

PRC-002-AB-2/PRC-005-AB1-6

Lessons Learned

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AESO ARS Compliance Monitoring team

- Peter Wong – Director, External Compliance Monitoring
- Daniela Cismaru – Manager, ARS Compliance Monitoring
- ➔ – Peter Tam – Compliance Specialist, ARS Compliance Monitoring
- Joan Gaerlan – Senior Auditor, ARS Compliance Monitoring
- Nicole Poulin – Engineer, ARS Compliance Monitoring
- Cameron Chung – Senior Compliance Specialist
- David Lemstra – Senior ARS Compliant Specialist

Purpose and Objectives

To share the lessons learned from the power system audits completed in Q1 ~ Q3/2020 so that the industry can

- Better understand the requirements
- Understand what is expected to demonstrate compliance

This session will cover lessons learned from 2020 audits on PRC-002 and PRC-005 including:

- Audit Findings
- AESO Expectations
- General Observations

Compliance monitoring lessons learned from Q1 ~ Q3/2020
ARS Audit for the following standards:

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- A red arrow with a blue outline pointing to the right, highlighting the first bullet point.
- PRC-002-AB-2 Disturbance Monitoring and Reporting Requirements
 - PRC-005-AB1-6 Protection System, Automatic Reclosing, and Sudden Pressure Relaying Maintenance

The 2020 audit periods are as follows:

- Q1/2020: January 1, 2017 to December 31, 2019
- Q2/2020: April 1, 2017 to March 31, 2020
- Q3/2020: July 1, 2017 to June 30, 2020

Audited Requirements for Q1 ~ Q3/2020

- R1, R12
- For the rest of the requirements, the compliant date is beyond Q1~Q3/2020 audit period (see Appendix 2 - Implementation Plan)

R1 Each legal owner of a transmission facility must:

R1.1 identify **bulk electric system** buses for which sequence of events recording and **fault** recording data is required by using the methodology in Appendix 1.

Appendix 1
Methodology for Selecting Bulk Electric System Buses for Capturing Sequence of Events Recording and Fault Recording Data
(Requirement R1)

To identify monitored **bulk electric system** buses for sequence of events recording and **fault** recording data required by requirement R1, each **legal owner** of a **transmission facility** must follow sequentially, unless otherwise noted, the steps listed below:

Step 1 Determine a complete list of **bulk electric system** buses that it owns.

For the purposes of this **reliability standard**, a single **bulk electric system** bus includes physical buses with breakers connected at the same voltage level within the same physical location sharing a common ground grid. These buses may be modeled or represented by a single node in **fault** studies. For example, ring bus or breaker-and-a-half bus configurations are considered to be a single bus.

Step 2 Reduce the list to those **bulk electric system** buses that have a maximum available calculated 3-phase short circuit MVA of 1,500 MVA or greater. If there are no buses on the resulting list, proceed to Step 7.

Appendix
1 consists
of 9 steps

Audit Findings

- Not ALL BES buses were identified
 - *Note: A BES bus is a bus rated at 100 kV or above*
- No evidence of the identification of the BES buses being done per Appendix 1 prior to the effective day of the standard
- Incorrect interpretation that enabling microprocessor relays to get sequence of event recording data, and fault recording data at all substations alone meets R1
- The rated short-circuit withstand capacity of the BES bus was misinterpreted as maximum available calculated 3-phase short circuit MVA
- The short circuit calculation is incorrectly used as evidence to demonstrate compliance with the requirement

AESO Expectations

- Evidence to demonstrate that the identification of ALL buses using the methodology as specified in Appendix 1 was done on or before October 1, 2019
 - Determine the complete list of BES buses per step 1 and
 - Identify the BES buses for which sequence of events recording and fault recording data is required per step 2 to step 9.
- Use the latest short circuit base cases to determine the maximum available calculated 3-phase short circuit MVA to ensure that all the latest system configurations and parameters are included in the base cases.

