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ADMINISTRATOR

Report on Alberta Electric System Operator Primary Frequency Response Compliance Monitoring Practices

July 23, 2026

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TABLE OF CONTENTS

EXECUTIVE SUMMARY	4
1 INVESTIGATION HISTORY	7
2 BACKGROUND	10
2.1 The role of PFR in the AESO.....	10
2.1.1 The PFR rules.....	11
2.1.2 The AESO's knowledge of issues with generating units' PFR	12
2.2 The AESO's compliance monitoring of the PFR rules	14
2.2.1 The AESO's compliance monitoring duties	14
2.2.2 The compliance monitoring program described by the AESO	15
3 MSA FINDINGS	19
3.1 During the investigation period, the AESO did not adequately monitor compliance with the PFR rules	19
3.1.1 The AESO did not directly assess compliance with the PFR rules using reliable model validation reports.....	20
3.1.2 The AESO's process screened out potential contraventions in 2020 for improper reasons	23
3.1.3 The AESO did not evaluate units' PFR performance on a regular basis.....	24
3.1.4 The AESO did not monitor generating units' PFR performance between March 2021 and August 2023	25
3.1.5 The AESO evaluated the PFR performance of a small proportion of assets in 2023.....	26
3.1.6 OEMS did not refer generating units that met the AESO's potential contravention criteria to ECM for investigation	27
3.1.7 The AESO used the wrong threshold to identify suspected contraventions	28
3.2 The AESO did not refer suspected contraventions of the PFR rules to the MSA.....	30
3.2.1 The AESO did not refer suspected contraventions to the MSA following the June 2020 event	30
3.2.2 The AESO did not refer certain suspected contraventions to the MSA following the 2022/23 events.....	32
3.3 The AESO's record-keeping practices were insufficient.....	35
4 AESO ACTIONS AFTER THE INVESTIGATION PERIOD	38
5 RECOMMENDATIONS	39
APPENDIX A: FREQUENCY EVENTS WHEN PFR SHOULD HAVE BEEN PROVIDED.....	40
APPENDIX B: AESO FORMULAS FOR PUPFR CALCULATION.....	41

APPENDIX C: ASSETS SUBJECT TO THE PFR RULES AND EVALUATED IN 2023.....	43
APPENDIX D: ASSETS INVESTIGATED IN RELATION TO THE JUNE 2020 EVENT [REDACTED]	46
APPENDIX E: INSTANCES WHEN SUSPECTED CONTRAVENTION CRITERIA WERE MET IN 2022 AND 2023, BUT NO REFERRAL WAS SENT TO THE MSA.....	47
APPENDIX F: AESO RESPONSE TO MSA SUMMARY OF FINDINGS	49

EXECUTIVE SUMMARY

This report presents the Market Surveillance Administrator's (MSA) findings and views on the Alberta Electric System Operator's (AESO) monitoring of generator compliance with the following subsections of the ISO rules between January 1, 2020, and March 5, 2025 (investigation period):

- subsection 9(1) of ISO Rule 502.5 *Generating Unit Technical Requirements* (ISO rule 502.5);
- subsection 4 of ISO Rule 502.6 *Generating Unit Operating Requirements* (ISO rule 502.6); and
- subsections 2(1) and 6 of ISO Rule 503.6 *Frequency & Speed Governing* (ISO rule 503.6).¹

These subsections of the ISO rules (collectively, the PFR rules) establish the requirements for generating units with respect to primary frequency response (PFR). In its 2023 Reliability Requirements Roadmap (2023 Reliability Roadmap) published during the investigation period, the AESO described PFR as the mechanism which “acts to stabilize system frequency following a disturbance,” and as a “buffer to supply-demand imbalance.” The AESO also explained the importance of PFR, stating that “[t]he AESO’s current highest priority is ensuring sufficient frequency response capability,” while also stating that, “[g]iven the importance of maintaining frequency stability without activating [under-frequency load shedding], focusing on inertia and PFR was a critical measure when determining the system’s capability to manage frequency response.”²

In August 2024, the MSA received a complaint that the AESO was failing to monitor generator compliance with ISO rules impacting frequency response and failing to refer all suspected contraventions to the MSA, contrary to the *Electric Utilities Act* SA 2003 c E-5.1 (EUA). The MSA notified the AESO of its investigation (investigation) in December 2024 and issued two rounds of information requests (IRs) to the AESO. Following receipt of the AESO’s responses to its IRs, the MSA provided a summary of its findings (summary of findings) to the AESO in December 2025 for the AESO’s response. The AESO responded to the summary of findings in March 2026 and provided comments on:

- the number of frequency events identified in the summary of findings;
- the breadth of the MSA’s application of the PFR rules;

¹ Footnotes in this report use MSA document ID numbers (e.g., “MSA 15229”) to refer to files from the MSA’s investigation.

² AESO 2023 *Reliability Requirements Roadmap* (March 2023), <https://www.aeso.ca/assets/Uploads/future-of-electricity/AESO-2023-Reliability-Requirements-Roadmap.pdf> (2023 Reliability Roadmap), pp. 2, 21 and 27

- the suspected contravention criteria described and applied in the summary of findings; and
- the MSA's investigation process.

The AESO's response to the summary of findings is attached as appendix F.

Based on the investigation and having considered the AESO's response to the summary of findings, the MSA finds that the AESO did not adequately monitor generators' compliance with the PFR rules during the investigation period. In particular, the AESO did not have processes in place to regularly monitor generating units' compliance with the PFR rules. In addition, when the AESO assessed compliance with the PFR rules in 2023, it only evaluated the compliance of a small number of assets subject to the PFR rules.

The MSA also finds that:

- In 2020, the AESO screened out potential contraventions of the PFR rules for improper reasons.
- Until 2021, the AESO had no active compliance monitoring program for generating units' frequency response to system frequency events.³
- For the period, the AESO did not provide records demonstrating that, between March 2021 and August 2023, it monitored compliance with the PFR rules of generating units it knew had PFR performance issues.
- In August 2021, the AESO referred one battery to the MSA for a violation of section 205.5 of the ISO rules.
- In November 2022 the MSA received a self-report from a large generator that mentioned an AESO information request they received in August 2022, though the AESO did not refer the same conduct to the MSA.
- In 2023, AESO staff did not refer potential PFR rule contraventions to the AESO's External Compliance Monitoring (ECM) group when they should have, based on the AESO's criteria for doing so.
- The AESO did not refer some suspected PFR rule contraventions to the MSA. The AESO did not refer suspected contraventions it ought to have following a frequency event on June 7, 2020 (June 2020 event), as well as 64 instances when a generating unit's

³ Root Cause Analysis Report for June 7, 2020 Load Shedding Event & Recommendations (January 2021 report), p. 91)

performance met the AESO's criteria for identifying suspected PFR Rule contraventions following a frequency event in 2022 or 2023.⁴

- The AESO's record-keeping practices with respect to its monitoring of compliance with the PFR rules were insufficient.

After receiving the AESO's response to the summary of findings, the MSA met with the AESO on May 8, 2026, to discuss the changes it had made to its processes for monitoring compliance with the PFR rules since March 2025 (when the MSA investigation period ended). The AESO also described completed and in-progress initiatives to meet the frequency stability-related action items listed in its 2025 Reliability Requirements Roadmap.⁵

Given the above information provided by the AESO, the MSA recommends the AESO:

- (a) maintain the changes to its PFR compliance monitoring process described in the May 8, 2026, meeting;
- (b) continue its progress toward meeting the frequency stability-related action items listed in its 2025 Reliability Roadmap;
- (c) revise the threshold set out in its External Compliance Monitoring Program for ISO rules (CMP) for referring suspected ISO rule contraventions to the MSA to align with the legislative framework; and
- (d) improve its record-keeping practices with respect to its monitoring of compliance with the ISO rules, particularly the decisions it makes as part of that process.

⁴ To identify frequency events, the MSA examined AESO PI data and identified instances where the system frequency went outside the 60 ± 0.036 Hz deadband prescribed in ISO rule 502.5, s. 9(1)(c) and ISO rule 503.6, s. 2(1)(c) (prescribed deadband) for at least 30 seconds (frequency event).

⁵ AESO 2025 Reliability Requirements Roadmap (August 2025), <https://www.aeso.ca/assets/Uploads/future-of-electricity/AESO-2025-Reliability-Requirements-Roadmap.pdf> (2025 Reliability Roadmap), p. 13

1 INVESTIGATION HISTORY

On August 27, 2024, the MSA received a complaint which alleged the AESO was failing to monitor generator compliance with ISO rules impacting frequency response and failing to refer all suspected contraventions to the MSA, contrary to sections 17(l.1) and 21.1 of the EUA.

In accordance with its processes, the MSA considered whether it had jurisdiction over the complaint. The MSA found it has jurisdiction over this matter, as section 39(1)(b) of the *Alberta Utilities Commission Act* SA 2007 c A-37.2 (AUCA) gives the MSA the mandate to investigate and undertake activities to address contraventions of the EUA and ISO rules and any other matters that relate to or affect the structure and performance of the electricity market. In addition, section 39(2)(a)(iii) of the AUCA specifies that the MSA's mandate includes investigation and enforcement in respect of the AESO's conduct.

The MSA issued a notice of investigation (NOI) to the AESO on December 19, 2024, which informed it of the MSA's investigation into possible contraventions by the AESO of sections 17(l.1) and 21.1 of the EUA and ISO rule 103.12 *Compliance Monitoring* (ISO rule 103.12). The NOI indicated that the investigation included the AESO's monitoring of generating unit owners' and operators' compliance with the PFR rules, and the AESO's referral of suspected contraventions of those rules to the MSA.⁶

The MSA issued an IR to the AESO on March 5, 2025 (first IR).⁷ In the first IR, the MSA requested the AESO provide:

- (a) a description of how the AESO monitored the PFR provided by generating units, the data or information the AESO used to do so, and any records describing the AESO's process or practices for doing so;
- (b) information about how the AESO assessed the PFR provided by dispatched generating units following a frequency event, including any records memorializing how it did so;
- (c) a description of the AESO's process to assess suspected contraventions of the PFR rules, including all records the AESO kept in respect of this process and any records memorializing its process to identify and assess suspected contraventions of the PFR rules;
- (d) a description of steps the AESO took which resulted in some suspected PFR rule contraventions being referred to the MSA in July 2024, for a frequency event on May 27, 2022,⁸ and all AESO records regarding those referrals and that frequency event;

⁶ MSA 15229; MSA 15230

⁷ MSA 15226; MSA 15227

⁸ This is one of the 2022/23 events discussed in this report.

- (e) descriptions of how the AESO determined that most generators did not provide PFR as required during the June 2020 event - as the AESO described in a presentation to industry in July 2020 - and all steps the AESO took to assess any conduct, behaviour or performance of any electricity market participant during the June 2020 event to determine whether it should be referred to the MSA;
- (f) all AESO records regarding the June 2020 event, including records memorializing any AESO decision to:
 - a. assess any conduct, behaviour, or performance of any electricity market participant during the June 2020 event to determine if it amounted to a suspected PFR rule contravention or
 - b. not refer any conduct, behaviour, or performance to the MSA; and
- (g) a description of all steps the AESO took during the investigation period to strengthen its compliance monitoring in respect of the PFR rules and records in respect of those steps.

The AESO provided its response to the first IR on April 2, 2025, with further records provided on May 9, 2025.

