



Transmission Reliability Criteria



Part I General
Part II Transmission System Planning Criteria
Part III Transmission Operating Criteria

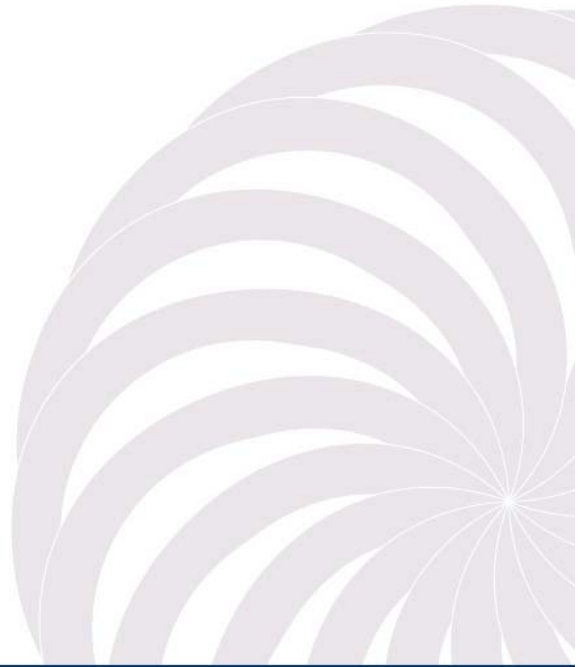
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PREFACE

The transmission system connects generators to loads over a large and diverse geographic area and delivers electric energy to Alberta customers reliably and efficiently under a wide variety of system operating conditions and continuously changing customer demands. Transmission is a vital component of the electric industry providing a platform for a competitive wholesale electricity market.

Through transmission lines that provide interconnection with neighbouring jurisdictions (called **interties**)¹, the Alberta Transmission System (**ATS**) also provides access to the entire North American electric grid. In addition to providing mutual assistance during emergencies, interties are an essential part of a competitive market providing Alberta the ability to import energy when needed, and to export energy when it is surplus to Alberta's needs.

The AESO Reliability Criteria (**Reliability Criteria**) is central to assessing the adequacy of the current and future ATS. The Reliability Criteria applies equally to regulated, non-regulated and merchant facilities interconnected with the ATS. With an adequate system and prudent operating criteria, the AESO is able to operate the ATS securely and at the same time facilitate an open and competitive electricity market.

Alberta has chosen to adopt both the North American Electric Reliability Council (NERC) and Western Electricity Coordinating Council (**WECC**) reliability criteria for application in Alberta as well as for its interconnections. The Reliability Criteria summarizes important elements of the NERC and WECC reliability criteria and identifies applicable performance standards and interpretations used in planning and operating the ATS.

The Reliability Criteria is intended to document the complete set of transmission reliability criteria used to plan and operate the ATS.

Reliability criteria provide one very important input to planning future developments or operating the ATS. The Reliability Criteria generally are a minimum standard to which the ATS should be planned and operated. However there are a wide variety of other considerations that must be weighed in the process of planning and operating the ATS. There are often a variety of solutions that may be considered to meet both the planning and operating criteria. Both planning and operating decisions must be made with due regard for the costs to meet the Reliability Criteria, impact on stakeholders, land use impacts and the risks associated with not meeting the Reliability Criteria. Development of the AIES, both the transmission and distribution systems, must be done in an economic, orderly and efficient manner. The AIES needs to be planned with an appropriate mix of transmission and distribution facilities to achieve this standard.

The AESO's transmission planning, design and interconnection standards or guides are or will be included in separate documents. The assumptions associated with particular studies or regulatory applications are stated therein.

The intent of this document is to create clarity around the Reliability Criteria that apply to Alberta and interpretations particular to Alberta.

¹ The first use of a defined term is in bold type.

1.0 INTRODUCTION

The WECC is the largest of ten regional reliability councils that make up **NERC**. The WECC was established in 1967 in part, to promote electric system reliability throughout the 14 USA western states, British Columbia, Alberta and the northern portion of Baja California, Mexico.

