TP-SPP-04 Data for Power System Modeling and Analysis

Transmission System Planning

Standards, Policies, and Procedures

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Version	Date	Description	Author	Review
V11	2/27/2017	Various Updates	Team	R. Maguire
V12	5/5/2018	WECC case building update	Team	R. Maguire
V13	4/29/2020	Update for PRC-006-2, Section 9.5.2.2	Team	S. Wilson
V14	6/15/2023	Standard references update, minor revisions	Team	S. Wilson
V15	4/1/2024	Add FAC-014-3: R6 reference, formatting	Team	S. Wilson

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1. Introduction

1.1. Purpose

Development and periodical review of the steady state, dynamic, and short circuit data used to model Avista's Planning Coordinator area of the Transmission System should be conducted in a well-documented and procedural format. Specific procedures are given to formulate a database containing all pertinent data of the system components for use in steady state and dynamic study software. By following the guidelines herein, the Transmission Planning department will be able to develop an accurate and consistent model of the Transmission System and also be able to track modeling changes for historical purposes.

The transmission system model updates are provided to Transmission Operations for inclusion in the models used for Daily Operational Planning Analysis as well as the SCADA Engineer for inclusion in the Avista real time model. The SCADA Engineer, in turn, forwards the updates on to the Reliability Coordinator for inclusion in their real time transmission system model.

Detailed data submittal procedures for the purpose of WECC base case development are provided to ensure proper data submission is completed. Further procedures outline the utilization of WECC approved base case to develop planning cases for internal studies.

1.2. Applicable Standards

The development of TP-SPP-04 and the execution of its guidelines are intended to ensure compliance with the following NERC Standards and regional criteria or guidelines:

- MOD-032-1 – Data for Power System Modeling and Analysis
  - Establish consistent modeling data requirements and reporting procedures
- TPL-001-5.1 — Transmission System Planning Performance Requirements
  - Studies required for Planning Assessments require Transmission Planners and Planning Coordinators to maintain models of their Transmission System.
- PRC-006-5, R6-R7 – Automatic Underfrequency Load Shedding
  - Establish maintenance and coordination requirements for UFLS database.
- FAC-014-3, R6 – Establish and Communicate System Operating Limits
  - Utilize Facility Ratings, System steady state voltage limits and stability criteria equal or more limiting than those described in the Reliability Coordinator's SOL Methodology.

1.3. Applicable Avista Registered Functional Entity

The following functional entities, of which Avista is registered and therefore are applicable to the Standard requirements identified in Section 1.2, are represented within TP-SPP-04 for the listed Standard requirements.

- Transmission Planner
  - TPL-001-5.1: R1-R2
  - MOD-032-1: R1, R4
  - FAC-014-3: R6

- Planning Coordinator
  - TPL-001-5.1: R1-R2
  - PRC-006-5: R6-R7
  - MOD-032-1: R1, R4
  - FAC-014-3: R6

1.4. Effective Date

April 1, 2024 (Revision 15)

2. Data Requirements

2.1. Data Format (MOD-032-1, R1.2.1)

The development of power system models will be performed by the Transmission Planner function based on the data collected from each Balancing Authority, Generator Owner, Resource Planner, Transmission Owner, Distribution Provider, and Transmission Service Provider. The following options are available to best fit the availability of the data from each entity:

- Provide data within PowerWorld .pwb or .aux file formats
- Tabulated spreadsheet (pre-populated tables with data from previous data submittals can be provided)

2.2. Level of Detail (MOD-032-1, R1.2.2)

The level of detail for each type of facility is described in its respective section within TP-SPP-04.

2.3. Case Types/Scenarios (MOD-032-1, R1.2.3)

Various case types and scenarios are used in power system analysis. Typical variations of data for power system modeling include seasonal load, generation, and voltage profiles. Additionally, power system analysis in the planning horizon requires utilizing forecasted profile data and assumptions regarding modification to the transmission system over time.