On September 4, 2025, the MSA issued a second IR to the AESO (second IR).⁹ In the second IR, the MSA requested the AESO provide:

- (a) a list of every AESO assessment of PFR provided by individual generating units following a frequency event during the investigation period, and records relating to every such assessment;
- (b) clarifications with respect to the criteria the AESO used to identify potential contraventions of the PFR rules (potential contravention criteria) described in the AESO's response to the first IR;
- (c) clarifications with respect to how the AESO established criteria for when it would suspect a contravention of the PFR rules, including supporting records;
- (d) a description of how the AESO determined the extent of its compliance monitoring with respect to the PFR rules and all records related to any such determination;
- (e) explanations of how the AESO selected six frequency events in 2022 and 2023 to assess PFR and the assets whose frequency response performance the AESO evaluated for those events; and

⁹ MSA 15220; MSA 15221

- (f) descriptions and explanations of values in the Python script that the AESO used to identify frequency events.

The AESO provided its response to the second IR on October 2, 2025.¹⁰

The MSA considered all information and records the AESO provided in response to the first IR and second IR and prepared its summary of findings, which was provided to the AESO on December 19, 2025, and required the AESO to provide its response, including any additional information or records the AESO wished the MSA to consider, by January 30, 2026. On January 21, 2026, the MSA extended the deadline for the AESO to respond to the summary of findings, to March 2, 2026. After requesting another extension, the AESO provided its response to the summary of findings on March 6, 2026.¹¹

After the AESO provided its response to the summary of findings, the MSA requested a meeting to have a forward-looking discussion of the AESO's PFR compliance monitoring and grid PFR performance. At a meeting on May 8, 2026, the AESO provided the MSA with information regarding changes to its PFR compliance monitoring process after March 2025 and the scope and timelines for frequency stability-related action items listed in its 2025 Reliability Roadmap.¹²

On July 15, 2026, after the MSA notified the AESO of its intention to make its report on this investigation public, the AESO provided the MSA with a complete copy of its *Root Cause Analysis Report for June 7, 2020 Load Shedding Event & Recommendations*, dated January 4, 2021 (January 2021 report). An incomplete draft copy of the January 2021 report had been provided on April 2, 2025 in response to IR 1.5(e) of the first IR.

On July 17, 2026, the AESO notified the MSA that its April 2, 2025 upload of the folder containing responses to MSA IR 1.5(e) was unsuccessful and provided approximately 1,400 records which had previously not been provided to the MSA.

The MSA reviewed the records provided on July 17, 2026 and, based on that review, finds the records are those gathered and prepared in the course of the AESO's investigation into the June 2020 event, which resulted in the January 2021 report. As the January 2021 report is based on and provides the AESO's conclusions from records, the MSA considers the January 2021 report an adequate summary of those records and the AESO's investigation into the June 2020 event. The MSA will further consider the records provided July 17, 2026 and may issue another report in this matter if warranted.

¹⁰ MSA 15224; MSA 14601

¹¹ Appendix F

¹² 2025 Reliability Roadmap, p. 13

2 BACKGROUND

2.1 The role of PFR in the AIES

As the balancing authority and reliability coordinator for the Alberta Interconnected Electric System (AIES), the AESO is required to maintain system frequency at 60 Hz under both normal and abnormal grid operating conditions.¹³ When the system frequency goes outside a certain deadband, automatic relays designed to protect generating equipment from damage will result in generating units tripping off, immediately reducing the amount of electricity supplied to the AIES and potentially leading to a cascading failure and loss of load event. Maintaining system frequency at the required level is therefore critical to the reliable operation of the AIES, a function in which generators play a key role.

System frequency deviations occur because of imbalances between supply and demand. PFR arrests frequency deviations by changing real power output to minimize the imbalance between supply and demand.¹⁴ PFR is the immediate proportional increase or decrease in real power output provided by a generating unit in response to a system frequency deviation. This response is in the direction that stabilizes system frequency;¹⁵ if system frequency decreases, a generating unit providing PFR immediately and proportionally increases its real power output, and vice-versa.

The droop value largely determines the magnitude of a generating unit's response, which decreases as the droop value increases. For example, a 100MW generating unit with a 5% droop will provide 33.3 MW of system response per 1 Hz in frequency deviation. Were the unit's droop value set to 3%, under identical circumstances, the generating unit would provide a 55.5 MW response.¹⁶

A generating unit, when its governor system is configured properly, will automatically provide PFR.¹⁷ The PFR rules also require generators to have a free acting governor, and must respond to system frequency changes.¹⁸ For that reason, when a generating unit provides no response, responds in the wrong direction, or does not sustain its response, this suggests a potential contravention of the PFR rules, as discussed in section 2.1.1.

When the AIES is islanded from the rest of the Western Interconnection, frequency stability must be maintained using resources internal to Alberta, including PFR provided by generating units in Alberta.¹⁹ Insufficient PFR capabilities have resulted in several instances of underfrequency load

¹³ 2023 Reliability Roadmap, p. 14

¹⁴ 2023 Reliability Roadmap, p. 20

¹⁵ NERC Reliability Standards Glossary of Terms (updated October 1, 2025), https://www.nerc.com/pa/Standards/Glossary%20of%20Terms/Glossary_of_Terms.pdf, pdf p. 83

¹⁶ January 2021 report, p. 10

¹⁷ January 2021 report, p. 10

¹⁸ ISO rule 502.5, s. 9(1); ISO rule 502.6, s. 4; ISO rule 503.6, ss. 2(1) and 6; January 2021 report, p. 85

¹⁹ 2023 Reliability Roadmap, pp. 14 and 15

shedding (UFLS) in Alberta,²⁰ when system frequency fell to such an extent that load had to be shed in order to return it to a secure state.²¹ In the case of the June 2020 event, approximately 235 MW of load was shed due to insufficient PFR.²²

2.1.1 The PFR rules

The PFR rules establish the requirements for generating units with respect to PFR.²³ While the PFR rules do not require generating units to provide a particular amount of real power in response to a frequency event, they set out requirements for how governors must be configured and operated so generating units provide PFR during frequency events.²⁴

With respect to configuration, the PFR rules require a generating unit with a maximum authorized real power (MARP) of 10 MW or more to have a continuously acting governor that is designed to be continuously in service and free to respond to frequency changes while the generating unit is transmission-connected and producing real power, with a droop setting between 3% and 5% (droop requirement) and the prescribed deadband (design requirements).²⁵

With respect to operation, the PFR rules require a generating unit to be operated with its governor in service, in droop mode, and free to respond to frequency changes while supplying active power to the AIES (operation requirement).²⁶ Whenever the AIES frequency is low (59.964 Hz or lower), the governor will increase the MW output of the generating unit, and similarly, whenever system frequency is high (60.036 Hz or higher), the generating unit will reduce its MW output.²⁷ A generating unit with a properly configured and operating governor will generally provide an immediate, proportional increase or decrease in real power output in response to a frequency event, and this response should continue for as long as system frequency is outside the 60 ± 0.036 Hz deadband (prescribed deadband).²⁸

As generating units must have a free acting governor and respond to system frequency changes,²⁹ operating a generating unit with any control systems in place which restrict, impede,

²⁰ 2023 Reliability Roadmap, p. 24

²¹ *Consolidated Authoritative Document Glossary* (updated October 28, 2025), <https://www.aeso.ca/assets/CADGLARA/Consolidated-Authoritative-Document-Glossary-2025-10-28.pdf>, p. 44

²² MSA 7114, p. 3; AESO, “Information session: Learnings and actions in response to recent system events” (March 9, 2021), <https://www.aeso.ca/assets/Uploads/Learnings-and-Actions-in-Response-to-Recent-System-Events-Info-Session-PPT.pdf> (March 9 presentation), p. 9

²³ ISO rule 502.5, s. 9(1); ISO rule 502.6, s. 4; ISO rule 503.6, ss. 2(1) and 6

²⁴ See e.g., 2023 Reliability Roadmap, p. 71

²⁵ ISO rule 502.5, s. 9(1); ISO rule 503.6, s. 2(1); January 2021 report, p. 10

²⁶ ISO rule 502.6, s. 4; ISO rule 503.6, s. 6; January 2021 report, p. 85

²⁷ January 2021 report, p. 10

²⁸ 2023 Reliability Roadmap, p. 21

²⁹ January 2021 report, p. 85

or otherwise prevent the governor from freely responding to frequency changes is a contravention of the PFR rules.

Compliance with the PFR rules can be monitored in two ways. First, information regarding the design and operation of governors can be requested from the operator of the generating unit and then assessed and reviewed against the PFR rules. For example, an engineer-certified report about the design and operation of a governor as of a particular time may be requested.

Second, a generating unit's compliance with the PFR rules can be evaluated based on how it responds to a frequency event. As the AESO noted in its response to the summary of findings, the PFR rules have no performance standard, in that they do not specify the amount by which a generating unit must change its real power output in response to a change in system frequency. However, a governor designed and operated in compliance with the PFR rules will generally provide an immediate, proportional and sustained response to a frequency event.³⁰ As such, while countervailing conditions may prevent such a response, when a generating unit's real power output does not change in response to a change in system frequency this could indicate that the generating unit may not be configured or operated in compliance with the PFR rules.

2.1.2 The AESO's knowledge of issues with generating units' PFR

The AESO has known about issues with generating units' PFR since at least 2020, and possibly earlier. In April 2021, a former AESO director wrote to an AESO vice president indicating that the AESO has been known, since 1999, to have "poor frequency control issues when generating units have control systems that defeat the governor" and these issues contributed to a UFLS event in 1999. As of August 2020, the AESO knew that "the Industry ha[d] been struggling for a long while [...] with the PFR issue."³¹

Following the June 2020 event, a team of OEMS employees investigated and prepared the January 2021 report. That report identified various factors negatively impacting generator frequency response, including poor PFR from an electricity market participant's generating unit during that event caused by a ramp rate limitation implemented by the original equipment manufacturer, as part of the generating unit's original control system settings configured in 2001.³² Other reasons for poor PFR observed in the January 2021 report include issues such as plant-based distributed control systems (DCS) interfering with unit response due to AGC signals conflicting with generator PFR.

³⁰ January 2021 report, p. 10

³¹ MSA 11231

³² MSA 12317; MSA 10471; see also March 9 Presentation, p. 32

The AESO's 2023 Reliability Roadmap identified ensuring sufficient frequency response capability as the AESO's "highest priority" and stated that "immediate action [was] required to reduce frequency stability risk," with PFR as "the primary driver impacting frequency stability."³³

The AESO's assessments of the PFR provided by selected assets during six frequency events in 2022 and 2023 revealed continued issues with generating units' PFR, including some generating units the AESO investigated in 2020.³⁴

During the investigation, the MSA analyzed AESO PI data to identify instances during the investigation period when system frequency went outside the prescribed deadband for 30 seconds or longer. This analysis revealed that there were frequency events on approximately 80 percent of the days during the investigation period, when generating units should have provided PFR because system frequency was outside the prescribed deadband for at least 30 seconds. Of these events, 19 involved a more significant system frequency deviation outside a 60 ± 0.2 Hz deadband for at least 30 seconds. All these events are described in appendix A.

In its response to the summary of findings, the AESO asserted that the MSA's use of the prescribed deadband over-estimated the number of events which were suitable cases for the AESO to investigate generator responses. The AESO asserted that it "uses a more realistic 59.4 to 60.6 Hz frequency range." As described in section 2.2.2, this does not accord with the AESO's responses to the MSA IRs.

