

List of Electrical and Physical Parameters for Transmission System Model

1. Load and Generation Measurement

1.1 Measurement Point

- Unique MP_ID

2. Load

- The bus to which load connects
- NAICS code
- Load response characteristic
- Load at energization

3. Transmission Facilities

- FACILITY_CODE
- Geographic location
- operatorCompany (OWNER*)

3.1 Substations and Switching Devices

- Component substation Single-Line Diagram or Diagrams indicating for each switching device the:
 - Type of equipment
 - Type of control
- Communications block diagram
- substation.description (*SUBSTATION_NAME)
- LAND_LOCATION
- subGeographicRegion (*AREA_CODE)

3.2 Transmission Lines

- Structure List or Line Survey
- Transmission Line Segment Summary
- Structure Drawings

4. topologicalNode (*Busses)

- Unique topologicalNode.name (*BUS_ID)
- nominalVoltage (*NOMINAL_VOLTAGE)

- equipmentContainer.name (*FACILITY_CODE)

5. Equipment (*ELEMENTS)

5.1 *General requirements for conductingEquipment (*Elements)*

- Equipment.name (*ELEMENT_CODE)
- equipmentContainer.name (*FACILITY_CODE)
- operatorCompany (*OWNER_NAME)
- normallyInService (*NORMALLY_INSERTED)
- Equipment in-service date or project
- Equipment decommission date or project (if known)

5.1.1 *Element-to-Measurement Point Mapping*

- MP_ID
- conductingEquipment.names (ELEMENT_CODEs*)
- Portion of MP_ID delivered to or from each conductingEquipment.

5.1.2 *Applicable Dynamic Control Systems*

- conductingEquipment.name (*ELEMENT_CODE)
- Control System Type
- Manufacturer
- Model
- Control System Block Diagram

5.1.3 *Applicable PSS/E or PSLF Model Data*

- conductingEquipment.name (*ELEMENT_CODE)
- Model Name
- Description of Model
- Model Block Diagram
- Parameter Names
- Parameter Values
- Source-code or compiled object

5.2 *Transformers*

- Transformer nameplate
- Test report

5.2.1 *Transformer Windings*

- Equipment.name** (*ELEMENT_CODE)
- Winding identifier
- Connection (delta/wye)
- Neutral Grounding status
- Grounding impedance
- Ratings
- Rated voltage
- Identification of the bus to which winding connects

5.2.2 *Transformer Tap Changers*

- Tap points
- Tap-changing strategy (manual, automatic)
- On-load tap changing (True/False)
- Control band
- Actual Tap

5.2.3 *Transformer Impedances*

- Transformer equivalent circuit
- Positive and zero-sequence real and reactive impedances
- Positive and zero-sequence real and reactive shunt admittances
- Short Circuit Impedances and Load Losses
- Open Circuit Excitation Currents and No-Load Losses
- Phase angle shift
- Significant Off-neutral impedance of tap-changing transformers

5.3 *Reactor and Capacitor Banks*

- Bank nameplate
- Capacitance (Farads)
- Inductance (Henrys)
- Rated MVA (Capacitive)
- Rated MVA (Inductive)
- Rated voltage
- Control strategy

- Control Bus
- Maximum control-band voltage
- Minimum control-band voltage
- Connection (Delta/Y)
- Neutral Grounding status
- Grounding impedance

5.3 Line Segments

For modification of existing line segments, provide an update if there is a change in connectivity or an impedance change from previous impedance data that is greater than 5%.

5.4.1 Line Segments Construction

- conductingEquipment.name**
- Line Segment length (km)
- Conductor type
- # of conductors per bundle
- Bundle spacing (m)
- Average sag (m)
- Typical tangent structure
- Typical structure height (m)
- Positive-sequence real and reactive impedances and susceptances
- Zero-sequence real and reactive shunt admittance

5.4.2 Line Segment Ratings

- Conditions
- Ratings
- Limiting Factors

5.4.3 Line Mutuals

- conductingEquipment.names** of the two Line Segments
- Real and reactive mutual impedances
- Start-of-parallel distance (m)
- End-of-parallel distance (m)
- Assumed direction of flow for the mutual calculation

5.5 **Generating Units, Aggregated Generating Facilities, Large Motors and Battery Storage Facilities**

This subsection is applicable to:

- a generating unit and an aggregated generating facility directly connected to the transmission system, or connected to an industrial complex that have a maximum authorized real power rating equal to or greater than 4.5 MW;
- generating units and aggregated generating facilities connected to an electric distribution system where the sum of the nameplate rated capacity is equal to or greater than five (5) MW at each point of delivery
- Battery Energy Storage Facilities (BESFs) governed by Section 502.13 of the ISO rules, *Battery Energy Storage Facility Technical Requirements* and Section 502.14 of the ISO rules, *Battery Energy Storage Facility Operating Requirements* with aggregated capacity greater than 4.5 MW.
- electric motors connected to a electric distribution facility at a voltage equal to or greater than 1000 volts and that are capable of a maximum consumption equal to or greater than 0.9 MW; and where each point of delivery has more than 4.5 MW of aggregated electric motors greater than 0.9 MW each;
- electric motors connected to an industrial complex at a voltage equal to or greater than 1000 volts and that are capable of a maximum consumption equal to or greater than 0.9 MW; and where each point of delivery has more than 4.5 MW of aggregated electric motors greater than 0.9 MW each;