Specific data requirements to represent the desired scenarios will be provided for each type of facility within TP-SPP-04. The following list is a general summary of the typical scenarios analyzed:

- Heavy Summer and Heavy Winter
  - Year two (next year, i.e., 2016 case if case is created and used in 2015) (TPL-001-5.1, R2.1.1, R2.4.1)
  - Year five (TPL-001-5.1, R2.1.1, R2.4.1)
  - Year ten (TPL-001-5.1, R2.2.1, R2.5)
- Light Summer and Light Winter
  - Year two (next year, i.e., 2016 case if case is created and used in 2015) (TPL-001-5.1, R2.1.2, R2.4.2)
  - Year five (TPL-001-5.1, R2.1.2, R2.4.2)
- Heavy Summer with Low Local Hydro Generation (generation dispatch scenario sensitivity)

  - Year two (next year, i.e., 2016 case if case is created and used in 2015) (TPL-001-5.1, R2.1.1, R2.4.1)
  - Year five (TPL-001-5.1, R2.1.3, R2.4.3 for R2.1.1 and R2.4.1)
  - Year ten (TPL-001-5.1, R2.5 for R2.2.1)
- Transfer Scenarios
  - West of Hatwai – East to West (TPL-001-5.1, R2.1.3, R2.4.3 for R2.1.2 and R2.4.2)
  - Montana to Northwest – East to West (TPL-001-5.1, R2.1.3, R2.4.3 for R2.1.2 and R2.4.2)
  - Montana to Northwest – West to East (TPL-001-5.1, R2.1.3, R2.4.3 for R2.1.1 and R2.4.1)
  - Idaho to Northwest – East to West (TPL-001-5.1, R2.1.3, R2.4.3 for R2.1.2 and R2.4.2)
  - Idaho to Northwest – West to East (TPL-001-5.1, R2.1.3, R2.4.3 for R2.1.1 and R2.4.1)

3. Reporting Procedure

3.1. Point of Contact

Applicable entities within Avista's Planning Coordinator Area, in accordance with MOD-32-1, shall submit documentation, data, and associated correspondence to the following email address:

- TransmissionPlanning@avistacorp.com

3.2. Annual Update

Data shall be submitted by each applicable entity as listed within TP-SPP-04 within the third calendar quarter of each year. (MOD-032-1, R1.2.4)

For data that has not changed since the last submission, a written confirmation that the data has not changed is sufficient. (MOD-032-1, R2)

3.3. Applicable Entities

- Avista: Balancing Authority, Generator Owner, Transmission Owner, Resource Planner, Distribution Provider and Transmission Service Provider, Transmission Operations, SCADA Engineering
- Clearway Renewable Operation and Maintenance LLC for Rattlesnake Flats
- Columbia Basin Hydropower for Main Canal and Summer Falls
- City of Spokane for Spokane Waste to Energy
- Palouse Wind LLC for Palouse Wind
- Reliability Coordinator

4. Sharing with Applicable Entities

4.1. Posting of Data Requirements and Reporting Procedures (MOD-032-1, R1.3)

TP-SPP-04 will be posted internally on the Avista Transmission Planning SharePoint site and externally on Avista's OASIS.

4.2. Sharing Data with Adjacent Entities (PRC-006-5, R7)

Avista Transmission Planning will share data collected through the process defined in TP-SPP-04 with adjacent entities, including Planning Coordinators, in its Interconnection within 30 calendar days of a request.

4.3. Model updating procedures (FAC-014, r6)

Avista Transmission Planning will provide transmission model updates to Transmission Operations and SCADA Engineering throughout the course of the year as system topology and ratings are updated. The update files will be provided in auxiliary file format (*.aux) suitable for incorporation in PowerWorld Simulator software. SCADA Engineering is responsible for converting the format as appropriate and submittal to the Reliability Coordinator for inclusion in their Real Time Model. This process in intended to provide for consistency in the models used for Transmission Planning Analysis, Transmission Operations Daily Operational Planning Analysis, SCADA Engineering's Real Time Model Analysis, and the Reliability Coordinators Real Time Model Analysis.