Moreover, the January 2021 report references the prescribed deadband and explains that generating units are expected to increase or decrease their MW output when system frequency deviates outside the prescribed deadband.³⁵ For example, in discussing the measures taken by a market participant to address issues stemming from the generating unit's DCS, the AESO evaluated said generating unit during the October 16, 2020 frequency event (October 2020 frequency event), during which system frequency increased to 60.072 Hz, declined to 59.799 Hz, and subsequently increased to 60.112 Hz. Based on its review of the event data and the corresponding generator response, the AESO concluded that the generator's "gross power responded to frequency quite as expected." Accordingly, the AESO's own analysis confirms that frequency deviations beyond the prescribed deadband are expected to produce a measurable governor response and that such a response was used to determine satisfactory performance.³⁶ However, the maximum deviation of the October 2020 frequency event is 0.112 Hz – less than the deadbands the AESO identified its response to the summary of findings.

In addition, the 59.4 to 60.6 Hz frequency range is more than 16 times wider than the prescribed deadband, so applying this frequency range would exclude many instances where generating units may not have provided PFR. Generating units are not required to be designed to

³³ 2023 Reliability Roadmap, p. 3

³⁴ See e.g., appendix D and appendix E, and section 3.1.4

³⁵ January 2021 report, pp. 10 & 85

³⁶ January 2021 report p. 71

continuously operate outside a 59.4 to 60.6 Hz frequency range without tripping; applying this frequency range would likely result in the AESO only examining PFR Rule compliance where generating units tripped off. Finally, 59.4 Hz is below the UFLS activation point in Alberta; applying a 59.4 to 60.6 Hz frequency range would effectively result in the AESO only evaluating generating units' compliance with the PFR rules after a load shed event.

2.2 The AESO's compliance monitoring of the PFR rules

2.2.1 The AESO's compliance monitoring duties

The AESO's compliance monitoring duties are established by sections 17(l.1), 21.1, and 16(1) of the EUA. Section 17(l.1) of the EUA requires the AESO to monitor electricity market participants' compliance with ISO rules. Section 21.1 of the EUA requires the AESO to refer a matter to the MSA if the AESO suspects that an electricity market participant has contravened an ISO rule, including the PFR rules.³⁷ ISO rule 103.12 requires the same.³⁸ Section 16(1) of the EUA requires the AESO to exercise its powers and carry out its duties, responsibilities and functions in a timely manner that is fair and responsible to provide for the safe, reliable and economic operation of the AES. This requires the AESO to act reasonably when exercising its powers or carrying out its duties, responsibilities and functions,³⁹ including those under sections 17(l.1) and 21.1 of the EUA and ISO rule 103.12.

Reading these sections together, the AESO must establish processes that will identify suspected contraventions of the PFR rules so they can be referred to the MSA. It must have processes for monitoring compliance with the PFR rules, and they must be effective for their purpose of identifying suspected contraventions of those rules. While the AESO has discretion as to the extent of compliance monitoring it undertakes,⁴⁰ its exercise of that discretion cannot result in ineffective or no monitoring of compliance with the PFR rules. That would be contrary to its duties to act reasonably and refer suspected ISO rule contraventions to the MSA and would contravene section 17(l.1) of the EUA.

The AESO must also act reasonably to identify suspected contraventions of ISO rules, including the PFR rules, and refer them to the MSA. If the AESO does not refer the matter to the MSA when it suspects an electricity market participant has contravened the PFR rules, or ought to have, that would be contrary to its duty to act reasonably and would contravene section 21.1 of the EUA and ISO rule 103.12.

³⁷ While the AESO does not need to refer the matter to the MSA if "otherwise provided by the regulations," no such provision has been made.

³⁸ ISO rule 103.12, s. 11(1)

³⁹ Decision 22942-D02-2019 Alberta Electric System Operator - 2018 Independent System Operator Tariff, September 22, 2019, para. 536

⁴⁰ ISO rule 103.12, s. 3(2)

2.2.2 The compliance monitoring program described by the AESO

In its first IR, the MSA requested the AESO provide a description of how it monitored PFR provided by generating units, the data or information it used to do so, and any records describing its process or practices for doing so. The MSA also asked the AESO to provide a description of all its processes to assess suspected contraventions of the PFR rules, including all records it kept in respect of this process and any records memorializing its process to identify and assess suspected contraventions of the PFR rules.

In response to the MSA IRs, the AESO provided no individual document that sets out a process established by the AESO to monitor compliance with the PFR rules, whether by evaluating the PFR provided by generating units during a frequency event or reviewing information to directly assess compliance with the PFR rules. The AESO provided its CMP, which summarizes its compliance monitoring approach for the ISO rules generally.⁴¹ Specifically with respect to PFR, the January 2021 report states that “the AESO has no active compliance monitoring program for the units’ frequency response to the system frequency events.”⁴²

The AESO also described how it monitors PFR rules compliance, both directly and indirectly. The AESO’s IR responses suggest that the same processes were in place throughout the investigation period.⁴³ However, the records provided indicate that the AESO only started using per unit primary frequency response (PUPFR) in 2023.

Directly assessing compliance with the PFR rules

The AESO’s response to the first IR suggests that it reviews governor baseline and model validation reports (model validation reports) submitted to it under the ISO rules,⁴⁴ to directly assess compliance with the design requirements and identify suspected contraventions.⁴⁵ This is discussed more in section 3.1.1.

Indirectly assessing compliance with the PFR rules

The AESO did not regularly assess generating units’ PFR performance during frequency events to monitor compliance with the PFR rules, as set out in section 3.1.3. While the AESO assessed system-level frequency response during frequency events more often,⁴⁶ the AESO only provided records of having done so once as part of its January 2021 report. To the extent the AESO

⁴¹ MSA 8317

⁴² January 2021 report, p. 91

⁴³ MSA 7425, pdf pp. 11, 13-14; MSA 14601, pdf pp. 8 and 10

⁴⁴ ISO rule 503.20, *Baseline and Model Validation Testing* (ISO rule 503.20), ss. 4(1)(d), (2) and (6); ISO rule 502.6, ss. 10(1)(d), (2) and (6)

⁴⁵ MSA 7425, pdf p. 10

⁴⁶ E.g., records provided in response to IR 2.1: see MSA 14601, pdf pp. 1-4

evaluated individual generating units' PFR performance during the investigation period, it did so on an ad hoc basis.

In its responses to the MSA, the AESO described the frequency range it applies in monitoring generating units' compliance with the PFR rules, as follows:

- the AESO stated that as part of its procedure for monitoring PFR provided by generating units, it identifies when a frequency event has occurred using a frequency range of 59.8 to 60.2 Hz;
- the AESO stated that, when it selected six frequency events in 2022 and 2023 to assess PFR, it selected frequency excursions greater than 60.2 Hz and less than 59.8 Hz; and
- the AESO stated that the Python script it used to identify events to evaluate generating units' compliance with the PFR rules used 59.8 Hz and 60.2 Hz as the default lower and upper thresholds for detecting frequency excursions.

In addition, the MSA reviewed the Python script that the AESO used to identify events; that script encoded 59.8 Hz and 60.2 Hz as the default lower and upper thresholds for detecting frequency excursions.

In its response to the summary of findings, the AESO stated that it uses a 59.4 to 60.6 Hz frequency range to identify frequency events. As this is inconsistent with the AESO's responses to IRs during the Investigation and the January 2021 report, the MSA finds that during the investigation period, the AESO used a frequency range of 59.8 to 60.2 Hz to identify events that were suitable cases to investigate generating units' PFR. The MSA also notes that, in its meeting with the MSA on May 8, 2026, the AESO stated that it currently uses 59.8 and 60.2 Hz as the thresholds for identifying events where it will evaluate generating units' compliance with the PFR rules.

While there were frequency events on approximately 80 percent of the days during the investigation period when generating units should have provided PFR, as noted in section 2.1.2, the AESO only provided evidence of having assessed individual generating units' PFR performance following frequency events twice: once in 2020 and once in 2023.⁴⁷

As described by the AESO, it evaluates generating units' PFR performance in two stages, each led by a different internal group at the AESO.

The first stage is a screening process led by the AESO's Operations Engineering and Market Support (OEMS) group.⁴⁸ While the full extent of OEMS' responsibilities is unclear to the MSA, they include monitoring the frequency response of generating units to identify potential

⁴⁷ The March 9 presentation provided "system event overviews" of frequency events on October 16, 2020, and February 21/22, 2021, in addition to the June 2020 event; however, there is no indication the AESO assessed individual generating units' PFR performance following those events.

⁴⁸ See e.g., MSA 8317, p. 3

contraventions of the PFR rules.⁴⁹ OEMS may evaluate individual assets' frequency response performance through a post-frequency event analysis,⁵⁰ but no document sets out the frequency of such evaluations or the methods OEMS uses.

If any OEMS employee determines that an asset's frequency response (or lack thereof) meets the AESO's potential contravention criteria, they are supposed to refer it to ECM,⁵¹ triggering the second stage of the AESO's compliance monitoring approach for the PFR rules. Only ECM may refer a suspected contravention of the PFR rules to the MSA under the AESO's process,⁵² and any potential contravention based on an asset's frequency response (or lack thereof) must be referred to it by OEMS.⁵³ Effectively, this means that if an OEMS employee does not refer a contravention based on an asset's frequency response (or lack thereof) to ECM, it will not be referred to the MSA.

The AESO described the criteria for potential non-compliance it applies to determine whether a referral should be made to ECM (potential contravention criteria) as:

- the generating unit “does not move in the correct direction with respect to the frequency excursion;”
- the generating unit “does not have sufficient and unconstrained capability to respond to a frequency excursion;” or
- the generating unit has an average PUPFR of less than 0.75 “averaged over at least four events over the course of 12 months” unless “there have been too few notable excursions in this time frame,” in which case “less excursions would be considered for averaging, or a longer time frame may be considered.”⁵⁴

The AESO began using PUPFR to evaluate compliance with the PFR rules in 2023. This metric is based on a performance standard in NERC Reliability Standard BAL-001-TRE-2 for PFR in the ERCOT region.⁵⁵ The AESO's PUPFR calculation compares the amount of PFR actually provided by a generating unit during a frequency event (PFR_{unit}), to the amount of PFR the AESO would have expected it to provide ($PFR_{expected}$) based on the frequency event, PFR rules, and certain

⁴⁹ MSA 7425, pdf p. 2; MSA 12334, p. 2; MSA 14601, pdf p. 8

⁵⁰ MSA 12334, p. 2; MSA 14601, pdf p. 8

⁵¹ MSA 7425, pdf p. 13; MSA 12334, p. 2

⁵² MSA 8317, pp. 1-4

⁵³ MSA 12334, p. 2; MSA 14601, pdf p. 8

⁵⁴ MSA 14601, pdf p. 6

⁵⁵ NERC Reliability Standard BAL-001-TRE-2 Primary Frequency Response in the ERCOT Region, <https://www.nerc.com/standards/reliability-standards/bal/bal-001-tre-2>; MSA 13922, p. 8; MSA 9216, p. 4; MSA 9267, p. 4

characteristics of the generating unit.⁵⁶ The AESO's formulas for calculating PUPFR, PFR_{unit} , and $PFR_{expected}$ are set out in appendix B.

