System Restoration Cranking Path

Assessment Guideline

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Alberta Electric System Operator
3000, 240 4 Avenue SW
Calgary, AB • T2P 4H4
aeso.ca

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PROFESSIONAL ENGINEER ALBERTA
MAHDI HAJIAN
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	Name	Signature	Date
Author – Principal Engineer / Engineer	Mahdi Hajian, P.Eng. Abdullah Shakil, P.Eng.		April 14, 2026 April 14, 2026
Checked & Approved – Senior Advisor, Operational Reliability	Changling Luo, P.Eng.		April 14, 2026

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Executive Summary

Purpose and Scope

The AESO has developed the System Restoration Cranking Path Assessment guideline to address emerging reliability challenges in Alberta Interconnected Electric System (AIES). This guideline:

- Addresses challenges connecting a new facility to system restoration cranking paths poses to system restoration plans
- Defines a standardized approach for system restoration cranking path assessments, including methodology, inputs, assumptions, performance criteria, reporting requirements and mitigation options
- Helps market participants (MPs) understand the requirements for connecting their facilities to the transmission system

Rationale

Connecting a new facility to system restoration cranking paths can create several grid reliability challenges including:

- Additional mega volt-amperes reactive (MVAr) charging due to new transmission line section(s) for the new facility and Ferranti effects
- Additional steps to isolate facilities on the cranking path, which consequently delays system restoration

Performance Criteria

- Connecting a new facility to system restoration cranking paths must not degrade the viability of system restoration plans

Application

System restoration cranking path assessment will be conducted by the AESO during connection alternative selection. In addition, and if required, mitigations will be specified in the functional specification (FS). MPs are expected to be aware of this guideline when the AESO assesses the connection alternatives and apply this guideline to implement the required mitigations specified in FS before energizing their facility.

1. System Restoration Cranking Path Introduction

1.1 Background

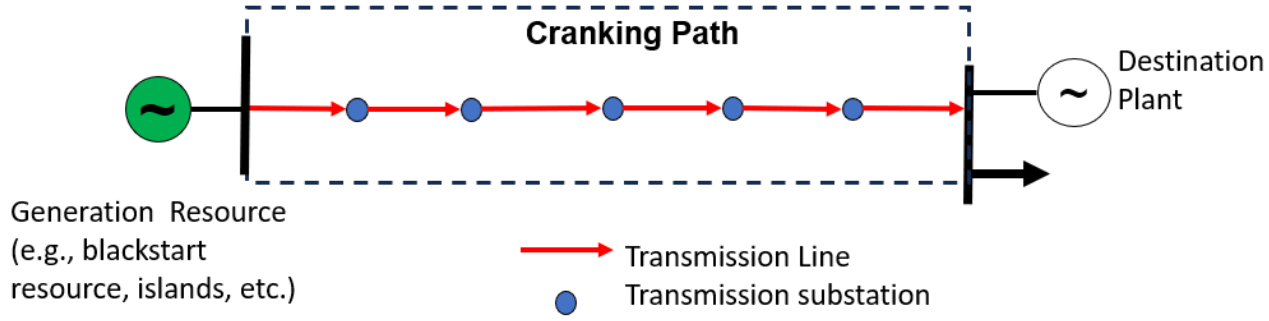
Energizing cranking paths during system restoration is an operational requirement new to the industry in Alberta. This requirement is currently not included in any AESO Authoritative Documents. MPs projects that have been identified as high-risk through the applicability, pre-screening criteria or screening steps will be required to conduct detailed study. The result of detailed study may lead to a mitigation or even a different connection alternative to avoid the impact on the cranking path.

The AESO developed this guideline to educate stakeholders about why energizing cranking paths during system restoration assessment is required and how a project will be assessed through a standardized approach. It provides transparency and guidance on how to conduct the applicability, pre-screening, screening and detailed study, demonstrating adherence to the requirements in the AESO's functional specification. It is noted that this guideline is not authoritative and for information purposes only.

The main objective of energizing cranking paths during system restoration is to provide start-up power to key plants (also known as destination plants) in each area from blackstart resources or other islands. Figure 1 shows a conceptual diagram of a restoration path, where a generation resource (e.g., a blackstart resource or another island) energizes multiple substations and lines to provide start-up power to a destination plant. Once the destination plant is started, it provides additional MW and megavolt-amperes reactive (MVAr) capability to enable the restoration of other transmission elements, generation facilities and load in the area. In other words, destination plants are pillars for the restoration of each area and it is critical that they are provided with start-up power as soon as possible. Further, thermal plants (which are typical destination plants) might become warm or even cold from hot conditions if they are offline for an extensive time, typically 4-48 hours for warm and longer than 48 hours for cold.[1] Starting up such plants in cold or even warm conditions will take a significantly longer duration, typically in the range of 7-10 hours for a warm start and 10-24 hours for a cold start. Hence, any delay in energizing the cranking paths will delay the start-up of the destination plants, which consequently delays the restoration time of areas in the AIES.