The facility ratings associated with these model updates will be reviewed on an annual basis to verify they are equally or more limiting than those used by Transmission Operations, who in turn provides them to the Reliability Coordinator. Less limiting facility ratings settings may be used by Transmission Planning if the technical rationale is provided to the affected Transmission Operator, Transmission Planner, Planning Coordinator and Reliability Coordinator.

5. Transmission Owner Data Requirements

5.1. Transmission System Oneline Drawing

Transmission system oneline drawings shall be provided by each applicable Transmission Owner. The oneline drawings shall contain the following attributes:

- Station topology including bus configuration
- Circuit breaker and switch location and labels
- Owner of each facility shown (MOD-032-1, Att. 1 SS-1b)
- Nominal voltage of equipment shown (MOD-032-1, Att. 1 SS-1a)

5.2. Substation Data

Substations are used in power system modeling to aggregate multiple buses and their connected devices. The requested data is listed below in Table 1. The description for each field shall be followed.

Level of Detail: Each BES station owned by each Transmission Owner.

Field	Description	MOD-032-01 Attachment 1
Name	Name of the station. A string of any length is permitted.	SS-9
Latitude	Geographic Latitude in decimal degrees.	SS-9
Longitude	Geographic Longitude in decimal degrees.	SS-9
IDExtra	Three- or four-letter abbreviation for station.	SS-9
RGround	Resistance(Ω) between the substation neutral and ground.	SS-9

Table 1: Substation Data Requirements

5.3. Transmission Line Data

The requested data is listed in the below table. The description for each field shall be followed.

Level of Detail: All BES transmission lines shall have data provided. A transmission line is defined by the stations with circuit breakers where the transmission line terminates. Modeling of transmission lines typically requires modeling several segments to account for taps and connected distribution substations. Each segment modeled shall have limits set according to the elements represented by each segment. Each section of transmission line as illustrated below needs to be represented for power system modeling. Data for radial taps greater than 0.1 miles shall be provided.