General Observations

- Detailed documented process for BES buses identification
- The process duly follows the Appendix 1 methodology
- Tools are used to determine a maximum available calculated 3-phase short circuit MVA of 1,500 MVA or greater
- Quality evidence - fault level calculation sheets or screenshots are provided to demonstrate compliance
- The legal owners of system elements connected to the BES buses identified per R1.1 were notified in a timely manner (within 90 days of completion of R1.1.)

Compliance monitoring lessons learned from Q1 ~ Q3/2020
ARS Audit for the following standards:

- PRC-002-AB-2 Disturbance Monitoring and Reporting Requirements
-  • PRC-005-AB1-6 Protection System, Automatic Reclosing, and Sudden Pressure Relaying Maintenance

Audited Requirements based on audit period:

- Q1/2020 : R1, R2, R5
- Q2/2020 : R1, R2, R5
- Q3/2020 : R1, R2, R3, R4 and R5

Note: The compliant date for R3 and R4 is April 1, 2020. (See Appendix 5- Implementation Plan)

The purpose of this reliability standard is to document and implement programs for the maintenance of the following:

- Protection systems,
- Automatic reclosing, and
- Sudden pressure relaying
- R1: Establish a protection system maintenance program (PSMP)
- R2: Follow procedures if performance-based maintenance is used
- R3: Perform components maintenance (time-based)
- R4: Perform components maintenance (performance-based)
- R5: Correct unresolved maintenance issues

R1 Each **legal owner** of a **transmission facility**, **legal owner** of a **generating unit**, and **legal owner** of an **aggregated generating facility** must establish a **protection system maintenance program** for its **protection systems**, automatic reclosing, and sudden pressure relaying.

The **protection system** maintenance program must:

- **R1.1** identify which maintenance method (a time-based method, the performance-based method per Appendix 2, or a combination of these maintenance methods) is used to address each **protection system**, automatic reclosing, and sudden pressure relaying **component type** (as identified in Appendix 1). All batteries associated with the station dc supply component type of a **protection system** must be included in a time-based program as described in Table 1-4 and Table 3 of Appendix 1.

- PRC-005-AB-6 is a prescriptive standard specifying maintenance activities and intervals for each component type in 18 tables, Appendix 1
- Component – Any individual discrete piece of equipment included in a Protection System, Automatic Reclosing, or Sudden Pressure Relaying.

Table 1-1 Maintenance Activities and Intervals for Protection Systems Component Type - Protective Relay Excluding distributed UFLS and distributed UVLS (see Table 3)		
Component Attributes	Maximum Maintenance Interval	Maintenance Activities
Monitored microprocessor protective relay with the following: <ul style="list-style-type: none"> <input type="checkbox"/> Internal self-diagnosis and alarming (see Table 2); <input type="checkbox"/> Voltage and/or current waveform sampling three or more times per power cycle, and conversion of samples to numeric values for measurement calculations by microprocessor electronics; and <input type="checkbox"/> Alarming for power supply failure (see Table 2). 	12 calendar years	Verify: <ul style="list-style-type: none"> <input type="checkbox"/> Settings are as specified; <input type="checkbox"/> Operation of the relay inputs and outputs that are essential to proper functioning of the protection system; and <input type="checkbox"/> Acceptable measurement of power system input values.

- Component Types - ID #2018-009

Device	Component Type
Protection System	<ul style="list-style-type: none"> • protective relay • communication system • voltage and current sensing devices providing inputs to protective relays • protection system station dc supply • control circuitry associated with protective functions
Automatic Reclosing	<ul style="list-style-type: none"> • reclosing relay • supervisory relay(s) or function(s) – relay(s) or function(s) that perform voltage and/or sync check functions that enable or disable operation of the reclosing relay • voltage sensing devices associated with the supervisory relay(s) or function(s) • control circuitry associated with the reclosing relay or supervisory relay(s) or function(s)
Sudden Pressure Relay	<ul style="list-style-type: none"> • fault pressure relay • control circuitry associated with a fault pressure relay

The **protection system** maintenance program must:

R1.2 include the applicable monitored component attributes applied to each **protection system**, automatic reclosing, and sudden pressure relaying component type consistent with the maintenance intervals specified in Tables 1-1 through 1-5, Table 2, Table 3, Tables 4-1 through 4-3, and Table 5 of Appendix 1, where monitoring is used to extend the maintenance intervals beyond those specified for unmonitored **protection system**, automatic reclosing, and sudden pressure relaying components.