[1] This assumes the destination plants were online prior to the blackout event. It is outside of the scope of this guideline to assess other scenarios.

Figure 1: A Conceptual Diagram of a System Restoration Cranking Path



It should be noted that the AESO's restoration plans are protected and confidential information and outside of the established external distribution list, the AESO will not share the details of its plan with external parties in the connection process.

The guideline addresses two main issues related to connecting new projects to existing cranking paths, which are as follows:

Issue 1

Connecting a new facility to the system restoration cracking path will introduce additional MVAr charging due to new transmission line section(s) for the new facility. This will consequently exacerbate high voltage concerns in system restoration. In general, during system restoration, the transmission system is lightly loaded and the MVAr charging of lines will result in high voltage issues, which is also known as Ferranti effects. The MVAr charging of the new transmission line section(s) will add to the overall MVAr charging in the cranking path, which in turn could exacerbate high-voltage issues. Addressing these issues may require additional operational measures (e.g., additional voltage adjustment, load pickup, etc.). This will add to the overall energization time of the cranking path delaying the start-up of destination plants and, in the worst case, render the use of the cranking path infeasible if there is insufficient reactive power capability in the cranking path.[2]

To address this concern, connection alternatives will need to be assessed from the system restoration perspective by considering the impact of MVAr charging of new line section(s) for the new facility on the cranking paths. This assessment needs to be only conducted for the cranking paths, which originate from the contracted blackstart resources.[3]

[2] For clarity, this concern is driven by the location of the new facility with respect to the existing transmission system in the area irrespective of connection type (e.g., t-tap, in-and-out, etc.).

[3] The rationale for performing this assessment only for cranking paths with contracted blackstart resources is that the system restoration islands with blackstart resources are relatively small and weak and hence the additional MVAr charging could be detrimental. The other cranking paths in the AESO's restoration plans have a relatively larger generation capacity and as such they are expected to be capable of absorbing the additional MVAr charging with proper operating measures. The AESO may expand this criterion in future based on restoration needs.

Issue 2

Introducing additional steps to isolate the new facilities on the cranking path consequently delays the start-up power to the destination plants. As indicated in the background section, the additional delay is particularly concerning because it impacts the start-up time of some of the key thermal plants (e.g., combined-cycle and gas-fired steam) due to hot, warm and cold start-up considerations. Additional coordination with the operator of the tapped facility may be required to isolate the new facilities, which will further add to the overall energization time of cranking paths.

To address this concern, T-tap connection to all system restoration cranking paths needs to include appropriate mitigation to ensure the tapped customer can be isolated quickly and efficiently during a restoration event. This mitigation typically is a breaker on the high-voltage side of the customer facility capable of remote open/trip by the interconnected transmission facility owner (TFO).

1.2 Roles and Responsibilities

This section outlines the high-level roles and responsibilities of various tasks in the study. All the parties can reach out AESO's project manager for details.

Table 1: RACI Chart for System Restoration Cranking Path Assessment

Note: R – Responsible; **A** – Accountable; **C** – Consult; **I** – Inform

Deliverable	AESO	Transmission Facility Owner (TFO) *	Generation Facility Owner (GFO) *	Market Participant (MP)
Applicability and Pre-Screening (Earliest Connection Process Stage: Stage 1)				
Identify if connection alternative(s) are on system restoration cranking path	A, R	NA	NA	I
Screening Assessment – For issue #1 (Earliest Connection Process Stage: Stage 1)				
Assess if the preferred connection alternative can be accommodated from the system restoration perspective, and/or select other alternatives in study scope for detailed study in engineering study results (ESR)	A, R	NA	NA	I
Detailed Study – For issue #1 (Earliest Connection Process Stage: Stage 2)				

Deliverable	AESO	Transmission Facility Owner (TFO) *	Generation Facility Owner (GFO) *	Market Participant (MP)
Include system restoration assessment of connection alternative(s) as part of ESR	A	NA	NA	I
Finalize the preferred connection alternative considering system restoration needs	R	NA	NA	I
Mitigation Recommendation – (Earliest Connection Process Stage: Stage 3)				
Determine and include mitigations in functional specification if the preferred connection alternative is on cranking paths	A, R	C	C	C
Energization Authorization (Earliest Connection Process Stage: Stage 5)				
Proof of hardware installation (if specified in functional specification): Single-line diagram (SLD), vendor information in 100-day energization package at stage 5	C	R	A	A
Accept the deliverables	R	I	C	C

Note:

Responsible (R) = “the doer”. Those who do work to achieve the task. There can be multiple resources responsible. The act of approving a deliverable can be categorized under the responsible party.