Alberta has chosen to follow both the NERC and WECC reliability criteria for planning and operating the ATS and its interconnections. NERC requires that each regional reliability council conform with the NERC Reliability Standards. WECC has responded to this requirement and has, for example, included the NERC Reliability Standards as the foundation for the NERC/WECC Planning Standards.

The WECC Reliability Criteria can be found at www.wecc.biz. In addition to the WECC planning standards, there are standards that are established specifically for the ATS.

The WECC Reliability Criteria contain both planning and operating criteria. The planning criteria are designed to ensure that there are adequate transmission resources available to the system operators so they are able to maintain system **reliability** through a wide variety of load levels, generation **dispatches**, interchange levels, adverse weather conditions and system outages. The AESO intends to apply both the planning and operating elements of the WECC Reliability Criteria to the ATS and its interconnections. The AESO recognizes there may be specific situations where meeting the NERC, WECC or Reliability Criteria does not meet a reasonable cost versus risk test. On the other hand, there may be circumstances where the AESO or a customer determines that facilities beyond those required to meet the Reliability Criteria are desirable. In either case, good engineering and business judgement will be applied.

The NERC and WECC reliability criteria apply to the Bulk Electric System which is defined as:

“The bulk electric system is a term commonly applied to that portion of an electric utility system, which encompasses the electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment, generally operated at voltages of 100 kV or higher.”

The Reliability Criteria will apply to the bulk electric system as defined by NERC and WECC as well as the 69 and 72 kV systems. This definition encompasses the entire ATS as defined by the EU Act.

Planners use the Reliability Criteria to ensure the system can withstand Category B and C events under a specific adverse generation scenario and peak loading conditions. Although this event may not occur over the heaviest load hour the system may experience more extreme events over hours with less load but with less favourable generation dispatch. The planner's role is to provide adequate transmission resources so the operator will be able to operate the system reliably in real time. The Reliability Criteria also serves as a foundation for needs documents, functional specifications and operating policies and procedures.

The AESO is also a signatory to the WECC's Reliability Management System (**RMS**) Agreement. The RMS is more specific in defining the requirements for meeting defined

standards of reliability, the measures, how to report compliance and sanctions for non-compliance. The RMS can be found on the AESO Web site at www.aeso.ca.

Operators know what the prevailing system conditions are at the moment but are unaware of what events may transpire in the future. They establish operating procedures to ensure that the system can withstand the next contingency events, in accordance with the WECC Minimum Operating Reliability Criteria (**MORC**). Operating Policies and Procedures based on the operating criteria can be found in the ISO Rules on the AESO web page.

The WECC Reliability Criteria includes a standard titled "Power Supply Assessment Policy" that addresses the requirement for the regions to assess and report on the adequacy of power supply in the future. With deregulation, Alberta depends on market forces to ensure the adequacy of supply and therefore there is no generation adequacy standard applied in Alberta.

Methods or guides adopted for use in Alberta are identified in the appropriate criteria.

2.0 DEFINITIONS

The definitions in the WECC Reliability Criteria are the bases for the terms used in this document unless otherwise defined herein. Appendix A contains definitions and acronyms specific to Alberta as well as selected important definitions from the WECC and NERC for the convenience of the reader.

The application of these definitions is intended solely for the purpose of the Reliability Criteria document and is not necessarily intended to represent the definitions used by the AESO in other documents.

In each Part the first use of a defined term is in bold type.

3.0 AESO POWERS TO CHANGE RULES

NERC and the WECC will make changes to their reliability criteria from time to time. The AESO will participate in the process of changing these criteria and will incorporate changes to the Reliability Criteria as required.

The AESO may exercise its powers under the Act to change the Reliability Criteria from time to time, as it considers desirable and appropriate. Any changes are subject to review by and directives from the Alberta Energy and Utilities Board (**EUB**).

The AESO will plan and operate according to this Reliability Criteria to the extent possible and reasonable. The AESO reserves the right to fall short of or exceed the Reliability Criteria when warranted and will disclose such exceptions to stakeholders and the EUB through information submissions or regulatory applications on a case by case basis.

