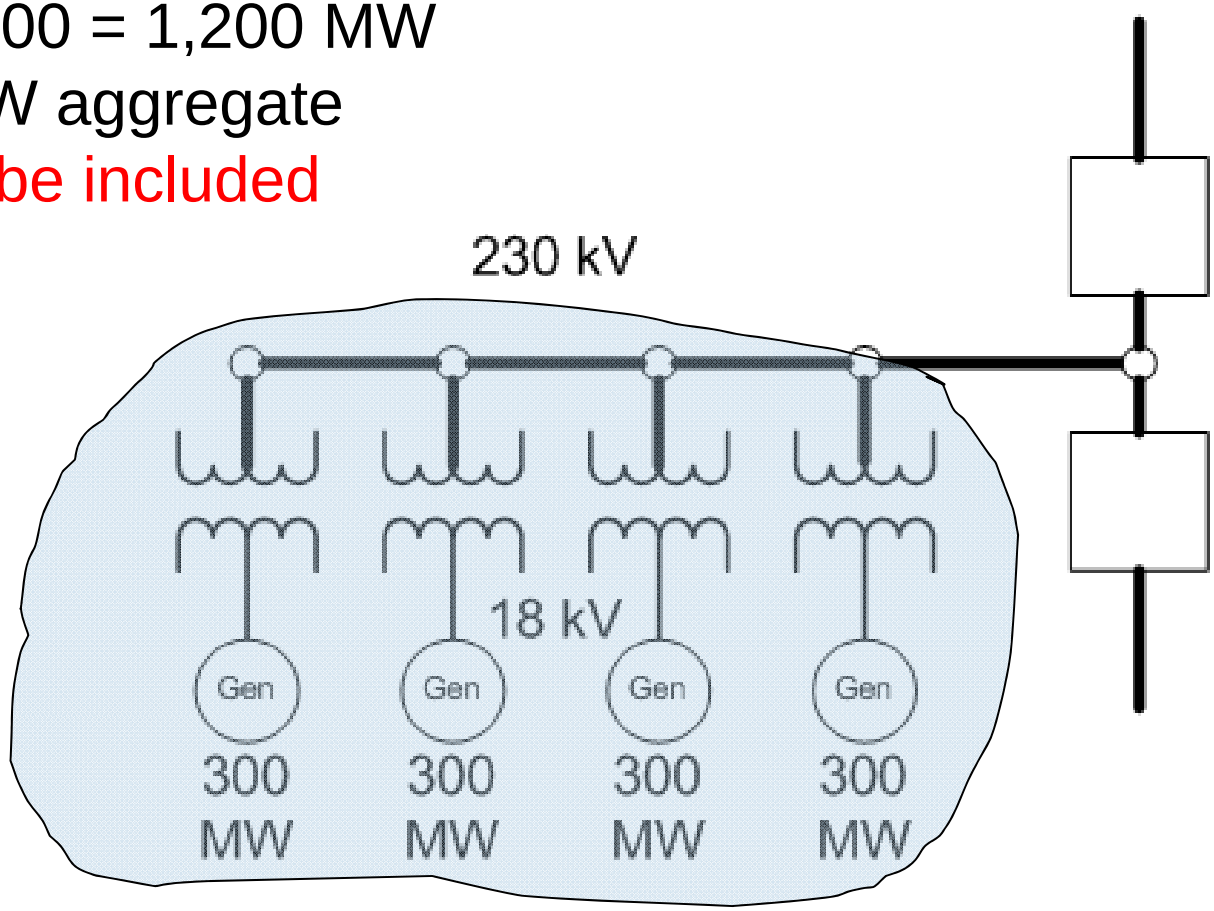


Bus with Generation

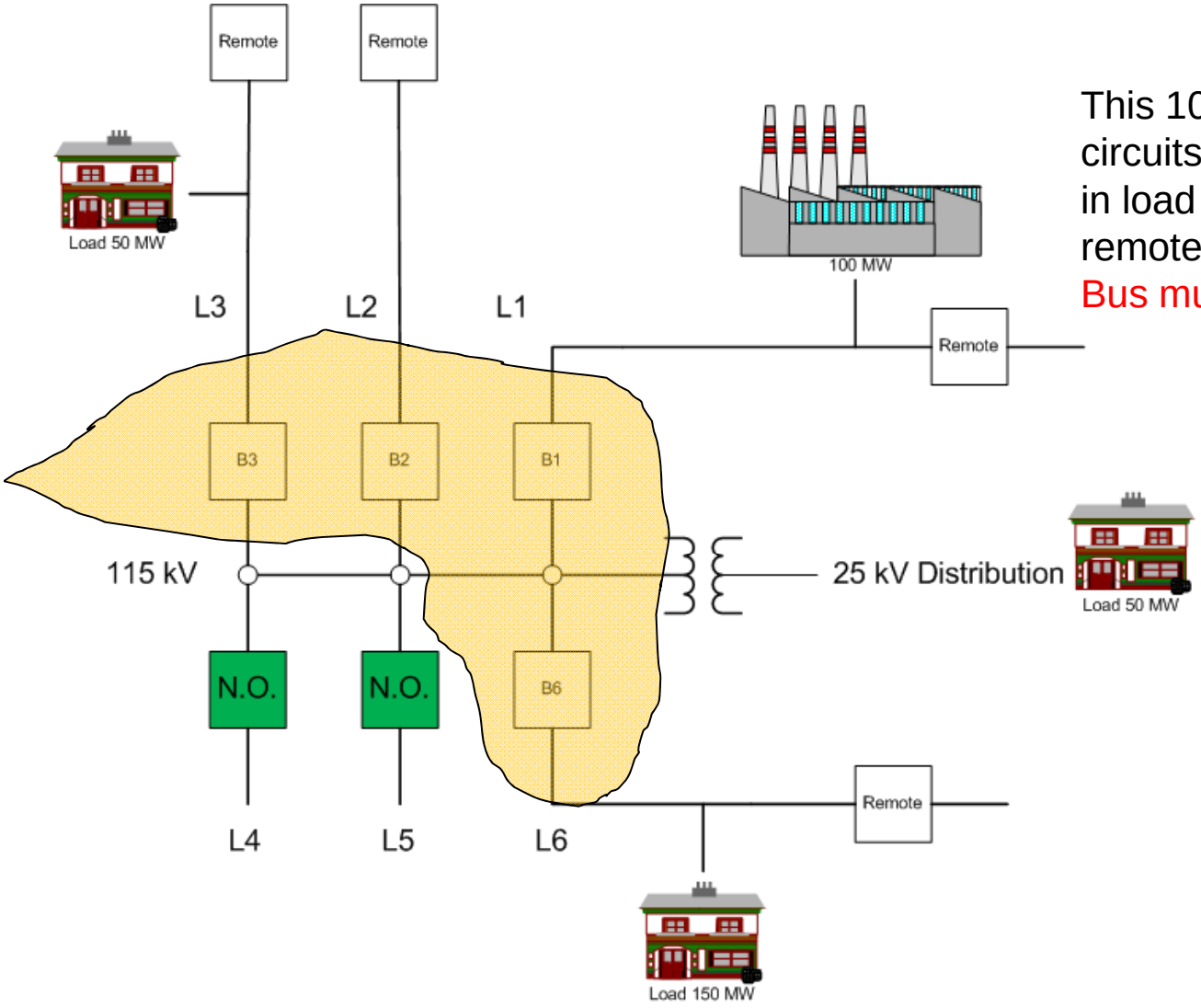
4 units x 300 = 1,200 MW

>1,000 MW aggregate

Bus must be included



100 kV & 300 MW Load Loss



This 100-200 kV bus has less than 6 circuits, but has more than 300 MW in load that would be lost during remote clearing.

Bus must be included.

Step 2

2. Each Transmission Planner will simulate a three-phase fault on each bus in its transmission planning area identified in step 1. The three-phase fault is cleared based on the following conservative simulation parameters:
   - Trip the remote terminals of all transmission lines connected to the faulted bus based on the maximum expected remote clearing time provided by the Transmission Owner or Generator Owner.
   - For each transformer connected to the faulted bus that is protected by through-fault protection, the Transmission Planner will trip the transformer at its other terminal(s) not connected to the faulted bus based on the maximum expected clearing time provided by the Transmission Owner or Generator Owner.