Accountable (A) = “the buck stops here”. The resource ultimately answerable for the correct and thorough completion of the task There can only be one “A” specified for each task.

Consulted (C) = “in the loop”. Those whose opinions are sought. Those who have special knowledge or expertise needed to make decisions or solve problem. Two-way communication.

Informed (I) = “in the picture”. Those who are kept up to date on progress and decisions (once made). May be impacted by decision but are not active in final decision. One-way communication.

* If the connecting facility is owned by the TFO or GFO, they will retain their designated roles in this RACI chart and assume the responsibilities assigned to the MP, as they are acting as the owner of the connecting project.

1.3 Applicability

This guideline applies to projects including:

- Transmission-connected generation projects
- Transmission-connected load projects

This guideline does not currently apply to distributed energy resources (DERs) and distribution load projects.

1.4 Pre-Screening

Pre-screening is required when project applicability cannot be directly applied, and engineering assessment must be applied by the AESO to determine if a connecting facility impacts system restoration cranking paths or it can be excluded from further analysis. Information that may be used by the AESO for pre-screening includes, but is not limited to:

- AESO's system restoration cranking path (AESO's confidential information)

1.5 Screening Assessment (Issue 1)

The AESO, based on available information in stage 1, assesses if the preferred connection alternative can be accommodated from the system restoration perspective based on issue 1 described above. If required, the AESO selects other alternatives as the preferred connection alternative in the study scope for detailed study in ESR. This assessment should be initiated irrespective of project connection type (i.e., t-tap, switching station, in-and-out, etc.).

1.6 Detailed Study (Issue 1)

If identified in the study scope, as part of the ESR, the AESO will perform restoration studies to assess which connection alternative can meet the system restoration needs. The AESO will use applicable information and data including connection project base cases and system restoration data to carry out this study. The selected alternative in ESR is expected to meet system restoration needs with appropriate mitigations applied as needed.

1.7 Mitigation Implementation

The AESO will include appropriate mitigation in the functional specification to address issue 1 and/or issue 2.

1.8 Energization Requirements

The AESO authorizes the project to connect to the AIES and achieve energization when the project meets all the AESO's energization checklist requirements, outlined in the 100-day and 30-day energization packages. The AESO encourages the market participant to check with AESO's project manager to fully understand how to meet the energization requirements. If a mitigation is included in the project functional specification, then the proof of installation in the form of applicable SLDs and other relevant documentation should be submitted and shared with the AESO for the records as part of the Stage 5, 100-day energization package.

Appendix A: GRIP Overview

Introduction

The Alberta Interconnected Electric System (AIES) is undergoing a period of grid transformation driven by multiple factors, including the increasing integration of inverter-based resources (IBRs) such as wind and solar, changes in system topology, and evolving operating conditions. Collectively, these factors present the following challenges to the Alberta Electric System Operator (AESO):

- High penetration of IBRs, which can reduce system capability to manage and maintain frequency stability, system strength and operational flexibility
- Restrictions on the availability of reliability support through interties due to weak connectivity with the Western Interconnection, where excessive reliance on external resources increases the risk of intertie tripping
- Increasing operational limitations associated with newly energized facilities
- An increase in reliability-related phenomena observed during real-time operations

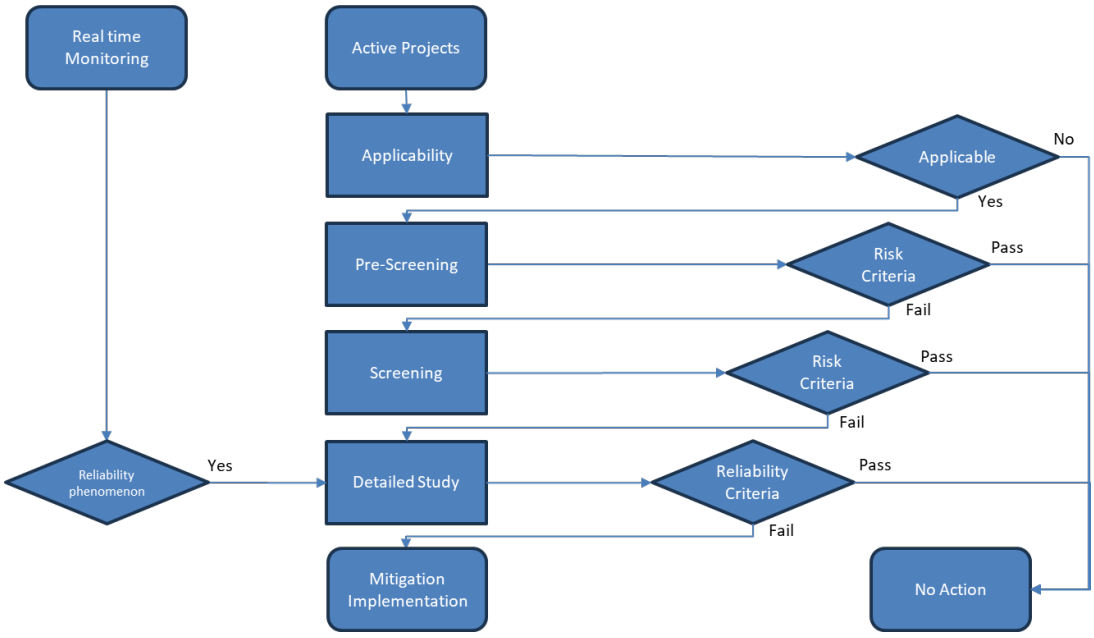
As a result of these emerging AIES reliability challenges, the AESO has identified several areas where performing Grid Readiness, Integration and Performance (GRIP) Requirements would be beneficial. System reliability, due to issues/reasons mentioned in the next section, is also heavily dependent on how market participants (MPs) conduct technical assessment and design the facility accordingly to meet connection requirements prior to energization. Therefore, we have created standard guidelines on how to conduct the APSA. We have adopted a risk-based approach, which considers the risk to the reliability of the AIES using project information, beginning with high-level screening assessments for all active connection projects and, where necessary, proceeding to more detailed studies. These studies may identify potential mitigation measures to be implemented during the connection process. This approach seeks to strike the right balance between moving efficiently through the connection process and exercising the due diligence required to ensure system reliability.