5.5.1 **Large individual machines**(as applicable to the specific machine or converter type)

- Nameplate
- Manufacturer's datasheet including at a minimum
 - Rated MVA
 - Rated kV
 - Maximum Authorized Real Power (MARP in MW)
 - Minimum stable generation (MW)
 - Reactive Power capability curve
 - Inertia constant
 - Positive-sequence saturated and unsaturated subtransient reactance
 - Positive-sequence saturated and unsaturated subsynchronous reactance
 - Positive-sequence saturated and unsaturated synchronous reactance
 - Transient time constant
 - Subtransient time constant
 - Negative sequence resistance

- Negative sequence synchronous reactance
- Zero-sequence resistance
- Zero-sequence synchronous reactance
- Station Service load (MW at zero generation)
- Unit Service load (incremental MW per MW of generation)
- Saturation
- “G” for “generator or “M” for “Motor”
- The bus to which machine connects
- The “D” curve (for Generators)
- The “V” curve (for Generators)
- Power Variation Curve as a function of Temperature
- Nameplate of Exciter (for synchronous Generators)
- Model Validation test report

5.5.2 *Aggregated Generating Facilities; as applicable to the specific machine or converter type:*

- Reduced representation diagram of Collector System
- Positive-sequence total real and reactive impedance of the collector system
- Zero-sequence total real and reactive impedance of the collector system if grounded
- Positive-sequence real and reactive shunt admittance of the collector system
- Zero-sequence real and reactive shunt admittance of the collector system if grounded
- Step-up transformer Impedances
- Typical generator nameplate
- Count of individual generators
- Maximum Authorized Real Power at collector bus (MARP in MW)
- Generator’s Manufacturer’s data sheet, including at a minimum
 - Generator type
 - Maximum real power out
 - Minimum real power operation
 - Maximum reactive power out
 - Minimum reactive power out

- Equivalent positive-sequence impedance for three-phase fault calculations
- Equivalent zero-sequence impedance for single-phase fault calculations
- Houseload
- Generator impedance
- Generator step-up transformer data
- Shunt device nameplate for shunt devices residing within turbine units
- Shunt device manufacturer's data for shunt devices residing within turbine units
- Count of individual shunt devices

5.5.3 Battery Energy Storage Facility; (as applicable to the specific converter type)

- Reduced representation diagram of Collector System
- Maximum Authorized Charging Power (MACP in MW)
- Maximum Authorized Discharging Power (MADP in MW)
- Generator's Manufacturer's data sheet, including at a minimum
 - Number of BES Converter Units
 - Unit Converter Rating (MVA)
 - Rated Terminal Voltage (kV)
 - Maximum Temporary Ratings and Time Characteristics
 - Minimum real power operation
 - Maximum reactive power out
 - Minimum reactive power out
 - Equivalent positive-sequence impedance for three-phase fault calculations
 - Equivalent zero-sequence impedance for single-phase fault calculations
 - Converter Type
 - Equivalent Converter Series Impedance
 - Battery Type
 - BESS Step-Up Transformers
- Auxiliary Load Characteristics
- Maximum Continuous Operation under Maximum Authorized Discharging Power (Hours)
- Model Validation Report

5.5.4 Industrial Complex Aggregated Machines and Distribution Connected Motors, in addition to checklist of Large individual machines or Aggregated Generating Facilities as applicable:

- ½-cycle Fault contribution on the high voltage side of the Point of delivery
- 3-cycle Fault contribution on the high voltage side of the Point of delivery
- Aggregate MVA (low-voltage induction motors)
- Aggregate MVA (medium-voltage induction motors)
- Aggregate MVA (medium-voltage synchronous motors)
- Aggregate MVA (synchronous generators)
- Aggregate MVA (induction generators)

5.5.5 Distributed Generators, in addition to checklist of Large individual machines or Aggregated Generating Facilities as applicable:

- Aggregate MVA for the Metering Point
- Step-up transformer impedances
- generator nameplate(s)
- reactive characteristics
 - (a) power factor control or voltage control
 - (b) Control settings
- Generic Type:

| Source | Synchronous/ Induction | Inverter | Heat Recovery | Q Ctrl |
|---------|---------------------------|----------|---------------|--------|
| Solar | N/A | Yes | No | V/PF |
| Storage | | | Yes/No | |
| Wind | | No | | |
| Hydro | Sync/Indc | Yes/No | No | |
| Gas | | | Yes/No | |
| Diesel | | | Yes/No | |
| Biomass | | | Yes/No | |

5.6 HVDC Converter Terminals

- Details to be established through discussion with the AESO

5.7 Series Compensation

- Nameplate
- MVAR rating
- Rated voltage
- Rated current
- Control strategy

5.8 Static VAR Compensators

- Nameplate
- Maximum/Minimum MVA (Capacitive)
- Maximum/Minimum MVA (Inductive)
- Rated voltage
- Control strategy
- Control Bus
- Maximum control-band voltage
- Minimum control-band voltage
- Connection (Delta/Y)
- Neutral Grounding status
- Grounding impedance

6. Other FACTS Devices

- Nameplate
- Component Single-Line Diagram
- Manufacturer's Test report
- Manufacturer's Data Sheet
- Details established by discussion with the AESO
- Description of operation