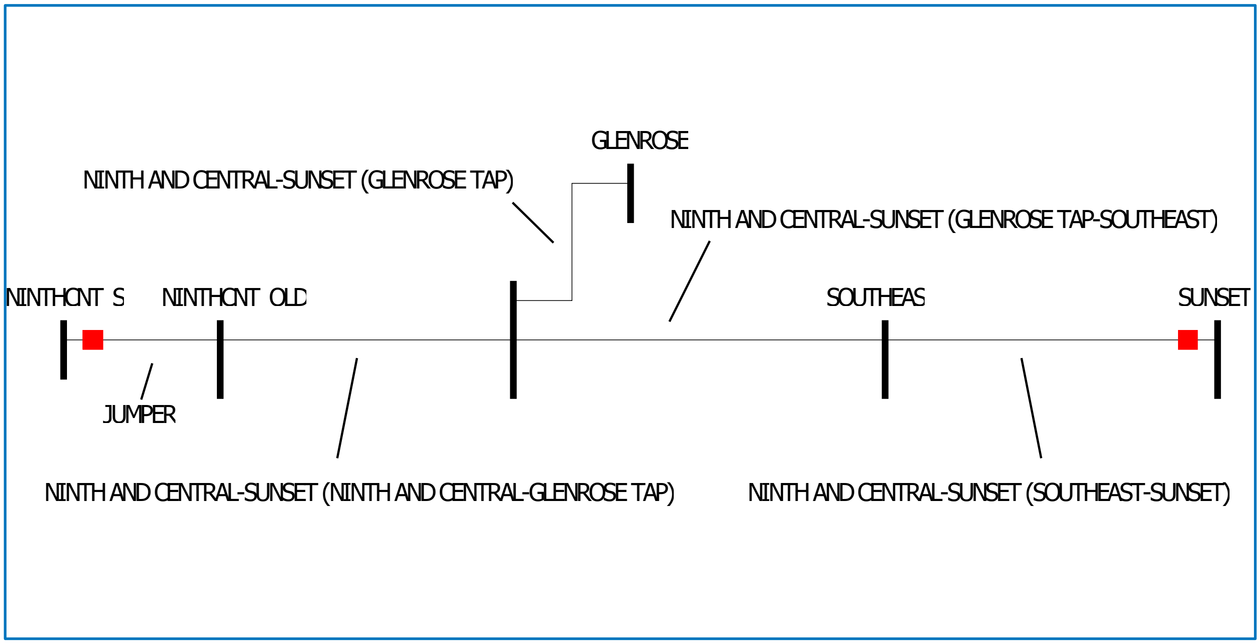

Figure 1: Transmission Line Data Requirements

5.3.1. Steady State

Field	Description	MOD-032-01 Attachment 1
Label	Unique label identifier for this object. Syntax: LineStationA-LineStationB kV (SectionStationA-SectionStationB) i.e., SUNSET-WESTSIDE 115kV (GARDEN SPRINGS-WTE TAP)	SS-9
StatusNormal	Normal status of the branch. Set to either OPEN or CLOSED	SS-4d
R	Series Resistance of the branch in per unit on the system MVABase and the nominal kV of the from bus	SS-4a
X	Series Reactance of the branch in per unit on the system MVABase and the nominal kV of the from bus	SS-4a

Field	Description	MOD-032-01 Attachment 1
B	Shunt Susceptance of the branch in per unit on the system MVABase and the nominal kV of the from bus	SS-4b
LineLength	Length of the line.	SS-9
LimitAMPA	Summer Normal Rating of the branch in Amps at 40°C	SS-4c
LimitAMPB	Summer Emergency Rating of the branch in Amps at 40°C	SS-4c
LimitAMPC	Winter Normal Rating of the branch in Amps at 0°C	SS-4c
LimitAMPD	Winter Emergency Rating of the branch in Amps at 0°C	SS-4c
LimitAMPE	Fall Normal Rating of the branch in Amps at 30°C	SS-4c
LimitAMPF	Fall Emergency Rating of the branch in Amps at 30°C	SS-4c
LimitAMPG	Spring Normal Rating of the branch in Amps at 30°C	SS-4c
LimitAMPH	Spring Emergency Rating of the branch in Amps at 30°C	SS-4c
FaultRZero	Zero sequence resistance of the branch in per unit on the system MVABase and the nominal kV of the from bus	SC-1c
FaultXZero	Zero sequence reactance of the branch in per unit on the system MVABase and the nominal kV of the from bus	SC-1c
ConductorType	Conductor size, material, and code name. i.e. 795 ACSS Drake	SS-9
TowerConfiguration	Typical structure type	SS-9

Table 2: Steady State Data Requirements

5.3.2. Dynamic

Thermal, phase overcurrent, and underfrequency (see Section 9.5.2.2) relay information shall be provided upon request. Explicit relay modeling may not be necessary in all circumstances. Information allowing for appropriate relays representation is desired.

5.4. Mutual Line Impedance Data

The requested data is listed in the below table. The description for each field shall be followed.

Level of Detail: Mutual impedance data shall be provided for transmission lines with average distance from adjacent transmission lines is less than an average of 700 feet.

Field	Description	MOD-032-01 Attachment 1
Line 1 Label	Line section Label as used in Section 5.3.	SC-2
Line 2 Label	Line section Label as used in Section 5.3.	SC-2
Mutual R	Mutual Resistance (R)	SC-2
Mutual X	Mutual Reactance (X)	SC-2
L1 Mut. Start	Line 1 Mutual Range Start in percent from FROM end	SC-2
L1 Mut. End	Line 1 Mutual Range End in percent from FROM end	SC-2
L2 Mut. Start	Line 2 Mutual Range Start in percent from FROM end	SC-2
L2 Mut. End	Line 2 Mutual Range End in percent from FROM end	SC-2

Table 3: Mutual Line Impedatance Data Requirements

5.5. Transformer Data

The requested data is listed in the below tables. The description for each field shall be followed. Transformer data shall be entered on the transformer base (transformer winding MVA base and winding voltage base.)