- See next slide for Unmonitored vs Monitored

Unmonitored vs Monitored

Table 1-1 Maintenance Activities and Intervals for Protection Systems Component Type - Protective Relay Excluding distributed UFLS and distributed UVLS (see Table 3)		
Component Attributes	Maximum Maintenance Interval	Maintenance Activities
Any unmonitored protective relay not having all the monitoring attributes of a category below.	6 calendar years	<p>For all unmonitored relays:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Verify that settings are as specified. <p>For non-microprocessor relays:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Test and, if necessary, calibrate. <p>For microprocessor relays:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Verify operation of the relay inputs and outputs that are essential to proper functioning of the protection system; and <input type="checkbox"/> Verify acceptable measurement of power system input values.

Table 1-1 Maintenance Activities and Intervals for Protection Systems Component Type - Protective Relay Excluding distributed UFLS and distributed UVLS (see Table 3)		
Component Attributes	Maximum Maintenance Interval	Maintenance Activities
<p>Monitored microprocessor protective relay with the following:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Internal self-diagnosis and alarming (see Table 2); <input type="checkbox"/> Voltage and/or current waveform sampling three or more times per power cycle, and conversion of samples to numeric values for measurement calculations by microprocessor electronics; and <input type="checkbox"/> Alarming for power supply failure (see Table 2). 	12 calendar years	<p>Verify:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Settings are as specified; <input type="checkbox"/> Operation of the relay inputs and outputs that are essential to proper functioning of the protection system; and <input type="checkbox"/> Acceptable measurement of power system input values.

- Per ID #2018-009, The AESO recognizes the NERC Supplementary Reference and FAQ document, October 2015 may be a useful reference for market participants for implementing PRC-005.
- 116 pages technical information



Audit Findings:

- Protection system maintenance program (PSMP) not being in place on the effective date of the standard
- Not all component types being identified in the PSMP, e.g.
 - Incorrect interpretation that determining maintenance interval and activities for an integrated system-wise end-to-end functional testing without need to defining each component type that comprises the end-to-functional testing meets R1:
 - *Supervisory relay, trip coils, lockout relays, control circuitry, etc.*
 - The protection systems such as relays with different functionality are bundled together in determining maintenance interval and activities that are inconsistent with Tables as defined in Appendix 1

– Incorrect component types

- The site-specific PSMP defines maintenance interval and activities for Value Regulated Lead Acid (VRLA) batteries but, in fact, Vented Lead Acid (VLA) batteries are actually used on site

– Deficient evidence

- Lack of initial evidence being submitted, which resulted in additional IRs and extensions. Examples are evidence about monitored component attributes
- Maintenance records are evidence for R3. Though the specific maintenance interval is noted therein, it is not deemed as evidence for R1 which requires a maintenance program.

AESO expectations

- PSMP correctly identifies the component types and update, where necessary.
- All applicable components types should be clearly differentiated and identified as per Appendix 1
 - Example – if relays are used for distributed UVLS/UFLS, document separately consistent with the following table:

Table 3 Maintenance Activities and Intervals for distributed UFLS and distributed UVLS Systems		
Component Attributes	Maximum Maintenance Interval	Maintenance Activities
Monitored microprocessor protective relay with preceding row attributes and the following: <ul style="list-style-type: none"> □ Ac measurements are continuously verified by comparison to an independent ac measurement source, with alarming for excessive error (See Table 2); and □ Some or all inputs and outputs are monitored by a process that continuously demonstrates ability to perform as designed, with alarming for failure (See Table 2). Alarming for change of settings (See Table 2).	12 calendar years	Verify only the unmonitored relay inputs and outputs that are essential to proper functioning of the protection system .
Voltage and/or current sensing devices associated with UFLS or UVLS systems.	12 calendar years	Verify that current and/or voltage signal values are provided to the protective relays.