Note: Step 2 will be modified as shown based on clarification to Step 1

Step 2, continued

- For each transformer connected to the faulted bus that is not protected by through-fault protection, the Transmission Planner will not trip the transformer or any element connected to the other terminal(s) of the transformer not connected to the faulted bus.
- Evaluate the system response for each simulated fault against the criteria in Table C, “Performance Measures.”
- Create an initial list of buses owned by each Transmission Owner and Generator Owner at which the simulated system response exceeds at least one performance measure criteria from Table C, “Performance Measures,” and provide this initial list to each respective Transmission Owner and Generator Owner.

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Table C

Table C: Performance Measures
1. System does not maintain stability (instability of units is not indicative of system instability, but must be included in the loss of generation in measure #3)
2. Unintended system separation resulting in an island of 1,000 MW or more, not as a direct result of the remote fault clearing
3. Loss of generation of 2,000 MW or more in the Eastern Interconnection or Western Interconnection, or 1,000 MW or more in the ERCOT or Québec Interconnections (total loss of generation includes generation disconnected as a direct result of the remote fault clearing and includes generating units that do not maintain stability)

Step 3

3. The Transmission Owner and Generator Owner will evaluate the protection system(s) for each element connected at each bus identified by the Transmission Planner in step 2 and for the physical bus(es), if any, to determine whether a single point of failure exists due to not meeting the attributes for any category in Table B, “Protection System Attributes to be Evaluated.”

Step 4

4. The Transmission Owner and Generator Owner will provide the Transmission Planner with a revised list of buses at which a single point of failure exists on any element for any component category in Table B. This revised list will be used by the Transmission Planner in steps 5 and 6 to reassess the conservative simulations performed in step 2.

Step 5

5. The Transmission Planner will consult with the Transmission Owner and the Generator Owner regarding actual clearing times for all elements that will trip for a fault on each bus identified on the revised list of buses provided in step 4.

The actual clearing time is the time calculated by the Transmission Owner or Generator Owner at which the remote terminals of elements will trip for a three-phase fault on the bus under study. In some cases, an element may not trip at its remote terminals if the protection system at those terminals will not detect the fault. In such cases, the fault will remain un-cleared in the simulation.

Step 6

6. The Transmission Planner will simulate a three-phase fault on each bus identified on the revised list of buses provided in step 4 using the actual clearing times provided by the Transmission Owner and Generator Owner in accordance with the method described in step 2, except that actual clearing times will be used in place of tripping elements based on the maximum expected clearing time.

By mutual agreement with the Transmission Owners and Generator Owners, the Transmission Planner may test all buses using actual clearing times provided by the Transmission Owner and Generator Owner in step 2.

Step 7

7. The Transmission Planner will update the revised list of buses owned by each Transmission Owner and Generator Owner developed in step 2, at which the simulated system response exceeds at least one performance measure criteria in Table C, "Performance Measures," and provide the final list to each respective Transmission Owner and Generator Owner.

Step 8

8. The Transmission Owner and Generator Owner will provide "as-built" information to the Transmission Planner necessary for the Transmission Planner to complete the data request reporting template. This data includes:
   - The attributes of the protection system(s) listed in Table B, "Protection System Attributes to be Evaluated," for each bus from the final list provided by the Transmission Planner in step 7.
   - The attributes of the station dc supply listed in Table D, "Station DC Supply Attributes to be Reported," for each bus that meet the criteria in Table A, "Buses to be Evaluated."

Table D

Table D: Station DC Supply Attributes to be Reported
The protection system includes two independent station dc supplies
The protection system includes one dc supply that is centrally monitored, including alarming for a battery open condition if the station dc supply is a battery
The protection system includes one dc supply that is centrally monitored, but does not include alarming for a battery open condition if the station dc supply is a battery
The protection system includes one dc supply that is not centrally monitored

Note: *A station dc supply includes one station battery, or single charger, or other single dc source.*

Step 9

9. The Transmission Planner will provide the following information in accordance with the data request reporting template.
   - Statistics concerning the buses evaluated
   - Statistics concerning the attributes of the protection system(s) associated with each identified element
   - Statistics concerning the attributes of the station dc supply at selected buses in each transmission planning area

Data reporting will be facilitated through a web-based application based on the data request reporting template provided with the data request. The accompanying template is unofficial and intended to assist the Transmission Planner. NERC will issue instructions on the method of reporting consistent with the reporting schedule.