At the second stage, ECM investigates in accordance with the CMP.⁵⁷ As described in the CMP, ECM assesses the relevant data and information and, if this suggests a potential contravention, ECM sends an IR to the electricity market participant. The IR outlines the relevant PFR rule(s) and information suggesting a potential contravention and invites the electricity market participant to provide additional relevant information. Once it is received, ECM reviews the IR response, along with the previous information and data, and decides whether it suspects a PFR rule contravention.⁵⁸

If ECM suspects a PFR rule contravention at the end of this process, it refers the matter to the MSA. If ECM does not suspect a PFR rule contravention, it sends a "not pursuing" letter to the electricity market participant, which indicates that the AESO will not pursue the matter any further.⁵⁹

The CMP does not set out the criteria ECM uses to determine whether it suspects a PFR rule contravention that it would refer to the MSA. The AESO indicated that it would suspect a contravention of the PFR rules if the owner admits that the governor is not being operated or has been materially impaired,⁶⁰ or if:

- the generating unit's real power output does not change within 30 seconds of the frequency disturbance, and is not constrained by its maximum or minimum limits of generation capability (no response);
- the generating unit's real power output changes, but does not move in the correct direction relative to the system frequency deviation, e.g., if system frequency increased and the generating unit's real power output also increased (negative response); or
- the generating unit's real power output changes, but the response decreases to the level of output observed before the frequency event while system frequency remains outside the prescribed deadband (unsustained response)⁶¹

(collectively, the suspected contravention criteria).

⁵⁶ MSA 7425, pdf pp. 3-4 and 10

⁵⁷ MSA 12334, p. 2; see also MSA 7425, pdf p. 12

⁵⁸ MSA 8317, p. 4; see also MSA 7425, pdf pp. 12-13

⁵⁹ MSA 8317, p. 4

⁶⁰ MSA 7425, pdf pp. 10 and 12

⁶¹ MSA 14601, pdf p. 9; see also MSA 7425, pdf pp. 10 and 12 regarding "no discernable" frequency response.

3 MSA FINDINGS

3.1 During the investigation period, the AESO did not adequately monitor compliance with the PFR rules

Based on the records and information gathered in the Investigation, the MSA finds that during the investigation period, the AESO did not adequately monitor compliance with the PFR rules.

The MSA requested from the AESO:

- (a) records relating to every AESO assessment of PFR provided by individual generating units during a frequency event in the investigation period;⁶² and
- (b) all records kept by the AESO in respect of its process to identify and assess suspected contraventions of the PFR rules during the investigation period.⁶³

The MSA also reviewed its own records of self-reported and AESO-referred PFR rule contraventions.

As noted above, there were frequency events when generating units should have provided PFR on approximately 80 percent of the days during the investigation period. Based on the records available to the MSA, the only steps the AESO took during the investigation period to monitor generating units' compliance with the PFR rules were:

- a post-frequency event investigation into the PFR provided by certain generating units during the June 2020 event, after which no potential PFR rule contraventions were referred to the MSA;
- an August 2021 referral for one small battery to the MSA for a suspected contravention of section 205.5 of the ISO rules;
- a November 2022 self-report from a large generator that mentioned an AESO information request received in August 2022 which the AESO did not refer to the MSA; and
- post-frequency event assessments of the PFR provided by selected assets during six frequency events in 2022 and 2023 using PUPFR scores, after which some suspected PFR rule contraventions were referred to the MSA.⁶⁴

As set out more fully below, the MSA finds that the AESO did not adequately monitor generating units' compliance with the PFR rules during the investigation period.

⁶² MSA 14601, pdf p. 1

⁶³ MSA 7425, pdf pp. 8 and 9

⁶⁴ The generating units and assets assessed in 2020 and 2023 are set out in appendix D and appendix C, respectively.

3.1.1 The AESO did not directly assess compliance with the PFR rules using reliable model validation reports

As noted in section 2.2.2, the AESO's response to the first IR suggests that it reviews model validation reports submitted to it under the ISO rules to directly assess compliance with the design requirements and identify suspected contraventions.⁶⁵ However, the MSA finds that the AESO did not review model validation reports for this purpose during the investigation period and, even if it had, those reports may not have presented reliable governor modelling data.

The AESO did not review model validation reports to assess PFR rule compliance

The AESO did not provide any records to the MSA which disclose any occasion when the AESO reviewed model validation reports to directly assess compliance with the design requirements, nor any process for it to do so. The MSA infers that no such records exist, given that it requested all records kept by the AESO in respect of its process to identify and assess suspected contraventions of the PFR rules during the investigation period, and any procedure or similar record memorializing such a process, and no such records were provided.⁶⁶

In an August 2020 email, OEMS decided PFR during the June 2020 event was “not a compliance issue,” in part because “[a]ll generators in the province” complied with the droop requirement, which was “validated when they submit[ted] their [model validation reports]” to another team at the AESO. However, the records provided disclose no occasion when such validation was done.

The January 2021 report states the AESO power system model management team reviews modelling reports and incorporate data provided by asset owners into AESO system power modelling. However, the January 2021 report does not indicate that model validation testing was reviewed to ensure proper governor system or related system configurations, and the AESO provided no records showing any such review occurred.

In response to the first IR, the AESO stated that “[i]n preparation to determine frequency performance metrics such as PUPFR, the AESO reviews modeling data submitted by legal owners of a generating facility and compares it to the [design] requirements” and if it were to observe a “material deviation” between the two, it would suspect a contravention.⁶⁷ In response to the second IR, the AESO stated that after a model validation report is submitted, the “[s]ettings in the various models can be checked against the expected frequency response setting” in the PFR rules by its subject matter experts team.⁶⁸ While the AESO described its general practice with respect to reviewing model validation reports, and the way in which they may be reviewed against the PFR rules, it provided no records to show that it did so during the investigation period.

⁶⁵ MSA 7425, pdf p. 10

⁶⁶ MSA 7425, pdf pp. 8 and 9

⁶⁷ MSA 7425, pdf p. 10

⁶⁸ MSA 14601, pdf pp. 8-9

In addition, the MSA has no record of receiving a referral for a suspected PFR rule contravention identified through such a review.

Based on the foregoing, the MSA finds that the AESO did not review any model validation reports to evaluate generating units' compliance with the PFR rules during the investigation period.

The AESO did not have current model validation reports during the investigation period

Even if the AESO had reviewed model validation reports to assess compliance with the PFR rules, those reports may not have presented governor modelling data that was accurate and could be relied upon to assess such compliance.

Generating unit owners must submit model validation reports when:

- a. the generating unit is synchronized to the transmission system for the first time; or
- b. any modification changes the governor's modelled behaviour with respect to the transmission system.⁶⁹

Model validation reports submitted when the generating unit is first synchronized to the transmission system may be quite dated, and records available to the MSA indicate that the AESO does not have an effective process for identifying when new modelling data is required.

The January 2021 report describes a number of circumstances where controls or control systems limit the generating unit's frequency response. To the extent model validation reports submitted prior to the June 2020 event demonstrated compliance with the PFR rules, the conclusions of the January 2021 report suggest that governor or related control settings were changed after initial submission of model validation reports.

While the ISO rules require governor model revalidation testing results to be submitted within five years of the most recent baseline testing or model revalidation testing,⁷⁰ a "model validation tracker" provided by the AESO shows cases where that was not done until significantly later. In the case of one generating unit whose PFR the AESO assessed in 2023, its model revalidation testing results were approximately two years overdue by 2023 and were not submitted to the AESO until 2024.⁷¹

The MSA's records of self-reported ISO rule contraventions show other generating units that the AESO assessed in 2023 but had model revalidation testing results that were overdue at that time. In some cases, those generating units were also required to submit governor model revalidation testing results to the AESO in 2021 but did not do so until 2024.

⁶⁹ ISO rule 503.20, ss. 4(1)(d), (2), (4) and (6); ISO rule 502.6, ss. 10(1)(d), (2), (4) and (6)

⁷⁰ ISO rule 503.20, ss. 6(1) and (2); ISO rule 502.6, ss. 11(1) and (2)

⁷¹ MSA 15156, e.g., row 76 in the "asset detail" sheet.

In each of these cases, if the AESO used governor model validation results to assess compliance with the PFR rules in 2023, those results would have been years outdated. During the periods when model revalidation testing results were overdue, the AESO apparently had not identified that new modelling data was required, based on tracking the most recent testing or by observing inconsistencies between the generating units' modelled responses and their observed responses.⁷² For these reasons, the MSA finds that, even if the AESO had reviewed model validation reports to assess compliance with the PFR rules, those reports may not have presented governor modelling data that was accurate and could be relied upon to assess compliance with the PFR rules.

Finally, if the AESO did review model validation reports to directly assess compliance with the design requirements, it only did so to flag "material deviations" between the modelling data submitted by a generating unit owner and the design requirements.⁷³ It is unclear what this means, including whether these reviews would uncover issues identified such as plant-level controllers or ramp-rate limitations, and the AESO did not describe how it identifies a "material deviation" when performing such a review in terms of the threshold applied, when the MSA asked it to do so.⁷⁴ It is also unclear why the AESO would only perform such a review to identify a "material deviation," rather than any deviation, which could indicate a potential contravention of the PFR rules.

Conclusion

Based on the foregoing, the MSA finds that:

- the AESO did not review model validation reports to directly assess compliance with the design requirements during the investigation period; and
- even if it had, the model validation reports reviewed by the AESO may not have presented governor modelling data that was accurate and could be relied upon for that purpose, and the AESO only reviewed them to flag "material deviations" between submitted modelling data and the design requirements.

These findings support the MSA's conclusion that the AESO did not adequately monitor generating units' compliance with the PFR rules during the investigation period.

⁷² In these cases, the AESO can request model revalidation testing: ISO rule 503.20, s. 6(3) and ISO rule 502.6, s. 11(3).

⁷³ MSA 7425, pdf p. 10

⁷⁴ MSA 14601, pdf pp. 8-9

3.1.2 The AESO's process screened out potential contraventions in 2020 for improper reasons

Based on the information provided, the MSA finds that in 2020 OEMS did not refer potential PFR Rule contraventions to ECM for investigation for reasons unrelated to compliance with the ISO rules.

Capital upgrades not undertaken

Through the investigation into the PFR provided by certain generating units during the June 2020 event, OEMS concluded that a generating unit's poor PFR during that event was caused by a ramp rate limitation implemented by the original equipment manufacturer as part of the generating unit's original control system settings configured during energization.⁷⁵ OEMS learned that the generating unit's ramp rate could have been increased, and its PFR improved, through a capital investment but, according to the AESO, the electricity market participant was unwilling to pay.⁷⁶ The AESO did not pursue action at the time "as there remain[ed] a question of compensation."⁷⁷

An electricity market participant's unwillingness to pay for a capital investment required to bring its asset into compliance with the ISO rules is not a proper reason to decline to pursue a potential contravention by that asset. Electricity market participants are obligated to comply with all ISO rules which are in effect at the time,⁷⁸ regardless of the cost, and they cannot expect the AESO (i.e., ratepayers) to pay to bring them into compliance. By not pursuing a potential contravention on this basis, the AESO acted improperly.

Industry-wide difficulty

In August 2020, OEMS decided not to treat generating units' PFR during the June 2020 event as a "compliance issue." One of the reasons given was that "the industry ha[d] been struggling for a long while [...] with the PFR issue."⁷⁹ OEMS made this decision despite ECM indicating that frequency response during the June 2020 event "may be [a] candidate for [its] ISO rules process given the reliability impact."⁸⁰ Effectively, OEMS directed ECM not to investigate PFR during the June 2020 event, in part, because "the industry" had been struggling to provide PFR for a long time.

The fact that electricity market participants struggled to provide PFR for a long time, despite the PFR rules, is not a proper reason to decline to pursue potential contraventions. If anything, it supports pursuing them, so that "the PFR issue" does not continue and reliability impacts like

⁷⁵ MSA 12317; MSA 10471; January 2021 report, p. 68; see also March 9 presentation, p. 32

⁷⁶ MSA 10471

⁷⁷ MSA 13922, p. 4; see also MSA 10471

⁷⁸ EUA, s. 20.8(a)

⁷⁹ MSA 11231

⁸⁰ MSA 11231

UFLS during the June 2020 event may be avoided in the future. To the extent the AESO did not pursue potential contraventions on this basis, it acted improperly.