APPENDIX A – Definitions and Acronyms

“abnormal operating conditions” means conditions where transmission facilities are out of service, emergency conditions exist, construction or commissioning of transmission facilities occur or situations when transmission facility maintenance cannot be coordinated with generation outages. (EU Act Transmission Regulation)

“Act” means the Electric Utilities Act (Alberta), as amended from time to time. (AESO Rules)

“adequacy” means the ability of the electric system to supply the aggregate electrical demand and energy requirements of the system access customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements. (AESO Rules)

“ADOE” means The Alberta Department of Energy

“AIES” means Alberta’s “Interconnected Electric System” as that term is defined in the Act. (AESO Rules)

“ATS” means Alberta Transmission System, the transmission component of the AIES as defined in the Act.

“bi-pole” means a DC power system which has both a positive and negative conductor.

“bulk electric system” means “that portion of an electric utility system, which encompasses the electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment, generally operated at voltages of 100 kV or higher.” This is the NERC and WECC definition and applies to the ATS as defined by the EU Act including 69 kV and 72 kV elements of the ATS.

“bus” means a group of conductors that serve as a common connection for two or more system elements.

“capacity” means the rated continuous load-carrying ability, expressed in megawatts (MW) or megavolt-amperes (MVA) of generation, transmission, or other electrical equipment. Used interchangeably with **capability**.

“capacitor bank” means a set of electrical devices used to maintain or increase transmission voltage by providing reactive power.

“cascading” means the uncontrolled successive loss of system elements triggered by an incident at any location. Cascading results in widespread service interruption which cannot be restrained from sequentially spreading beyond an area predetermined by appropriate studies. (NERC/WECC Planning Studies Table 1 page 25)

“circuit” means a conductor or a system of conductors through which electric current flows and can be automatically segregated by circuit breakers or fuses.

“circuit breaker” means a protective switch which automatically interrupts the flow of an electric current in case of an overload, electrical fault, or short circuit.

“**cogeneration**” means a generating facility that produces electricity and another form of useful thermal energy (such as heat or steam), used for industrial, commercial, heating, or cooling purposes.

“**combined cycle**” means an electric generating technology in which electricity and process steam is produced from otherwise lost waste heat exiting from one or more combustion turbines. The exiting heat is routed to a conventional boiler or to a heat recovery steam generator for use by a steam turbine in the production of electricity. This process increases the efficiency of the electric generating unit.

“**congestion**” means the condition under which the transactions that market participants wish to implement exceed the constraints on a transmission path. Congestion usually requires the system operator to adjust the output of generators, decreasing it in one area to relieve the constraint and increasing it in another to continue to meet customer demand.

“**constraint**” means a restriction on a transmission system or segment of a transmission system that may limit the ability to transmit power between various locations. A path rating establishes the limits of power flow across defined paths. The path rating is established taking into account physical limitations, such as the thermal limits of a transmission elements; local voltage and stability restrictions, or contingency limits that are established to assure secure operations in the event of an unexpected failure of a transmission elements or a generation facility.

“**contingency**” means an event occurring on the ATS resulting in the loss of a system element.

“**largest single generation contingency**” means the loss of an ATS or customer element that would result in the largest loss of generation measured in MW. This contingency includes more than one generator if a single elements outage could result in a prolonged outage of associated generators i.e., a combined cycle turbine outage may result in the outage of an associated steam generator or a interconnection transformer may result in the outage of more than one generator.

“**single contingency**” - The loss of a single system element under any operating condition or anticipated mode of operation. Single contingency events are Category B events and include the outage of a generator, single transmission circuit or a transformer. For the purpose of the Reliability Criteria a double or multiple circuit outage is not considered a single contingency.

“**multiple contingency**” - The loss of two or more system elements caused by unrelated events or by a single low probability event occurring within a time interval too short (less than ten minutes) to permit system adjustment in response to any of the losses.