Schedule

Period*	Activity
1st month	Starting point of the data request period
2nd month	Transmission Planners must acknowledge the request for data
4th month	Transmission Planners must report which step(s) are complete
7th month	Transmission Planners must report which step(s) are complete
10th month	Transmission Planners must report which step(s) are complete
11th month	Electronic data reporting period opens (60 days)
Last day of the 12th month	Transmission Planner data reporting must be complete

***Period** is the first calendar day of the month number following BOT approval, except as noted otherwise.

Rationale

- Developed to reduce burden on registered entities
  - Transmission Planners may utilize existing studies
  - Asset owners may utilize existing “as-built” information
- Representative sample of buses > 100 kV
  - Avoids testing all buses, but includes sample of 100-200 kV
- Collects data to identify specific areas of potential exposure
  - Protection systems
  - Station dc supply

Rationale, continued

- Three-phase faults
  - Bounds the concern with single-line-to-ground faults evolving to multi-phase
  - Facilitates use of existing analyses
- Performance measure
  - Based on system performance observed in past events that formed basis for NERC Industry Alert (March 2009)

Data Reporting

- Reporting template
  - Reporting template provided as a tool to assist entities
  - Further guidance to be provided on the reporting method
- Data to be reported
  - Statistics concerning the number of buses evaluated
  - Statistics concerning attributes of protection systems
  - Statistics concerning the attributes of station dc supplies
- The data collection is designed to avoid skewing the data; e.g.,
  - The request for voltage transformers and current transformers excludes common primary windings
  - The request for station dc supply requests additional information regarding alarming when only one station battery is used