OEMS's failure to pursue potential PFR rule contraventions for the above reasons meant the AESO's process for evaluating PFR rules compliance was not completed in 2020. This supports the MSA's conclusion that the AESO did not adequately monitor generating units' compliance with the PFR rules during the investigation period.

3.1.3 The AESO did not evaluate units' PFR performance on a regular basis

While the AESO stated that it evaluates compliance with the PFR rules by evaluating generating units' PFR performance following frequency events,⁸¹ the MSA finds that it did not do so on a regular basis. There were frequency events when generating units should have provided PFR on approximately 80 percent of the days during the investigation period, as noted in section 2.1.2; however, the AESO only provided records to show it assessed individual generating units' PFR performance following frequency events twice in the investigation period: once in 2020 and once in 2023. In correspondence with the MSA, the AESO asserted it investigated frequency events which occurred on October 2020, February 2021, and June 2021, but provided no records of having evaluated generator responses in those investigations to the MSA.

As part of the AESO's process for monitoring PFR provided by generating units, OEMS "may" evaluate individual assets' frequency response performance through a post-frequency event analysis.⁸² No document sets out the extent to which OEMS does so, and during the investigation period, the records provided by the AESO demonstrate they evaluated generating units' PFR performance during the June 2020 event and six frequency events in 2022 and 2023.

Some records provided by the AESO indicate that its PFR assessment process in 2023 was to be expanded, beyond the selected assets, "to all other relevant assets;"⁸³ however, when the MSA asked the AESO to describe the status of its review of "all other relevant assets," the AESO indicated that it had been focused on developing frequency response detection tools "to improve these processes."⁸⁴ The MSA understands this to mean that, as of when the AESO provided its response to the second IR on October 2, 2025, it had not taken any further steps to review the PFR provided by other assets during past frequency events.

Based on the information and records provided by the AESO, it is unclear when the AESO may evaluate other generating units' PFR performance to assess compliance with the PFR rules. The AESO has performed such evaluations on an ad hoc basis in the past, and no documents set out any criteria or other guidance for when OEMS should perform such evaluations in the future.

⁸¹ MSA 7425, pdf p. 6

⁸² MSA 12334, p. 2; MSA 14601, pdf p. 8

⁸³ MSA 7049, p. 14; MSA 7050, p. 14; MSA 7051, p. 14; MSA 7055, p. 14; MSA 7056, p. 14

⁸⁴ MSA 14601, pdf pp. 12-13

Based on the foregoing, the MSA finds that the AESO did not evaluate compliance with the PFR rules by evaluating generating units' PFR performance following frequency events on a regular basis during the investigation period.

3.1.4 The AESO did not monitor generating units' PFR performance between March 2021 and August 2023

The MSA finds that, although the AESO was aware of certain generating units' poor PFR performance, it did not monitor those generating units' compliance with the PFR rules between March 2021 and August 2023.

At the end of the AESO's engagement with generating unit owners about their "under-performance" during the June 2020 event, multiple electricity market participants were left with action items to address "inadequate frequency response" from some of their assets.⁸⁵ The January 2021 report stated that generating unit owners were to develop a "mitigation/implementation plan" to address generating unit issues affecting PFR by June 2021 and, where solutions were implemented earlier, provide the AESO with a final report outlining the issues and solutions identified. The January 2021 report further indicated that the AESO require generating unit owners to submit "quarterly activities reports" for review by the AESO, but that in addition to these reports, that the AESO would produce an "internal update report" incorporating information provided by generating unit owners.⁸⁶

The only record provided of the AESO attempting to follow up on those action items before 2023 is an email that was sent to one of the electricity market participants in June 2022 (more than one year after the AESO concluded its investigation into the PFR provided by certain generating units during the June 2020 event by March 2021). While that email requested updates on the action items left with the electricity market participant,⁸⁷ the AESO provided the MSA with no record of any such updates, the AESO following up with the electricity market participant, or any of the other electricity market participants with action items until May 2023.⁸⁸ The next follow-up was by the AESO engineer who approved the January 2021 report. In May 2023, OEMS "looked into" these action items again and noted that most were still outstanding.⁸⁹ While the 2023 Reliability Requirements Roadmap indicated that PFR "is the primary driver impacting frequency stability within the next 10 years," the AESO took minimal steps to improve generator PFR performance between January 2021 and May 2023.

⁸⁵ MSA 10471; see also MSA 13922, pp. 3-5

⁸⁶ January 2021 report, p. 92

⁸⁷ MSA 10713

⁸⁸ MSA 10237, p. 1 indicates that as of May 16, 2023, the AESO had "recently taken a closer look at [frequency response] again" after frequency events in 2021.

⁸⁹ MSA 10471

At that time, OEMS decided to work with these “problematic generators” to “reset the expectations and relationship” on frequency response.⁹⁰ That “reset” included evaluating the PFR performance of some of their generating units during frequency events on the following dates:⁹¹

- January 12, 2022;
- May 27, 2022;
- September 30, 2022;
- April 19, 2023;
- May 18, 2023; and
- June 2, 2023.

The evaluation of PFR performance during these 2022/23 events started in August 2023 and resulted in OEMS identifying frequency response issues with various generating units⁹² and referring some potential PFR rule contraventions to ECM, some of which were later referred to the MSA.⁹³

The MSA is aware of a referral made by the AESO in August 2021 of a battery in violation of section 205.5 of the ISO rules. In November 2022, the MSA received a self-report from a large generator that mentioned an AESO information request they received in August 2022, though the AESO never made a referral in regard to the same conduct. In the context of the records provided by the AESO in response to MSA information requests, the MSA does not consider these narrow examples demonstrate an adequate compliance monitoring program.

In summary, after identifying action items to address “inadequate frequency response” which contributed to UFLS during the June 2020 event, the AESO did not properly follow up until 2023. When it took further steps then, it discovered further frequency response issues. Also, although the AESO was aware of issues with generating units’ PFR performance, it did not monitor compliance with the PFR rules between March 2021 and August 2023.

3.1.5 The AESO evaluated the PFR performance of a small proportion of assets in 2023

After 2020, the only time the AESO provided evidence of having assessed individual generating units’ PFR performance following frequency events during the investigation period was in 2023. In fact, the MSA finds that the only time during the investigation that the AESO assessed individual generating units’ PFR performance following frequency events was in 2023, and even then, the AESO only evaluated the PFR rule compliance of a small proportion of assets by evaluating their PFR performance (26 of 74 assets that were subject to PFR rules at the time).

⁹⁰ MSA 10237, p. 1; see also MSA 13143, p. 4

⁹¹ The dates are based on the event timestamp in UTC.

⁹² See e.g., MSA 9267, pp. 8-11

⁹³ See Table 2

The AESO provided no evidence to show it evaluated the PFR performance of any of the other 48 assets in 2023, or any other time after 2020.⁹⁴

Of the 26 assets that were evaluated in 2023, only 17 of them had a generating unit that could be evaluated using the AESO's threshold for adequate PFR. That threshold is a generating unit PUPFR score of 0.75.⁹⁵ Generally it is averaged over at least four events over the course of 12 months,⁹⁶ but in 2023, the AESO averaged generating unit PUPFR scores over the six 2022/23 events in 18 months, when generating units were online and not at maximum generation (admissible events). Only 17 of the 26 assets had a generating unit with at least four admissible events that could be used to evaluate the generating unit's PFR performance using the AESO's threshold for adequate PFR.⁹⁷

Appendix C sets out the 74 assets subject to the PFR rules during the investigation period and indicates which were among the 26 such assets evaluated by the AESO in 2023; and which were among the 17 of those assets that had a generating unit that could be evaluated using the AESO's threshold for adequate PFR.

Based on the foregoing, the MSA finds that after 2020, the AESO only evaluated PFR rule compliance of a small fraction of assets. Therefore, the MSA has concluded that the AESO did not adequately monitor generating units' compliance with the PFR rules during the investigation period.

3.1.6 OEMS did not refer generating units that met the AESO's potential contravention criteria to ECM for investigation

As stated above, the MSA finds that OEMS's application of its PUPFR methodology in 2023 also resulted in its referring fewer potential PFR rule contraventions to ECM than it should have, based on the AESO's potential contravention criteria.

As noted in section 2.2.2, one of the AESO's potential contravention criteria is an average PUPFR of less than 0.75, generally averaged over at least four frequency events over the course of 12 months. When it applied its PUPFR methodology in 2023, OEMS calculated average PUPFR scores over up to six admissible events in 18 months.

Based on the AESO's potential contravention criteria and the contemporaneous evidence provided, OEMS should have referred potential contraventions from 22 generating units across 17 assets to ECM, on the basis that they had an average PUPFR of less than 0.75, averaged over at least four admissible events. OEMS did not do so. The generating units that met this criterion are listed in Table 1.

⁹⁴ Only some of the assets subject to the PFR rules were evaluated in 2020: compare appendix C and appendix D.

⁹⁵ MSA 14601, pdf p. 9; MSA 7425, pdf pp. 9-10

⁹⁶ MSA 14601, pdf p. 6

⁹⁷ MSA 7049; MSA 7050; MSA 7051; MSA 7055; MSA 7056

Table 1: Generating units with average PUPFR less than 0.75, averaged over at least four admissible events⁹⁸

Generating unit (asset ID) [REDACTED⁹⁹]	Average PUPFR
	0.21
	0.34
	0.24 ¹⁰⁰
	-0.02
	0.24
	-0.02
	0.60
	0.61
	0.03
	0.71
	0.47
	0.01
	0.72
	-0.04
	0.13
	-0.06
	0.18
	0.02
	0.27
	0.18
	0.14
	0.02

The MSA finds that, because OEMS did not refer these generating units to ECM for further investigation based on their average PUPFR, the AESO did not follow its own compliance monitoring process. Accordingly, the MSA finds that the AESO did not adequately monitor generating units' compliance with the PFR rules during the investigation period.

3.1.7 The AESO used the wrong threshold to identify suspected contraventions

Finally, the MSA finds that during the investigation period, the AESO applied too high a threshold to decide when a suspected ISO rule contravention should be referred to the MSA, pursuant to section 21.1 of the EUA and ISO rule 103.12.

⁹⁸ The information in Table 1 is based on MSA 7049, MSA 7050, MSA 7051, MSA 7055, and MSA 7056.

⁹⁹ Information in this column has been redacted so generating units are not identified.

¹⁰⁰ MSA 7051, p. 30 gives an average PUPFR of 0.48, but that should read 0.24 based on the event-specific PUPFR scores on pp. 29-30.

The CMP describes the threshold that the AESO used as follows: “If after reviewing all of this information, the AESO believes that the evidence supports a determination that an ISO rule has been contravened”¹⁰¹ (referral threshold).

The Legislature empowered the MSA to decide whether “the evidence supports a determination that an ISO rule has been contravened,” not the AESO. Under the statutory scheme, the MSA has been given the mandate to investigate and undertake activities to address contraventions of the ISO rules.¹⁰² If the MSA is satisfied that a person has contravened an ISO rule, the MSA can take enforcement action.¹⁰³ This requires the MSA to review the available evidence and decide whether, on the basis of the evidence available to it, an ISO rule has been contravened.