- Present information/evidence in table form consistent with tables in Appendix 1
- Provide evidence to demonstrate monitored component attributes

General Observations

- Comprehensive standards/policies for defining site-specific PSMPs were provided
- Detailed maintenance practices and procedures were available, although they are not required by the standard
- Quality evidence
 - Spreadsheet format is easier for assessment and data manipulation
 - Evidence of monitored component attributes are well prepared
- Performance-based evaluation procedures being duly followed

R3 Each **legal owner** of a **transmission facility**, **legal owner** of a **generating unit**, and **legal owner** of an **aggregated generating facility** that uses time-based maintenance program(s) must maintain its **protection system**, automatic reclosing, and sudden pressure relaying components that are included within the time-based maintenance program in accordance with the minimum maintenance activities and maximum maintenance intervals prescribed within Tables 1-1 through 1-5, Table 2, Table 3, Tables 4-1 through 4-3, and Table 5 of Appendix 1.

- Per Measures for R3 , evidence may include, but is not limited to, dated maintenance records, dated maintenance summaries, dated check-off lists, dated inspection records, or dated work orders or other equivalent evidence.

Component Attributes	Maximum Maintenance Interval	Maintenance Activities
Protection system station dc supply using Vented Lead-Acid (VLA) batteries not having monitoring attributes of Table 1-4(f).	4 months unless a variance is granted by the AESO	Verify: <ul style="list-style-type: none"> <input type="checkbox"/> Station dc supply voltage Inspect: <ul style="list-style-type: none"> <input type="checkbox"/> Electrolyte level; and <input type="checkbox"/> For unintentional grounds
	18 months	Verify: <ul style="list-style-type: none"> <input type="checkbox"/> Float voltage of battery charger <input type="checkbox"/> Battery continuity <input type="checkbox"/> Battery terminal connection resistance <input type="checkbox"/> Battery intercell or unit-to-unit connection resistance

Audit Findings

- No evidence to demonstrate that the required maintenance activities were being performed
- Submission of maintenance procedures or guides are not sufficient to demonstrate implementation

AESO Expectations

- Dated maintenance records demonstrating that the required maintenance activities being performed
- Checkoff for each minimum maintenance activities, e.g.
 - Inspect for unintentional grounds
 - Check electrolytic level
- Quality check on maintenance records regularly to ensure that the required maintenance activities are properly documented

An example of 4-month battery maintenance record

Collected Reads Data by Inspection Form and Equipment

Location:	EXAMPLE	Equip Type:	Battery
Equip #:	BA-Example-1	Manufacturer:	ALCAD
Equip Position:	EXAMPLE 125 V SUBST	Model:	SD11
Serial #:		Mfg Date:	4/1/2000 00:00

Inspection Form	Inspection Start Date	Inspection End Date	Inspection Type	Reading Type
EXAMPLE Substation Inspection	12/1/2014 12:30	12/1/2014 14:00	Patrol	BatteryInspection

Charger Amps:	2.50	amps
DC Supply Voltage:	135.00	volts
Battery Electrolyte Level OK:	Y	
No Unintentional Grounds:	Y	
Battery Condition:	OK	
Ground Test Negative:	OK	
Ground Test Positive:	OK	
Fuses in Good Condition:	OK	
Breakers Reset:	OK	
Battery Placard Posted:	Y	

Items highlighted in yellow are required maintenance activity verifications/inspections per PRC-005-

- Source: *Standard Application Guide PRC-005-6 Version 2.2a*
- ERO Enterprise-endorsed implementation guidance, can be found in NERC web site. <http://www.nerc.com>
- More templates of maintenance records can be found in the above document

- Table 1- 4(f) lists all the exclusions for protection system station dc supply monitoring devices and systems

Table 1-4(f) Exclusions for Protection System Station dc Supply Monitoring Devices and Systems		
Component Attributes	Maximum Maintenance Interval	Maintenance Activities
Any station dc supply with high and low voltage monitoring and alarming of the battery charger voltage to detect charger overvoltage and charger failure (See Table 2).	No periodic maintenance specified	No periodic verification of station dc supply voltage is required.
Any battery based station dc supply with electrolyte level monitoring and alarming in every cell (See Table 2).		No periodic inspection of the electrolyte level for each cell is required.