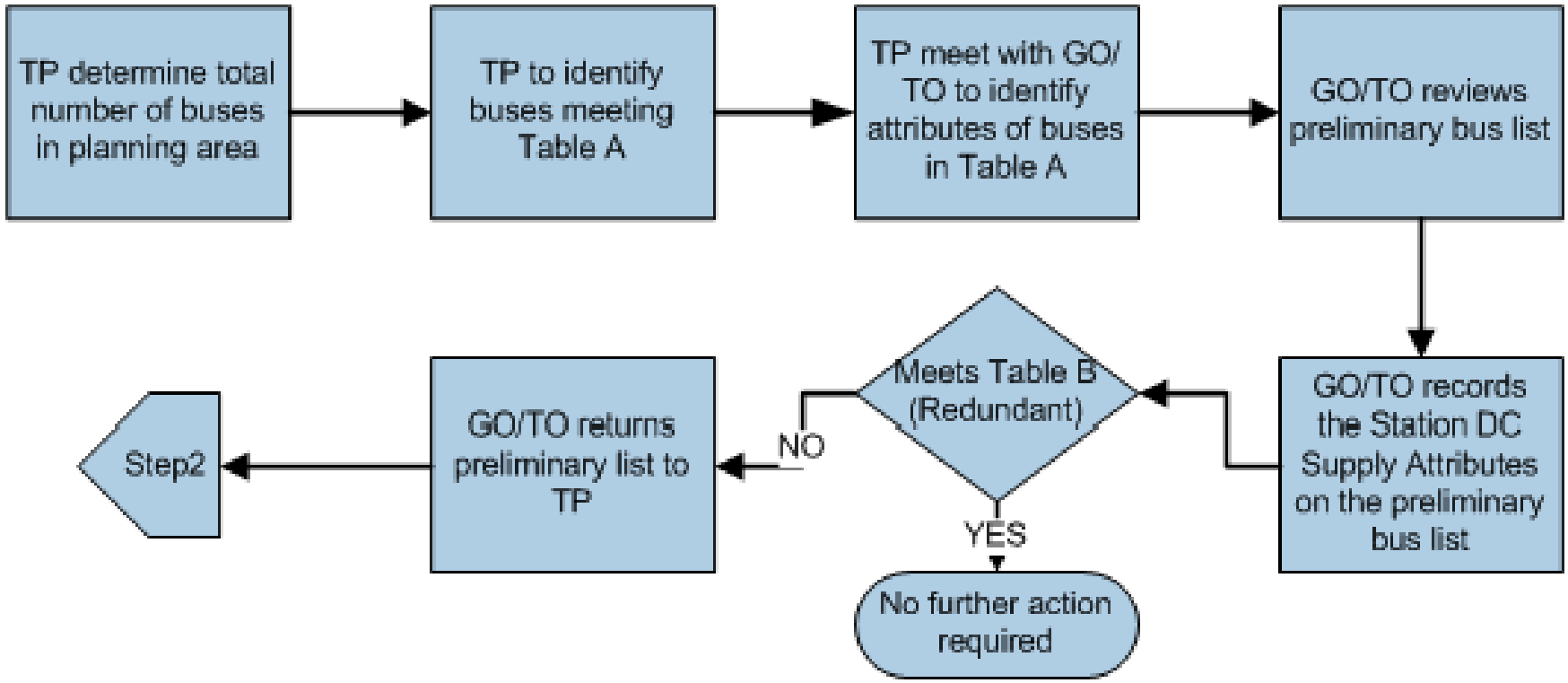
Posted for Comment

- Informal Comment Period
  - 45 days, ending February 6, 2012
  - Use website for submitting comments
  - Summary consideration of comments
- Desired comment feedback
  - Method
  - Template
  - Schedule
  - Other items
- If submitting as a group . . .