The threshold for when the AESO suspects an ISO rule contravention must be different than its referral threshold, under which it only refers matters if “the evidence supports a determination that an ISO rule has been contravened.” The Legislature is presumed to choose its words carefully and, where different words are used in legislation, they must mean different things.¹⁰⁴ By requiring the MSA to be satisfied, on the evidence available, that an ISO rule has been contravened,¹⁰⁵ on one hand, and the AESO to suspect an ISO rule has been contravened,¹⁰⁶ on the other, the Legislature did not intend for the AESO to only refer a matter when it is satisfied the evidence supports a determination which the MSA has the statutory authority to make. If the Legislature intended that, it would have used different language in section 21.1 of the EUA, and it would not have removed previous language from the EUA about the AESO being “satisfied” that an ISO rule has been contravened.¹⁰⁷

Based on the statutory scheme, the threshold for when the AESO suspects an ISO rule contravention must be lower than its referral threshold.

By using the current threshold and only referring matters to the MSA when it “believe[d] that the evidence support[ed] a determination that an ISO rule ha[d] been contravened,” the AESO prevented the MSA from carrying out its mandate in respect of ISO rule contraventions. Accordingly, the CMP ought to be revised so that its threshold for referring suspected ISO rule contraventions to the MSA aligns with the legislative framework.

¹⁰² AUCA s. 39(1)(b)(i)

¹⁰³ AUCA ss. 51(1)(a)(i) and 52(1)

¹⁰⁴ *Marche v. Halifax Insurance Co.*, 2005 SCC 6, para. 95; *R. v. Essegheier*, 2021 SCC 9, para. 52; *Calgary (City) v. Alberta (Municipal Government Board)*, 2008 ABCA 187, para. 31

¹⁰⁵ AUCA ss. 51(1)(a)(i) and 52(1)

¹⁰⁶ EUA, s. 21.1

¹⁰⁷ EUA, s. 22, as it appeared between April 20, 2007 and December 31, 2007, <https://www.canlii.org/en/ab/laws/stat/sa-2003-c-e-5.1/40472/sa-2003-c-e-5.1.html#sec22subsec1>

3.2 The AESO did not refer suspected contraventions of the PFR rules to the MSA

The MSA finds that the AESO did not refer suspected contraventions of the PFR rules during the June 2020 event and 2022/23 events to the MSA when it ought to have.

3.2.1 *The AESO did not refer suspected contraventions to the MSA following the June 2020 event*

The MSA finds that the AESO failed to refer suspected contraventions of the PFR rules during the June 2020 event to the MSA when it ought to have.

On June 7, 2020, the AIES frequency fell to 59.15 Hz and approximately 235 MW of load was shed under the AESO's UFLS program, after the AIES was islanded from the rest of the Western Interconnection. This resulted from a trip on transmission line 1201L, the main Alberta-British Columbia tie line.¹⁰⁸

Based on records described below, the MSA finds that the AESO suspected contraventions as early as July 13, 2020. On that date, the AESO determined there “were many generators which performed poorly” during the June 2020 event. By July 17, 2020, it prepared a list of 19 assets that had “underperformed badly” (July 2020 list).¹⁰⁹ Appendix D sets out these 19 assets as well as other assets that were later investigated by the AESO in relation to the June 2020 event.

On July 20, 2020, at the request of an AESO Director, an OEMS employee emailed them the July 2020 list, contact information for the associated electricity market participants, and a draft “letter to under-performing generators”¹¹⁰ (July 2020 letter). The July 2020 letter described the droop requirement and indicated that, contrary to it, the 19 assets “did not provide the appropriate frequency response as required by ISO rules.”¹¹¹ The July 2020 letter went on to state that the AESO was “concerned by the lack of an appropriate frequency response” from those assets and wanted to work with the associated electricity market participants to ensure those assets could “respond, in accordance with ISO rules, during system events.”¹¹²

Further, on July 28, 2020, the AESO publicly delivered a presentation that highlighted the PFR rules’ requirement for transmission-connected generating units to have a continuously acting governor responsive to frequency changes and the droop requirement and stated “[m]ost generators did not provide [PFR] as required under ISO rules – [a]round 25 assets under

¹⁰⁸ MSA 7425, pdf p. 18; MSA 7114, p. 3

¹⁰⁹ MSA 9667; MSA 9668

¹¹⁰ MSA 13237; MSA 9668; MSA 13239

¹¹¹ MSA 13239; the July 2020 letter did not specifically indicate which assets it was contemplating but the MSA infers that it was contemplating the 19 assets in MSA 9668 (the July 2020 list) based on the email in MSA 13237, which attached both the July 2020 letter and the July 2020 list.

¹¹² MSA 13239

performed.”¹¹³ Based on this statement, the MSA finds that the AESO suspected the PFR rules were contravened during the June 2020 event as of July 28, 2020.

On January 14, 2021, the January 2021 report was approved by an AESO engineer. In that report, AESO engineers noted that:

In Alberta, as per the section [sic] 502.5 of the ISO rules, generators which are 10MW and above in size and when connected to transmission voltage levels are required to have a continuously acting governor. This governor must be responding to the system frequency excursions based on the droop setting of the generator.

The report found a number of issues affecting generator PFR performance during the June 2020 event including ramp limitations, DCS interfering with the unit’s response to under frequency event, and AGC signals conflicting with unit response. The report also documents generating units that were operated in a generating mode that would not provide a response to low frequency excursions primarily for commercial reasons. While the circumstances surrounding a suspected contravention may be relevant to the MSA’s determination as to whether a contravention occurred, the PFR Rules do not provide an exception from providing a response for commercial reasons.

Furthermore, in the January 2021 report, the AESO refers to various “mitigations”, implying potential contraventions or non-compliant generators which ought to be brought into compliance. While it may be that the AESO expected the mitigation actions to address the concerns, the 2021 January Report indicates its engineers suspected contraventions of the PFR rules.

On March 9, 2021, the AESO delivered a public presentation (March 9 presentation) in which it announced its findings from the January 2021 report. The AESO’s findings referred to:

- “[d]istributed control systems] operation inadvertently interfering with the generating unit’s frequency response;”
- “[p]lant level controller overriding units’ droop response;”
- “[s]ome assets had a limit on how much the asset is able to respond during system events;” and
- “[s]uspected conflict between [automatic generation control (AGC)] signals and a certain class of assets leading to response withdrawal.”¹¹⁴

¹¹³ AESO, “Available transfer capability risk mitigation measures overview information session” (July 28, 2020), <https://www.aeso.ca/assets/Uploads/ATC-Risk-Mitigation-Measures-Overview-Information-Session-July-28-2020-FINAL.pdf>, pp. 34 and 36; this presentation did not list the 25 assets that “under-performed,” but the MSA notes that the AESO subsequently started engaging with generating unit owners in relation to 24 assets listed in MSA 7443.

¹¹⁴ March 9 presentation, pp. 31-32

While the AESO stated in its presentation that it had “no compliance concerns” arising out of the June 2020 event, each of the circumstances described above would have contravened the operation requirement of ISO rule 502.6, which requires a generating unit to be operated with its governor in service, in droop mode and free to respond to frequency changes, as noted in the January 2021 report.¹¹⁵ The implementation or use of any control systems which restrict, impede, or otherwise prevent the governor from remaining “free to respond to frequency changes” is a contravention of the operation requirement.¹¹⁶

The MSA notes that, in July 2024, the AESO referred suspected contraventions of the operation requirement to the MSA based on similar facts. For example, an electricity market participant’s generating unit was referred to the MSA for a suspected contravention of the operation requirement that was apparently caused by an AGC conflict.¹¹⁷

Conclusion

Based on the foregoing, the MSA finds that, as of July 2020, the AESO suspected contraventions of subsection 4 of ISO rule 502.6 but did not refer those suspected contraventions to the MSA. Even if the AESO had not suspected contraventions of subsection 4 of ISO rule 502.6 by July 2020, it ought to have by March 9, 2021.

3.2.2 The AESO did not refer certain suspected contraventions to the MSA following the 2022/23 events

The MSA finds that the AESO failed to refer certain suspected contraventions of the PFR rules during the 2022/23 events to the MSA when it ought to have.

By May 2023, OEMS had developed a new frequency response performance monitoring process, in which it would:

- identify frequency events that resulted in less than expected response using a new monitoring tool;
- quantify generating units’ response performance based on a series of frequency events using PUPFR scores (discussed in section 2.2.2); and
- meet with electricity market participants to share its observations and establish action items.¹¹⁸

By July 11, 2023, OEMS selected five electricity market participants to evaluate the PFR

¹¹⁵ January 2021 report, p. 85

¹¹⁶ MSA 11231

¹¹⁷ MSA 9267, p. 10; MSA 7048; MSA 7177; MSA 3106

¹¹⁸ MSA 13921; MSA 13922, pp. 6-9

performance of certain of their generating units.¹¹⁹ OEMS evaluated these units' PFR performance based on the six 2022/23 events between January 2022 and June 2023.¹²⁰

OEMS evaluated 26 assets subject to the PFR rules (indicated in appendix C). For their generating units, OEMS:

- calculated a PUPFR score for each admissible event, then averaged those PUPFR scores; and
- prepared a frequency plot with the generating unit's "actual power" and "expected power" during each such event.¹²¹

On November 21, 2023, OEMS referred 11 generating units to ECM for potential contraventions during one or more of the 2022/23 events.¹²² Table 2 sets out the generating units OEMS referred to ECM, the events each was referred for, the reasons given for each referral, and whether each event was subsequently referred to the MSA and, if not, why not.¹²³

¹¹⁹ MSA 9215

¹²⁰ MSA 7049, p. 12; MSA 7050, p. 12; MSA 7051, p. 12; MSA 7055, p. 12; MSA 7056, p. 12

¹²¹ MSA 7049; MSA 7050; MSA 7051; MSA 7055; MSA 7056; the MSA understands "actual power" and "expected power" in these frequency plots to be synonymous with PFR_{unit} and $PFR_{expected}$, respectively, as discussed in section 2.2.2 and appendix B.

¹²² MSA 7048

¹²³ To the extent event dates or generating units being referred were not expressly stated in the email in MSA 7048, they were identifiable by contrasting the unit or date given in the email, with the PUPFR scores in the AESO presentation for that electricity market participant attached to that email.

Table 2: Generating units and events OEMS referred to ECM on November 21, 2023¹²⁴

Generating unit (asset ID) [REDACTED ¹²⁵]	Event referred	Reason for referral	Referred to MSA
	September 30, 2022	Unsustained response	Yes
	April 19, 2023	Unsustained response	Yes
	May 27, 2022	Unsustained response	Yes
	September 30, 2022	Unsustained response	No (not pursuing letter issued)
	May 18, 2023	Unsustained response	Yes
	June 2, 2023	Unsustained response	Yes
	May 27, 2022	Unsustained response	No (not pursuing letter issued)
	May 27, 2022	Unsustained response	No (not pursuing letter issued)
	May 27, 2022	Unsustained response	Yes
	May 27, 2022	No response	Yes
	May 27, 2022	Negative response	No (self-reported)
	May 27, 2022	Negative response	No (self-reported)
	May 27, 2022	No response	No (self-reported)
	May 27, 2022	No response	No (self-reported)
	May 27, 2022	No response	No (self-reported)

The MSA reviewed the frequency plots the AESO prepared for each generating unit and applied the AESO's suspected contravention criteria. This review indicates that there were 64 instances when a generating unit's performance during a 2022/23 event met the AESO's suspected contravention criteria but a suspected contravention of the PFR rules was not referred to the MSA, as set out in appendix E. Accordingly, the MSA finds that the AESO failed to refer suspected contraventions of the PFR rules to the MSA in these 64 instances.