“**criteria**” means standards on which a judgment or decision may be based. (Merriam-Webster Dictionary)

“**cycle**” means the single complete series of changes in voltage and current direction of an alternating electric current. The standard used in North America is 60 cycles per second. One cycle is equal to 1/60th of a second or 17 milliseconds.

“**DC**” (**direct current**) means current that flows continuously in the same direction (as opposed to alternating current). The current supplied from a battery is direct current.

“**dynamic VAR control devices**” means a device that can rapidly vary its VAR output in response to control signals that are more than simply on off.

“**dispatch**” has the same meaning as that provided in the Act, which means a direction from the ISO to a pool participant to cause, permit or alter the exchange of electric energy or ancillary services. (AESO Rules)

“**distributor**” means a party providing “distribution access service” as defined in the Act. (AESO Rules)

“**double circuit**” means a transmission line having two separate circuits on a single structure. In an AC system each circuit carries three-phase power, requiring three conductors or conductor bundles per circuit.

“**economic dispatch**” means a method of managing the operation of generation and transmission facilities to produce the most cost-effective result. Economic dispatch most commonly involves the selection of the lowest-cost available generating units.

“**element**” means any electric device with terminals that may be connected to other electric devices, such as a generator, transformer, circuit breaker, bus section or transmission line. An element may be comprised of one or more components. A fault on an element usually results in the clearing of one protective zone by circuit breakers.

“**EUB**” means the Alberta Energy and Utilities Board established under the Alberta Energy and Utilities Board Act (Alberta). (AESO Rules)

“**fault**” means an event occurring on an electric system where abnormally high current flow resulting in the operation of a protection device or such as a short circuit, or a total interruption of an electrical circuit.

“**firm load**” means the load that the ISO and system members will use reasonable best efforts to supply without interruption. (AESO Rules)

“**frequency**” means the number of cycles through which an alternating current passes in a second. The North American standard is 60 cycles per second, known as 60 hertz.

“**general distribution POD**” means a point of delivery to a distributor where the energy is delivered to many end use customers, typically less than 90% of the load is to one industrial customer.

“**HEE Act**” means the Hydro and Electric Energy Act of Alberta.

“**in merit**” means a designation applied to an asset dispatched by the system controller that qualifies the asset as eligible to set pool price. (AESO Rules)

“**interchange**” means electric power or energy that flows between Alberta and other jurisdictions such as British Columbia and Saskatchewan.

“**interconnected system**” means a system consisting of two or more individual electric systems that normally operate in synchronism and have connecting tie lines.

“**intertie**” means a transmission line that interconnects the ATS with jurisdictions outside of Alberta. Used interchangeably with tie line.

“**load**” means a customer or process that takes energy from the AIES.

“**local network**” is “a non-radial portion of a system and has been planned such that a disturbance may result in loss of all load and generation in the LN.

1. The LN is not a control area.

2. The loss of the LN should not cause a Reliability Criteria violation external to the LN.” (WECC Reliability Criteria, Part IV page 5)

“**losses**” means the energy that is lost through the process of transmitting electric energy. (AESO Rules)

“**Mega VAR**” or “**MVAR**” means 1 million VARs or 1000 kiloVARs of reactive power. (AESO Rules)

“**merit order**” means the list of all valid offers and bids for a settlement interval sorted in order of offer and bid price blocks.

“**MORC**” means WECC’s Minimum Operating Reliability Criteria.

“**most critical generator**” means the generator outage that results in the worst system performance during subsequent outages and includes additional generators if a single element outage could result in a prolonged outage of associated generators i.e., a combined cycle turbine outage may result in the outage of an associated steam generator or an interconnection transformer may result in the outage of more than one generator.

“**MVA**” means Mega Volt Amperes.

“**MW**” means megawatt(s) or means 1 million watts or 1000 kilowatts of real electrical power. (AESO Rules)

“**MWh**” means megawatt hour(s). A unit of energy. (AESO Rules)

“**MCR**” (Maximum Continuous Rating) is the maximum output a plant can sustain on a continuous basis and prescribed conditions.