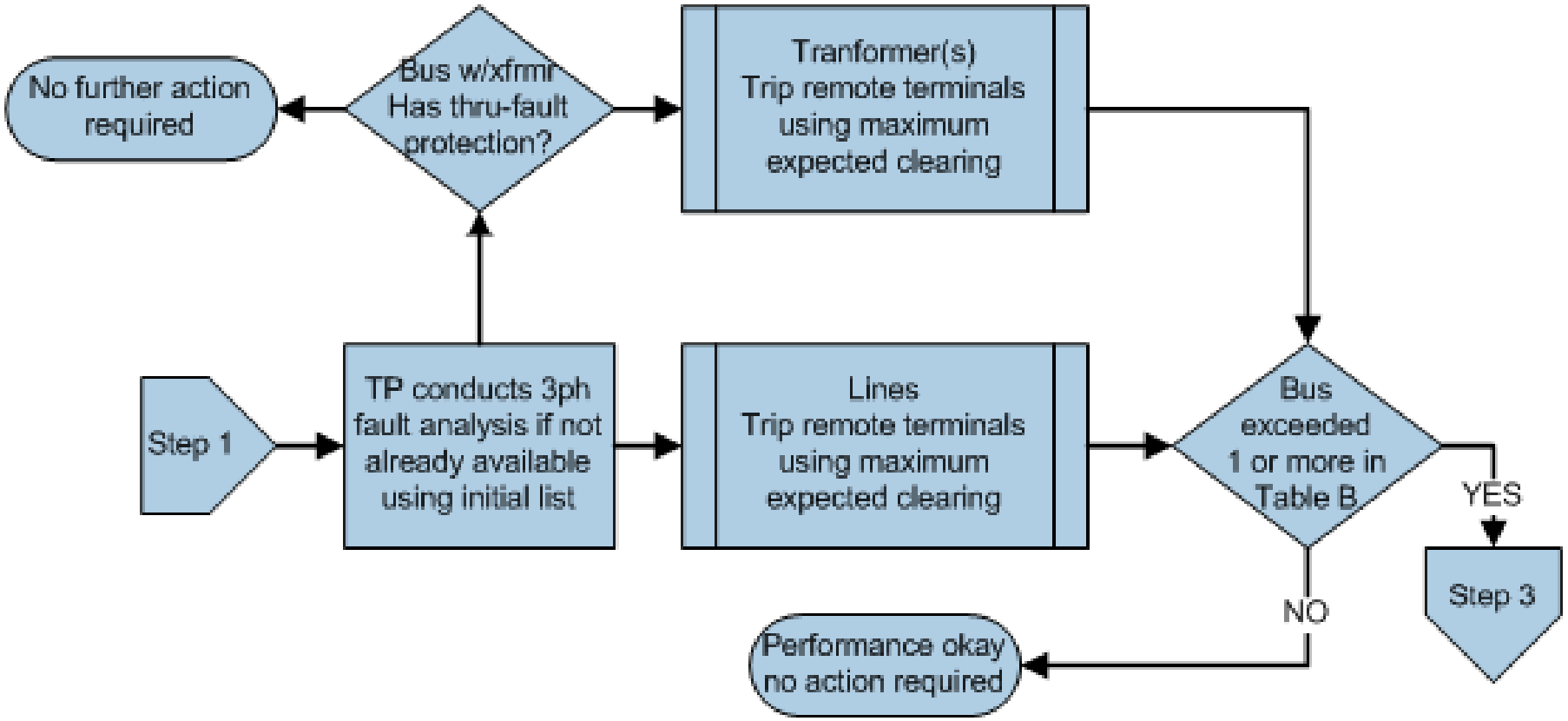
Questions and Answers

- Please submit your questions via the chat feature in ReadyTalk
- The presenters will respond to as many questions as possible during remainder of the scheduled webinar
- Complete slide set will be posted tomorrow on the Order 754 project page in the “Standards Under Development” area

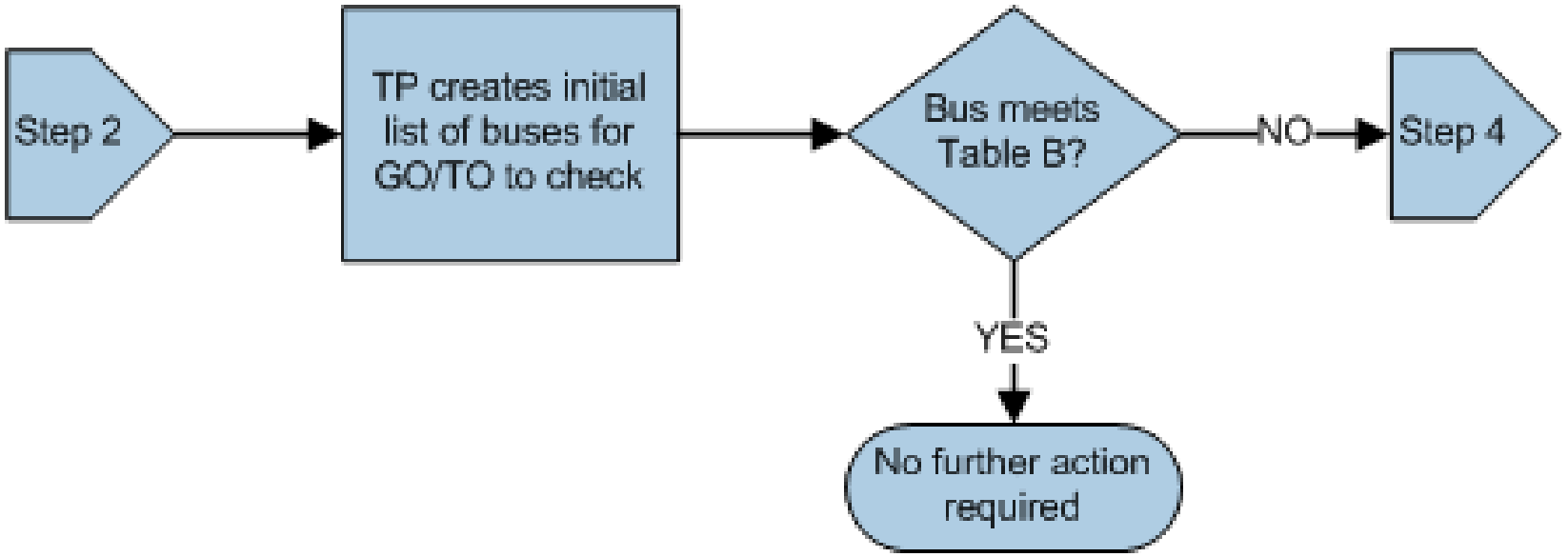
Step 1


TP determine total number of buses in planning area
TP to identify buses meeting Table A
TP meet with GO/TO to identify attributes of buses in Table A
GO/TO reviews preliminary bus list
GO/TO records the Station DC Supply Attributes on the preliminary bus list
Meets Table B (Redundant)
NO
YES
GO/TO returns preliminary list to TP
Step2
No further action required