In response to the summary of findings, the AESO stated that the MSA's finding that "[t]he AESO's failure" to refer up to 64 "non-compliances" from 2022/2023 events has "no technical grounding." As noted above, the suspected contravention criteria were the circumstances, described by the AESO in response to the MSA IRs, where the AESO would suspect a contravention of the PFR rules. In response to information requests, the AESO did not provide any contemporaneous records explaining technical reasons why the referrals to ECM were not made. To the extent identifying suspected contraventions by applying the suspected contravention criteria lacks technical grounding, the suspected contravention criteria may require revision in accordance with the AESO's processes.

¹²⁴ Information in Table 2 about generating units and events referred, and reasons therefor, is based on MSA 7048, MSA 7049, MSA 7050, MSA 7051, MSA 7055 and MSA 7056; the not pursuing letters are MSA 2262 and MSA 11060.

¹²⁵ Information in this column has been redacted so generating units are not identified.

3.3 The AESO's record-keeping practices were insufficient

The MSA finds that the AESO's record-keeping practices with respect to its monitoring of compliance with the PFR rules did not record the AESO's reasons for referring, or not referring, suspected contraventions of the PFR rules to the MSA, and were therefore insufficient.

Through IRs, the MSA asked the AESO to provide records relating to decisions or determinations made by the AESO as part of its process to monitor compliance with the PFR rules, including:

- all “records memorializing the AESO’s decision and reasons to refer or not refer, specific conduct, performance, or behaviour to the MSA pursuant to EUA s. 21.1” with respect to the PFR rules;¹²⁶
- all “records memorializing the AESO’s decision and reasons” to refer suspected contraventions of the PFR rules to the MSA on July 9, 2024;¹²⁷
- all “records memorializing any AESO decision to assess or investigate any conduct, behaviour or performance during the [June 2020 event] to determine if such conduct, behaviour, or performance amounted to a suspected contravention of any ISO rule then in force;”¹²⁸
- all “records memorializing any AESO decision not to refer any conduct, behaviour, or performance to the MSA as a suspected contravention of any ISO rule” with respect to the June 2020 event;¹²⁹ and
- all records related to any AESO determination of the extent of compliance monitoring of electricity market participants with respect to the PFR rules.¹³⁰

The records that the AESO provided in response indicate decision-making processes that were not well-documented, including the reasons for decision. It is often unclear who made a decision (e.g., whether to refer conduct or not), and on what basis. For example, the records provided do not memorialize any OEMS decisions not to refer conduct, behaviour or performance to ECM, nor any reasons for such decisions, so it is unclear to the MSA who made those decisions and whether they were made for proper reasons.

While some records provided by the AESO do indicate who made a decision, the reasons are often unclear. For example, ECM issued “not pursuing letters” for a few of the potential PFR rule contraventions that OEMS referred to it on November 21, 2023, as shown in Table 2, but those

¹²⁶ MSA 7425, pdf p. 9

¹²⁷ MSA 7425, pdf p. 14

¹²⁸ MSA 7425, pdf p. 18

¹²⁹ MSA 7425, pdf p. 18

¹³⁰ MSA 14601, pdf p. 8

letters are unclear as to why ECM decided to not pursue them. They indicate it was based on the information provided in an email sent by the electricity market participant, and ECM's re-evaluation of the frequency event,¹³¹ with no further reasons provided.

The AESO's IR responses suggest these potential PFR rule contraventions "were dropped by ECM due to mitigating factors,"¹³² but provide no records demonstrating what factors were considered, or how these factors were applied. If ECM decided they were not contraventions of the PFR rules due to mitigating factors, there should be a contemporaneous record of those reasons, so it is clear whether those decisions were made for justifiable reasons.

The AESO also did not provide records which would allow the MSA to assess direction or guidance provided to ECM regarding which contraventions should be processed through the compliance process. In an August 2020 email about the June 2020 event, an ECM employee stated that "Compliance has been provided ongoing guidance from the rule owner to not take some AS requirements through our process unless instructed." The ECM employee went on to "recommend Compliance receive direction from the rule owner and/or key AESO stakeholders about carrying [the June 7, 2020] under performance events through our Compliance process."¹³³ The AESO did not provide any documentation of the guidance or direction from rule owners referred to in this email. Without documentation of any guidance or direction provided, the MSA cannot determine whether any guidance provided to ECM was appropriate in light of the AESO's compliance monitoring obligations.

Finally, the AESO did not provide records which would allow the MSA to assess how the AESO resolved differing views on the requirements of the PFR rules, including any application of engineering judgment.

In the same email chain as the August 2020 email referred to above, an OEMS engineer stated PFR during the June 2020 event was "not a compliance issue," in part because "[a]ll generators in the province" complied with the droop requirement, which was "validated when they submit[ted] their [model validation reports]" to another team at the AESO.¹³⁴ This engineer later signed the January 2021 report as a reviewer. In the same email chain the AESO's Chief Engineer stated that the PFR rules' requirement to have a continuously acting governor, continuously in service, free to respond to frequency changes and controlling the response to frequency changes "[...] was intended to prohibit any so-called outer control loops. Have [sic] such controls is counter to the rule. To my mind, the effective droop issue is a different challenge."¹³⁵

¹³¹ MSA 2262; MSA 11060

¹³² MSA 7425, pdf p. 16

¹³³ MSA 11321

¹³⁴ MSA 11321

¹³⁵ MSA 11321

As of August 27, 2020, it appears that AESO engineers did not agree on the requirements of the PFR rules. The OEMS engineer noted that:

[...] this is what we are trying to determine by engaging generator owners. We want to find out exactly what the root cause [was] and correct the problem. We don't want to treat this as a compliance issue at the moment because we don't know what the root causes are and we don't want to speculate.¹³⁶

The engagement referred to resulted in the January 2021 report which describes a number of circumstances where controls or control systems limit the generating unit's frequency response. Based on the interpretation of the PFR rules advanced by the AESO's Chief Engineer, these would amount to contraventions of the PFR rules. However, in the March 9, 2021 presentation, the AESO stated that it had "no compliance concerns" arising out of the June 2020 event.¹³⁷ The AESO provided no records to the MSA to demonstrate how the AESO resolved its engineers' differing interpretations of the PFR rules to conclude there were no compliance concerns.

The MSA accepts that interpreting the PFR rules may require the exercise of engineering judgement. However, as the Alberta Utilities Commission recently found, "engineering judgment cannot be used as a shield to scrutiny of those decisions, nor a justification for failure to document practices."¹³⁸ Further,

Where project documentation that should exist is deficient or missing, it is difficult for the Commission to conclude [the market participant] applied sound and principled engineering judgment. This demonstrates the critical importance in regulated utilities having a robust quality management system and thought-out risk assessments documenting how engineering judgment was exercised.¹³⁹

To the extent engineering judgement was exercised to resolve AESO engineers' differing interpretations of the PFR rules and determine there were no compliance concerns, the lack of documentation makes it impossible for the MSA to determine why this decision was made.

¹³⁶ MSA 11321

¹³⁷ March 9 presentation, p. 31

¹³⁸ Alberta Utilities Commission, *Decision 30074-D01-2026 Enforcement Staff of the Alberta Utilities Commission Application for the commencement of a proceeding pursuant to paragraph 41(1)(b) of the Hydro and Electric Energy Act and sections 8 and 63 of the Alberta Utilities Commission Act (Redacted)*, April 14, 2026 (Decision 30074), at para. 134

¹³⁹ Decision 30074, at para. 142

4 AESO ACTIONS AFTER THE INVESTIGATION PERIOD

After the AESO provided its written comments on the MSA's summary of findings, the MSA requested a meeting with the AESO to discuss any changes to its PFR compliance monitoring process since March 2025 (when the investigation period ended), and the scope and timelines for frequency stability-related action items listed in its 2025 Reliability Roadmap published in August 2025.

The requested meeting occurred on May 8, 2026. In the meeting, the AESO described various changes to its processes for monitoring compliance with the PFR rules since March 2025, including:

- using a minimum rate of change of frequency to identify events for PFR compliance monitoring, in addition to criteria relating to the duration of a frequency excursion and frequency thresholds of above 60.2 Hz or below 59.8 Hz;
- evolution of the AESO's tools for PFR compliance monitoring over time, with those tools becoming more automated and routine and capturing individual events for analysis, rather than requiring multiple events;
- closer collaboration between the OEMS and ECM teams; and
- a feedback loop of learnings, in which IR responses from electricity market participants provide learnings to technical subject matter experts and inform future assessments and IRs to electricity market participants.

With respect to the frequency stability-related action items listed in 2025 Reliability Roadmap, the AESO described initiatives that had been completed and were in progress, including the status of in-progress initiatives. The AESO also described the scope and timelines for initiatives that were under consideration or at a preliminary work stage.

5 RECOMMENDATIONS

Generator PFR performance continues to be of concern for the MSA, and the AESO's monitoring of generator compliance with the PFR rules supports the reliable operation of the AES. Accordingly, the MSA recommends the AESO:

- (a) maintain the changes to its PFR compliance monitoring process described in the May 8, 2026, meeting;
- (b) continue its progress toward meeting the frequency stability-related action items listed in its 2025 Reliability Roadmap;
- (c) revise the threshold set out in its External Compliance Monitoring Program for ISO rules (CMP) for referring suspected ISO rule contraventions to the MSA to align with the legislative framework; and
- (d) improve its record-keeping practices with respect to its monitoring of compliance with the ISO rules, particularly the decisions it makes as part of that process.

APPENDIX A: FREQUENCY EVENTS WHEN PFR SHOULD HAVE BEEN PROVIDED

MSA staff reviewed AESO PI data to identify frequency events during the investigation period when a frequency response consistent with the PFR rules would have been expected, i.e., when system frequency was outside the prescribed deadband for at least 30 seconds.¹⁴⁰ The MSA found such frequency events happened on approximately 80% of days during the investigation period, meaning frequency deviations where some PFR is expected from generators are exceedingly common.

MSA staff further reviewed AESO PI data to identify which of these events involved a system frequency deviation outside a 60 ± 0.2 Hz deadband for at least 30 seconds, based on criteria used by the AESO.¹⁴¹ The 19 events that met these criteria are listed in Table A1. For clarity, the durations in Table A1 only include the contiguous 30-second intervals when system frequency was outside the 60 ± 0.2 Hz deadband for the entire 30-second interval.