“**NERC**” means the North American Electric Reliability Council.

“**normal operating conditions**” means conditions where all transmission facilities are available for service including generators.

“**operating reserves**” means the capability above system demand required to provide for regulation, load forecasting errors, equipment forced and scheduled outages and local area protection. It consists of spinning reserve and non-spinning reserve. (AESO Rules)

“**opportunity service**” means “system access service offered to any system access customer who can establish to the ISO’s satisfaction that it would not take system access service pursuant to rate schedule DTS and with respect to which, therefore, the service requirement presents the opportunity for incremental revenue with which the ISO can offset transmission costs, subject to the availability of transmission capacity.” (AESO Rules) Opportunity service is often used interchangeably with non-firm or interruptible service.

“**out-of-merit**” means a designation applied to a block dispatched by the system controller that disqualifies the block from being eligible to set pool price. (AESO Rules)

“**over frequency**” means the abnormal operating state or system condition that results in a system frequency above the normal 60-hertz. (AESO Rules)

“**path**” means a transmission line or set of lines that carry energy from one region to another.

“**path rating**” means “the rating assigned to the transmission facility when it was placed in service and rated in accordance with reliability standards.” (EU Act Transmission Regulation s1(1), (d)). The term can also be used to reflect the current rating of a path.

“**p.u.**” means per unit.

“**PCR**” (peak continuous rating) means the maximum rating a generator can produce for a prescribed period of time and conditions.

“**peak demand**” means the maximum power demand registered by a customer or a group of customers or a system in a stated period of time such as a month or a year. The value may be the maximum instantaneous load or more, usually the average load over a designated interval of time, such as one hour, and is normally stated in kilowatts or megawatts.

“**peaking**” means plants that run when the pool price is high. Typically capacity factors are below 50% and the cost of fuel is relatively high.

“**RMS**” means the WECC’s Reliability Management System agreement with participating WECC members.

“**POD**” (point of delivery) means a conceptual point of delivery from the transmission system. A POD is the point at which energy is deemed to be delivered from the transmission system to the distribution system. (AESO Rules)

“**post transient**” means the state of equilibrium of a power system after a transient event.

“**power factor**” means the ratio of real power to apparent power. (AESO Rules)

“**radial customer**” means a customer served from an electric system in which the electrical service is through a single transmission element. (NERC)

“**reactive power**” means the portion of electricity that establishes and sustains the electric and magnetic fields of alternating current equipment, usually expressed in kiloVAr (“kVAr”) or megaVAr (“MVAR”). (AESO Rules)

“**reliability**” means the degree of performance of the elements of the bulk electric system that results in electricity being delivered to customers within accepted standards and in the amount desired. Reliability may be measured by the frequency, duration, and magnitude of adverse effects on the electric supply. Electric system reliability can be addressed by considering two basic and functional aspects of the electric system adequacy and security.

“**adequacy**” means the ability of the electric system to supply the aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.

“**security**” means the ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system elements.

“**reliability criteria**” means a set of standards and principles used to design, plan, operate, and assess the adequacy of an electric system.

“**Reliability Criteria**” means the AESO’s Reliability Criteria except where otherwise noted.

“**remedial action scheme (RAS)**” means protection schemes designed to perform pre-planned corrective measures following a disturbance to provide for acceptable AIES performance or equipment protection. (AESO Rules) Used interchangeably with special protection system (SPS). Typical automatic remedial actions include generator tripping or equivalent reduction of energy input to the system, controlled tripping of interruptible load, DC line ramping, insertion of braking resistors, insertion of series capacitors and controlled opening of interconnections and/or other lines including system islanding. Typical manual remedial actions include manual tripping of load, tripping of generation, etc.

“**safety net system**” means a control system that protects the system from widespread cascading outages and loss of load. Systems include under frequency load shedding, and under voltage load shedding.

“**single pole trip and reclose (SPT&R)**” mean a transmission circuit protection system which is capable of opening only the faulted phase of a circuit for single phase faults and successfully reclosing after the fault has been cleared.