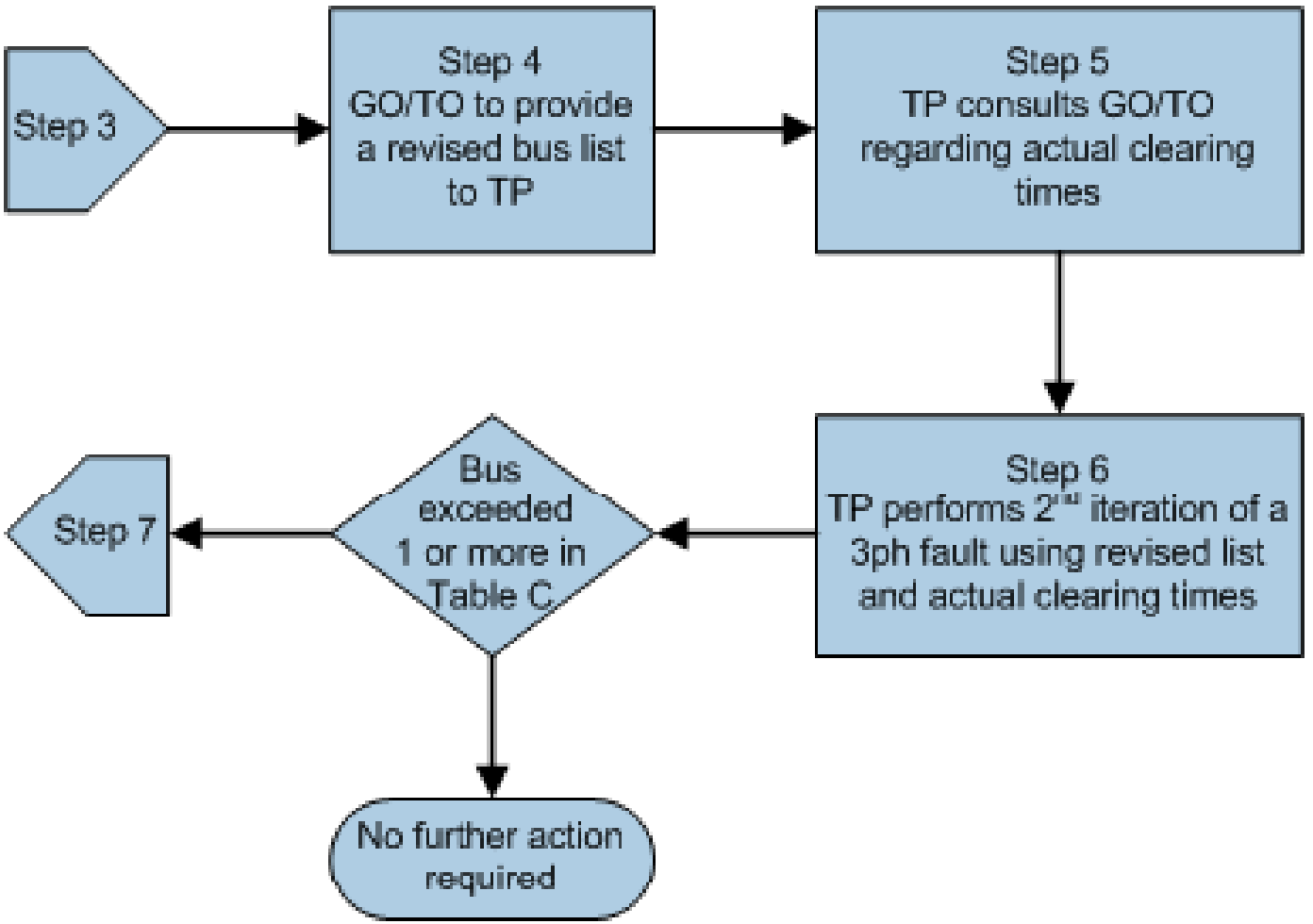
Step 2


No further action required
Bus w/xfmr Has thru-fault protection?
Tranformer(s) Trip remote terminals using maximum expected clearing
Step 1
TP conducts 3ph fault analysis if not already available using initial list
Lines Trip remote terminals using maximum expected clearing
Bus exceeded 1 or more in Table B
YES
Step 3
NO
Performance okay no action required