Table A1: Events during the investigation period when system frequency was outside a 60 ± 0.2 Hz deadband for at least 30 seconds

Start time	End time	Maximum frequency (Hz)	Minimum frequency (Hz)	Duration (seconds)
2020-06-07 20:50:04	2020-06-07 20:55:04	59.71	59.166	300
2020-06-07 20:58:26	2020-06-07 21:03:26	60.311	60.203	300
2020-06-07 21:24:50	2020-06-07 21:28:20	59.799	59.688	210
2020-06-07 21:29:02	2020-06-07 21:29:32	59.796	59.716	30
2020-10-16 13:31:44	2020-10-16 13:35:14	59.778	59.576	210
2021-02-22 04:12:56	2021-02-22 04:14:26	59.787	59.441	90
2021-02-22 04:21:44	2021-02-22 04:25:44	60.242	60.2	240
2021-02-22 04:25:58	2021-02-22 04:26:28	60.228	60.202	30
2021-02-22 04:26:46	2021-02-22 04:27:16	60.216	60.201	30
2021-02-23 01:22:04	2021-02-23 01:26:04	59.8	59.485	240
2021-06-03 20:43:48	2021-06-03 20:47:48	59.784	59.362	240
2021-10-23 05:04:22	2021-10-23 05:05:52	59.794	59.735	90
2021-10-23 23:29:22	2021-10-23 23:31:22	59.751	59.491	120
2023-04-19 02:03:04	2023-04-19 02:06:34	59.797	59.623	210
2023-05-18 12:19:14	2023-05-18 12:22:44	59.8	59.542	210
2024-09-30 00:31:14	2024-09-30 00:34:44	59.771	59.652	210
2024-10-02 17:49:38	2024-10-02 17:50:38	59.786	59.721	60
2024-10-03 00:15:54	2024-10-03 00:17:54	59.797	59.748	120
2024-10-03 00:18:48	2024-10-03 00:19:18	59.799	59.782	30

¹⁴⁰ MSA 14610, pdf p. 9

¹⁴¹ MSA 7425, pdf p. 4; MSA 14610, pdf pp. 9 and 12

APPENDIX B: AESO FORMULAS FOR PUPFR CALCULATION

B.1 The AESO's formula for PUPFR

The AESO calculates PUPFR for a generating unit using the following formula:¹⁴²

$$PUPFR = \frac{PFR_{unit}}{PFR_{expected}}$$

B.2 The AESO's formula for PFR_{unit}

Under simplifying assumptions, the AESO calculates PFR_{unit} for a generating unit using the following formula:¹⁴³

$$PFR_{unit} = \frac{P_B - P_A}{f_B - f_A}$$

where:

$$P_A = \frac{1}{16} \int_{t_0-18}^{t_0-2} P_{unit}(t) \cdot dt$$

$$P_B = \frac{1}{32} \int_{t_0+20}^{t_0+52} P_{unit}(t) \cdot dt$$

$$f_A = \frac{1}{16} \int_{t_0-18}^{t_0-2} f(t) \cdot dt$$

$$f_B = \frac{1}{32} \int_{t_0+20}^{t_0+52} f(t) \cdot dt$$

where:

- P_{unit} is the real power output of the generating unit (MW);
- f is the system frequency (Hz); and
- t_0 is the time when a frequency excursion begins.

¹⁴² MSA 7425, pdf p. 9

¹⁴³ MSA 7425, pdf p. 3

B.3 The AESO's formula for $PFR_{expected}$

Under simplifying assumptions, the AESO calculates $PFR_{expected}$ for a generating unit using the following formula:¹⁴⁴

$$g(f) = \frac{1}{60 \text{ Hz}} \times \begin{cases} 60 \text{ Hz} - (f - db_{unit}) & f > 60 \text{ Hz} + db_{unit} \\ 0 & 60 \text{ Hz} - db_{asset} < f < 60 \text{ Hz} + db_{unit} \\ 60 \text{ Hz} - (f + db_{unit}) & f < 60 \text{ Hz} - db_{unit} \end{cases}$$

$$P_0 = \min\{\max\{0, P_A - g(f_A) \times MARP_{unit} \times K_{unit}\}, AC_{unit}\}$$

$$P_{EB} = \min\{\max\{0, P_0 + g(f_B) \times MARP_{unit} \times K_{unit}\}, AC_{unit}\}$$

$$PFR_{expected} = \frac{P_{EB} - P_A}{f_B - f_A}$$

where:

- f is the system frequency (Hz);
- db_{unit} is the asset's frequency deadband used in the droop controller (Hz);
- $MARP_{unit}$ is the asset's maximum authorized real power (MW);
- K_{unit} is the inverse of the unit's droop percent (unitless); and
- AC_{unit} is the unit's available capability (MW).

¹⁴⁴ MSA 7425, pdf pp. 3-4

APPENDIX C: ASSETS SUBJECT TO THE PFR RULES AND EVALUATED IN 2023

To determine the assets subject to the PFR rules during the investigation period, MSA staff reviewed the “model validation tracker” provided by the AESO on October 2, 2025, to identify assets that have at least one generating unit with a MARP of 10 MW or more.¹⁴⁵ To identify which of those generating units are transmission-connected, MSA staff reviewed the asset dimension table in the AESO's enterprise data warehouse production database (EDWP).

MSA staff also identified assets that had a transmission-connected generating unit with a MARP of 10 MW or more but were not included in the model validation tracker, because they were decommissioned during the investigation period. This was done by reviewing asset dimension tables and using MARP information from a record provided by the AESO.¹⁴⁶

Table C1 includes all the assets identified in these ways, which were subject to the PFR rules during the investigation period.¹⁴⁷ It also indicates which of them: (a) were assessed by the AESO in 2023; and (b) had at least one generating unit with four or more admissible events.

Table C1: Assets subject to the PFR rules and whether they were evaluated by the AESO in the 2023¹⁴⁸

Asset ID [REDACTED ¹⁴⁹]	Assessed in 2023?	Unit(s) with 4+ admissible events
	Y	N
	Y	Y
	Y	Y
	Y	Y
	Y	Y
	Y	Y
	Y	N
	Y	Y
	Y	N
	Y	N
	Y	N
	Y	N
	Y	Y

¹⁴⁵ MSA 15156; MARP values were identified using the “Pmax (MW)” column in the “asset detail” sheet

¹⁴⁶ MSA 7050, pp. 15-18

¹⁴⁷ Table C1 does not include aggregated facilities or energy storage resources, which were not subject to the PFR rules (as defined in this report)

¹⁴⁸ Information in Table C1 about the assets the AESO selected for assessment in 2023, and generating units that had four or more admissible events, is based on MSA 7049, MSA 7050, MSA 7051, MSA 7055, and MSA 7056; it does not include any assets which were not subject to the PFR rules (as defined in this report).

¹⁴⁹ Information in this column has been redacted so asset owners are not identified.

	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A
	N	N/A

**APPENDIX D: ASSETS INVESTIGATED IN RELATION TO THE JUNE 2020 EVENT
[REDACTED¹⁵⁰]**

¹⁵⁰ Information in this appendix has been redacted so asset owners are not identified.

APPENDIX E: INSTANCES WHEN SUSPECTED CONTRAVENTION CRITERIA WERE MET IN 2022 AND 2023, BUT NO REFERRAL WAS SENT TO THE MSA

Table E1: Instances when generating unit met suspected contravention criteria during a 2022/23 event, but was not referred to the MSA¹⁵¹

Generating unit(s) (asset ID) [REDACTED ¹⁵²]	No response	Unsustained response	Negative response
		April 19, 2023	
	June 2, 2023		
	September 30, 2022; June 2, 2023		
			May 18, 2023
		June 2, 2023	
		September 30, 2022; April 19, 2023; May 18, 2023	January 12, 2022
		January 12, 2022; April 19, 2023; May 18, 2023	September 30, 2022;
		January 12, 2022; April 19, 2023; June 2, 2023	
	April 19, 2023	September 30, 2022	
	January 12, 2022		April 19, 2023
	January 12, 2022; September 30, 2022		
			September 30, 2022; April 19, 2023
	September 30, 2022		
			September 30, 2022
		September 30, 2022	
			January 12, 2022; June 2, 2023
		April 19, 2023; May 18, 2023; June 2, 2023	May 27, 2022
		September 30, 2022	
	April 19, 2023; May 18, 2023	September 30, 2022	

¹⁵¹ Information in Table E1 is based on MSA 7049, MSA 7050, MSA 7051, MSA 7055, and MSA 7056 and coordinated universal time (UTC).

¹⁵² Information in this column has been redacted so owners of generating units are not identified.

	January 12, 2022; September 30, 2022	May 27, 2022; June 2, 2023	
	January 12, 2022	September 30, 2022; May 18, 2023;	
	June 2, 2023	January 12, 2022; September 30, 2022; May 18, 2023	April 19, 2023
	April 19, 2023	May 18, 2023	January 12, 2022; June 2, 2023
	September 30, 2022; June 2, 2023	May 18, 2023	January 12, 2022
			January 12, 2022; May 18, 2023; June 2, 2023
		May 18, 2023	January 12, 2022; June 2, 2023

APPENDIX F: AESO RESPONSE TO MSA SUMMARY OF FINDINGS

March 6, 2026

Sent By Email

Alberta Market Surveillance Administrator
440 2 Ave SW
Calgary
T2P 5E9

Attention: [REDACTED]

Norton Rose Fulbright Canada LLP
400 3rd ave SW, Suite 3700
Calgary, AB T2P 4H2 Canada

[REDACTED]
nortonrosefulbright.com

[REDACTED]
Legal Assistant
[REDACTED]

Our reference
1001297211

Your reference
24-042

Dear Sir:

Response to the MSA's 24-042 Summary of Findings

We are legal counsel to the AESO in this matter and write on its behalf. The AESO has reviewed the Market Surveillance Administrator's (MSA) December 19, 2025 Summary of Findings (SOF) concerning its 24-042 written investigation into primary frequency response (PFR).¹ The AESO has also reviewed the documents the SOF relies on, plus the AESO's practices, records, and information request (IR) responses.

The AESO provides two sets of responses below. First, the SOF appears to make engineering mistakes that invalidate its conclusions – the AESO investigates PFR and makes referrals to the MSA appropriately. Second, these mistakes were exacerbated by the MSA rejecting dialogue in favour of broad document requests and negative inferences, creating fairness and efficiency concerns.

The AESO remains available to discuss any of these matters, not least because professional engineering ethical obligations entitle MSA engineers to discuss AESO engineers' concerns with their work in the SOF.

There are three main engineering concerns:

- a) **Incorrect number of events:** The MSA has dramatically overestimated the number of frequency events. The SOF uses the individual governor system deadband (60 Hz +/- 0.036 Hz) to create an AES deadband of 59.96-60.03 Hz, and identifies "events" based on this criteria.

The AESO uses a more realistic 59.4-60.6 Hz frequency range derived from other ARS/ISO rule obligations. As a result, most of the events identified by the MSA's criteria are not suitable cases for the AESO to investigate generator responses, as a response would either be negligible or the MSA's criteria would fail to identify discrete events. In these instances, any investigation would lack valid data.

¹ Specifically, sections 502.5 and 502.6 of the ISO Rules (*Generating Unit Technical Requirements* and *Generating Unit Operating Requirements*, respectively) and, after April 1, 2023, when the AESO transitioned Division 502 into Division 503, section 503.6 (*Frequency & Speed Governing*) – collectively, the PFR Rules.

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March 6, 2026

- b) **Overbroad application:** While the MSA applies the PFR Rules to overall plant response, the PFR Rules have no performance standard, and apply to governor system settings. The MSA incorrectly claims that subsection 502.6(4) meant “[using] any control systems which restrict, impede, or otherwise prevent the governor from remaining “free to respond to frequency changes” is a contravention...”
- c) **Misunderstanding screenings relative to PUPFR:** The MSA’s creation and assessment of the “Suspected Contravention Criteria” is inconsistent with how the AESO described PUPFR screenings to the MSA. The AESO’s “failure” to refer up to 64 “non-compliances” from 2022/2023 frequency events has no technical grounding.

The AESO also has two process concerns:

- a) **Fairness:** The MSA appears to have structured its investigation to presume the wrongdoings alleged by the complaint it received, and picked through the records received from its document requests to see if they disprove the (unseen) allegations. The MSA did not even-handedly ask questions and drill down to establish what practices do and do not exist, leading to errors in its analysis.
- b) **CMP:** Incredibly, the SOF casts the AESO’s External Compliance Monitoring Program – ISO Rules (CMP) document² itself as a breach of the EUA. It is a public 2020 document well-familiar to the MSA.

Please contact the writer if you have any questions or would like to discuss any of the foregoing with the AESO.

Yours very truly,

Norton Rose Fulbright Canada LLP



**Law Corporation*

² External Compliance Monitoring Program ISO Rules ([Online](#))