- If exclusion is applied, evidence must be submitted to support or justify the exclusion
- Additional criteria can be found in Table 2 (see next slide)

- Table 2 describes about monitoring and alarming paths

Table 2 – Alarming Paths and Monitoring		
In Tables 1-1 through 1-5, Table 3, Tables 4-1 through 4-3, and Table 5 alarm attributes used to justify extended maximum maintenance intervals and/or reduced maintenance activities are subject to the following maintenance requirements		
Component Attributes	Maximum Maintenance Interval	Maintenance Activities
<p>Any alarm path through which alarms in Tables 1-1 through 1-5, Table 3, Tables 4-1 through 4-3, and Table 5 are conveyed from the alarm origin to the location where corrective action can be initiated, and not having all the attributes of the “Alarm Path with monitoring” category below.</p> <p>Alarms are reported within 24 hours of detection to a location where corrective action can be initiated.</p>	12 Calendar Years	Verify that the alarm path conveys alarm signals to a location where corrective action can be initiated.
<p>Alarm Path with monitoring:</p> <p>The location where corrective action is taken receives an alarm within 24 hours for failure of any portion of the alarming path from the alarm origin to the location where corrective action can be initiated.</p>	No periodic maintenance specified	None.

General Observations

- Maintenance records contain sufficient information to demonstrate compliance - they include, but are not limited to, the following:
 - Date/time of the maintenance activity
 - Names of maintenance crew in charge
 - Identification of the elements subject to maintenance
 - Checkoff for each minimum maintenance activities, e.g.
 - *Inspect for unintentional grounds:*
 - *Check electrolytic level :*
- Maintenance intervals and activities are duly followed

R5 Each **legal owner** of a **transmission facility**, **legal owner** of a **generating unit**, and **legal owner** of an **aggregated generating facility** must demonstrate efforts to correct identified unresolved maintenance issues.

- Unresolved Maintenance Issue (UMI) is not an defined term
- Per NERC Supplementary Reference and FAQ document:
 - UMI refers to deficiency identified during a maintenance activity that causes the component to not meet the intended performance, cannot be corrected during the maintenance interval, and requires follow-up corrective action
 - Maintenance activity necessarily includes both the detection of problems and the repairs needed to eliminate those problems
 - This standard does not identify all of the Protection System problems that must be detected and eliminated, rather it is the intent of this standard that an entity determines the necessary working order for their various devices, and keeps them in working order