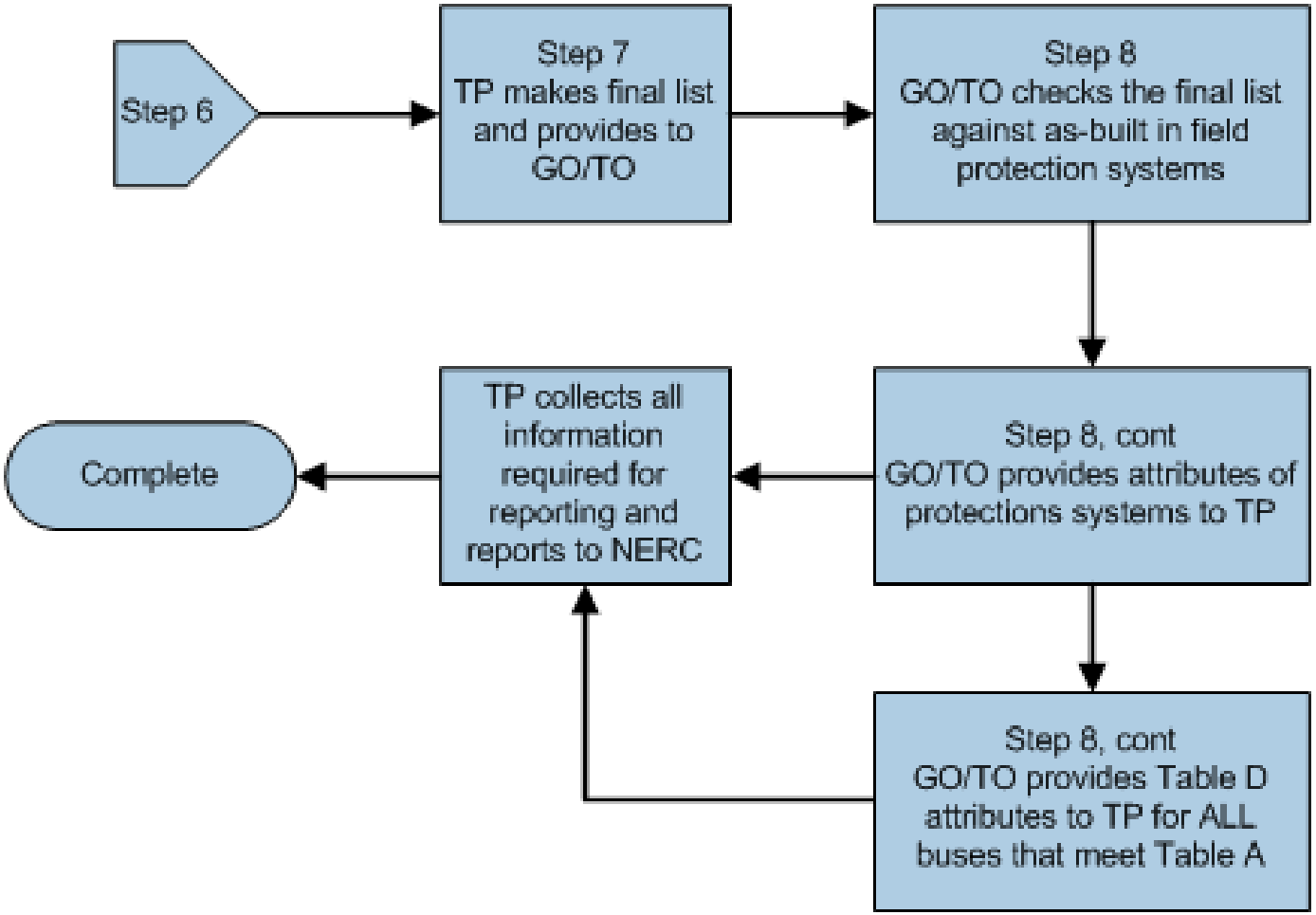
Step 3


Step 2
TP creates initial list of buses for GO/TO to check
Bus meets Table B?
NO
Step 4
YES
No further action required

Step 4 - 6


Step 3
Step 4
GO/TO to provide a revised bus list to TP
Step 5
TP consults GO/TO regarding actual clearing times
Step 6
TP performs 2nd iteration of a 3ph fault using revised list and actual clearing times
Bus exceeded 1 or more in Table C
Step 7
No further action required

Step 7 - 9


Step 6
Step 7
TP makes final list and provides to GO/TO
Step 8
GO/TO checks the final list against as-built in field protection systems
Step 8, cont
GO/TO provides attributes of protections systems to TP
Step 8, cont
GO/TO provides Table D attributes to TP for ALL buses that meet Table A
TP collects all information required for reporting and reports to NERC
Complete