“**special protection scheme**” means the same as RAS.

“**stability**” means the ability of an electric system to maintain a state of equilibrium and synchronism between its parts during normal and abnormal system conditions or disturbances.

“**stability limit**” means the maximum power flow possible through some particular point in the system while maintaining stability, during both normal and defined contingencies, in the entire system or the part of the system to which the stability limit refers.

“**steady state**” means the operation of a power system with no disturbances or after regaining equilibrium after a disturbance.

“**stacking order**” means the order in which plants are assumed to dispatch in the merit order.

“**standard**” means something established by authority, custom, or general consent as a model or example. (Merriam-Webster Dictionary)

“**substation**” means a facility for switching electrical elements, transforming voltage, regulating power, or metering.

“**summer rating**” means the rating a piece of equipment is given when summer ambient weather conditions prevail.

“**switching station**” means a facility for switching electrical elements

“**synchronism**” means the timing of alternating current generators so that their voltage waves go through their maximum and minimum values at exactly the same rate.

“**system**” means integrated electrical facilities which may include generation, transmission, distribution, protection, control and communications facilities.

“**thermal rating**” means the maximum amount of electrical current that a transmission line or electrical facility can conduct over a specified time period before it sustains permanent damage by overheating or before it violates public safety requirements.

“**tie line**” means a circuit connecting two or more systems and used interchangeably with intertie.

“**transfer capability**” means the measure of the ability of interconnected electric systems to move or transfer power *in a reliable manner* from one area to another over all transmission lines (or paths) between those areas under specified system conditions. The units of transfer capability are in terms of electric power, generally expressed in megawatts (MW).

“**transformer**” means an electrical device for changing the voltage of alternating current.

“**transient**” means the period when a power system is moving from one state of equilibrium to another (post transient) state.

“**transmission circuit**” means a set of wires energized at transmission voltages extending beyond a substation which has its own protection zone and set of breakers for isolation.

“**transmission facility owner (TFO)**” has the same meaning as that provided for “owner” and “transmission facility” in the Act. (AESO Rules)

“**transmission line**” means a set of structures, wires and insulators that together make up one or more transmission circuits.

“**transmission must-run (TMR)**” means a generator is constrained on to operate at a minimum specified MW output level in order to maintain system security. (AESO Rules)

“**transmission reliability margin (TRM)**” means that amount of transmission transfer capability necessary to ensure that the interconnected transmission network is secure under a reasonable range of uncertainties in system conditions. (AESO Rules)

“**trip**” means the disconnection or breaking of a circuit, usually in context of an automatic interruption of the circuit such as the opening of a circuit breaker.

“**underfrequency**” means the abnormal operating state or system condition that results in a system frequency below the normal system operating frequency of 60-hertz. (AESO Rules)

“**VARS**” means volt-amp reactive, a measure of reactive power. (AESO Rules)

“**voltage collapse**” means an event that occurs when an electric system does not have adequate reactive support to maintain voltage stability. Voltage collapse may result in outage of system elements and may include interruption in service to customers.

“**voltage instability**” means a system state in which an increase in load, disturbance, or system change causes voltage to decay quickly or drift downward, and automatic and manual system controls are unable to halt the decay. Voltage decay may take anywhere from a few seconds to tens of minutes. Unabated voltage decay can result in angular instability or voltage collapse.

“**voltage limits**”

Normal Voltage Limits

The operating voltage range on the interconnected systems that is acceptable on a sustained basis.

Emergency Voltage Limits

The operating voltage range on the interconnected systems that is acceptable for the time sufficient for system adjustments to be made following a facility outage or system disturbance.

“voltage recovery” means the nature of voltage returning to an equilibrium state after a transient event.

“voltage stability” means the condition of an electric system in which the sustained voltage level is controllable and within predetermined acceptable limits.

“WECC” means the Western Electricity Coordinating Council.

“winter rating” means the rating a piece of equipment is given when winter ambient weather conditions prevail.