AESO's Risk-Based Assessment Approach

The AESO's process for GRIP utilizes a risk-based framework, as shown in Figure A1, which consists of:

- Applicability
- Pre-screening
- Screening
- Detailed study, report and submission
- Result acceptance
- Mitigation implementation

Figure A1: Risk-Based Assessment Approach



The phases of this process occur at different points throughout the AESO's Connection Process. For topics related to AESO Authoritative Documents, market participants are responsible for completing applicability, pre-screening, and screening steps independently and are encouraged to use the approach and methodology outlined in this guideline. In all other cases, the AESO will conduct these initial steps. These steps will determine whether a facility requesting system access can be excluded from further analysis or requires further study as a high-risk project. If required, the AESO will conduct a detailed study for high-risk projects. This guideline provides details on the AESO's approach for conducting the overall assessment. Based on the detailed study result and other operational requirements, the AESO may revise project's functional specification.

Applicability

The objective of applicability phase identifies projects requiring further assessment using applicability criteria by the AESO based on accessible project information available early in the customer connection process such as, facility location and connection type.

Once a project meets the applicability criteria it will move to the next relevant step following the guideline.

Pre-screening

The objective of pre-screening is to conduct a further assessment once the connection alternatives are selected. At this stage, the project details such as point of connection, nearby facilities and project scope are known, which are used to help identify potential high-risk projects. This information helps the MP and the AESO understand the risk of meeting operational requirements.

Screening

The objective of screening is to conduct a further assessment for issue 1 as described above by the AESO. If the screening identifies potential risks for issue 1, other connection alternatives may be selected as the preferred alternative and/or a detailed study will be carried out to further assess the preferred connection alternative. For issue 2 as described above and based on the applicability/pre-screening results, projects proceed directly to mitigation and applicable requirements will be included in the functional specification.

Detailed Study, Report and Submission

The objective of the detailed study is to demonstrate compliance with the AESO's operational requirements through advanced calculations or simulation outlined in this guideline prior to project energization. If required, the AESO will conduct the detailed study based on project information, models and system restoration plans.

Mitigation

The detailed study report may identify a reliability issue. When this occurs, the AESO will propose mitigations and the project functional specification will be revised to reflect the required mitigations, as applicable. Deliverables related to system restoration cranking path mitigations must be submitted prior to the project energization, preferably 100 days prior to the project energization, and must be accepted to achieve project energization. It is noted that the TFO shall directly coordinate with the MP on the proposed mitigations if the AESO includes a requirement in the functional specification.

Result Acceptance

If applicable, the market participant must submit the implementation of the mitigation solution, which must be accepted by the AESO before the on-service date of project. The AESO shall review the submission within a reasonable time. The AESO may comment on the submission and ask the market participant to respond prior to our acceptance. The AESO may revise the functional specification of the project according to the study result or proposed mitigation solution. Any delay on the submission may result in a delay in project energization.

It is important to note that this guideline is meant to assist the AESO in understanding and mitigating the risks to reliability of the AIES. This risk-based assessment is not conclusive and if the reliability phenomenon is observed in real-time, we will work with the MP on real-time mitigation measures. Furthermore, project changes, accepted through the AESO's Project Change Proposal process may trigger the need for additional applicability, pre-screening, screening and detailed study.

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