Audit Findings

- Some unresolved issues were not identified

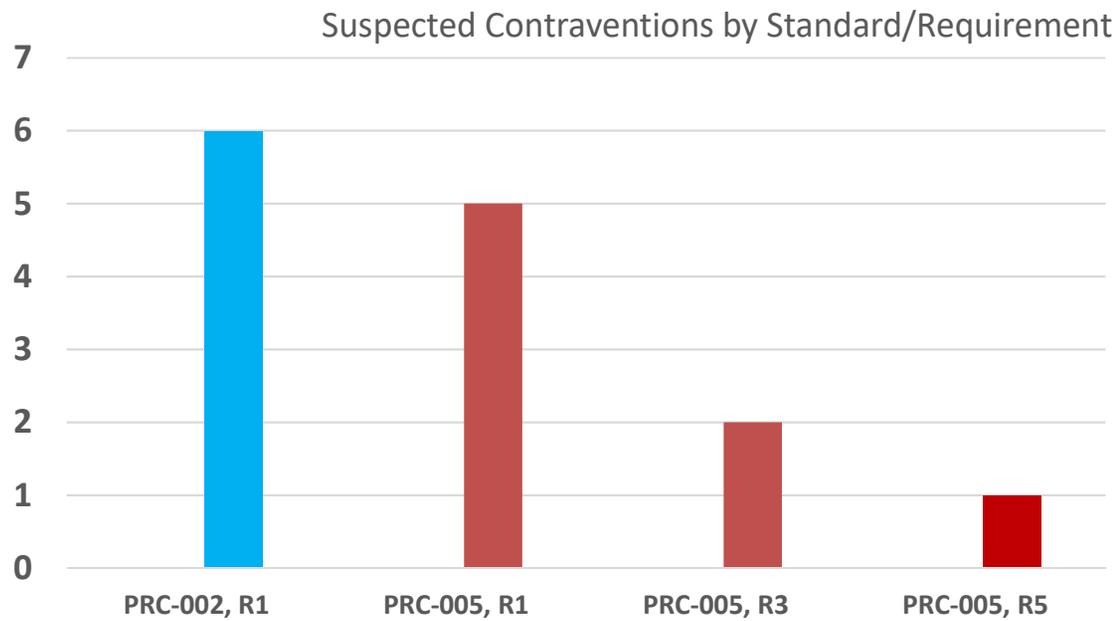
AESO Expectations

- All unresolved maintenance issues must be identified
- Evidence of effort to resolve the issues must be readily available to demonstrate compliance e.g. corrective action plans, work orders to repair the issue, purchasing orders to replace the defects
- An attestation letter if no unresolved maintenance issues are identified and additional evidence may be asked to corroborate the assertion

General Observations

- A documented process has been established to define and handle unresolved maintenance issues
- Tools are used to keep track of unresolved maintenance issues and notify the responsible personnel
- Quality evidence to demonstrate compliance

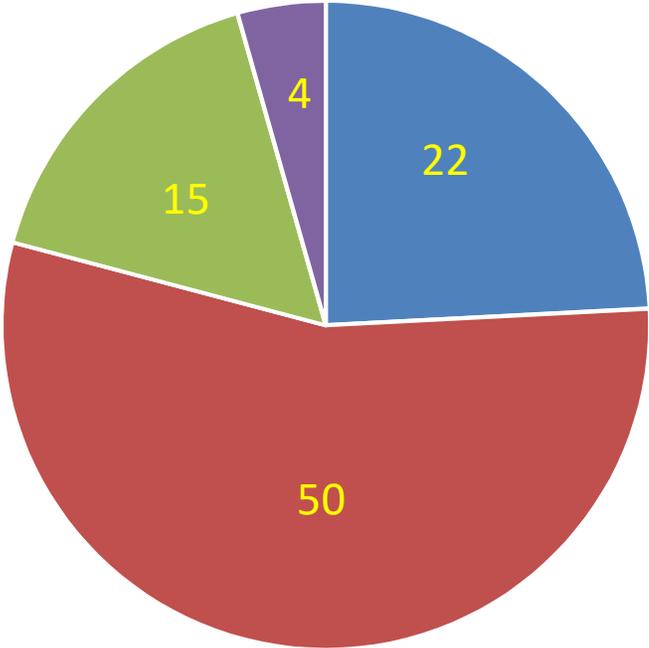
Suspected Contraventions Statistics



Information Request Statistics



Number of IR Questions



■ PRC-002, R1 ■ PRC-005, R1 ■ PRC-005, R3 ■ PRC-005, R5

	IR Issues	IR Questions
PRC-002, R1	15	22
PRC-005, R1	22	50
PRC-005, R3	11	15
PRC-005, R5	4	4

- No updates to IDs are planned as a result of the 2020 audits on PRC-002 and PRC-005
- In the event that you need further information regarding the requirements of an existing Authoritative Document, please refer to:
 - ID #2017-001, Requests for Information Regarding Authoritative Documents

Q&A

- Any further questions regarding the content of the presentation or ARS compliance monitoring program can be sent to:
 - rscompliance@aeso.ca
- Questions regarding standards or requirements can be submitted through the formal AESO RFI process:
 - ID #2017-001, Requests for Information Regarding Authoritative Documents

ARS Workplan Update

Ken Gardner

<https://www.aeso.ca/rules-standards-and-tariff/alberta-reliability-standards/>

Alberta reliability standards program work plan

- To see ARS currently scheduled for development, view the [Alberta reliability standards program work plan](#).
- Update: November 2020



Adobe Acrobat
Document