Level of Detail: Each BES transformer. Transformers with three windings where the third winding does not have a connected device (other than station service) can be represented as a two-winding transformer.

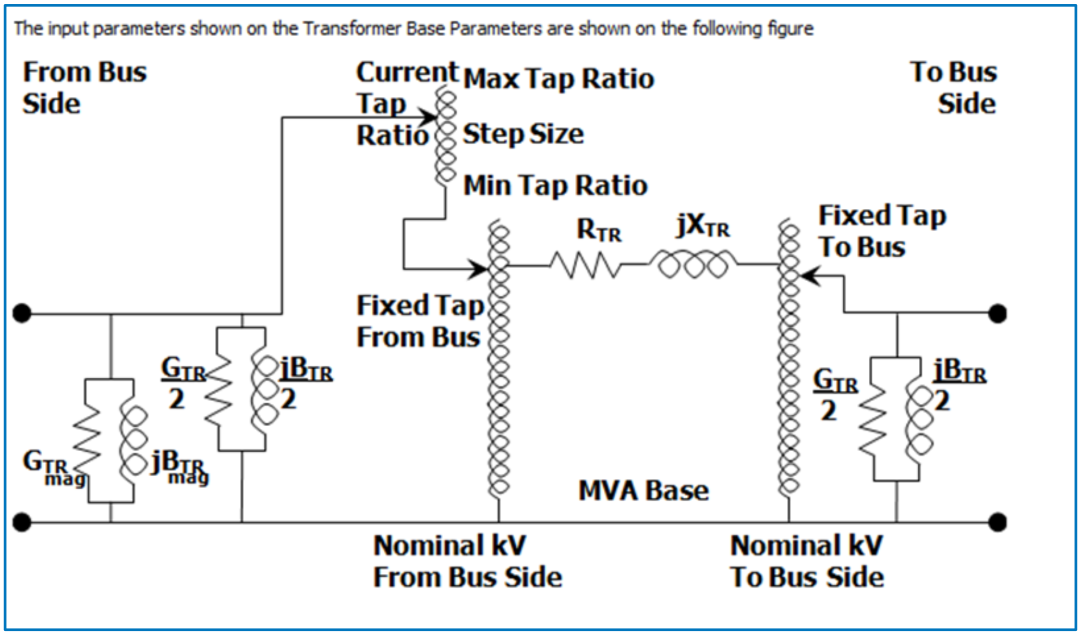

Figure 2: Transformer Model on Transformer Base

5.5.1. Steady State

5.5.1.1. Two-Winding Transformer Data

Field	Description	MOD-032-01 Attachment 1
Label	Unique label identifier for this object. Syntax: Station # kV/kV i.e. BEACON #1 230/115kV	SS-9
StatusNormal	Normal status of the branch. Set to either OPEN or CLOSED	SS-6h
ControlType	Control Type of the transformer. Choices are Fixed, LTC, Mvar, Phase. LTC means that a voltage is controlled by moving the transformer tap. Mvar means that the Mvar flow on the branch is controlled by moving the tap ratio. Phase means that the MW flow on the branch is controlled by changing the phase shift angle.	SS-9
AutoControl	Set to either YES or NO to indicate whether automatic transformer control is available for this branch. If the ControlType = Phase, then the choice OPF is also available to indicate that the phase angle can be an OPF control variable.	SS-9
RegBusNum	Regulated Bus Number. Only used for the ControlType = LTC	SS-6f
UseLineDrop	Set to either YES or NO NO: Use normal voltage control based on the regulated bus and voltage setpoint. YES: Use line drop compensation voltage control always, including in the power flow solution. In order to use line drop compensation, the regulated bus must be one of the terminals of the branch. The line drop is then calculated looking out from that branch into the rest of the system.	SS-9
Rcomp	Line Drop Compensation resistance value used during a contingency power flow solution. Value will be expressed in per unit on the system MVA base.	SS-9

Field	Description	MOD-032-01 Attachment 1
Xcomp	Line Drop Compensation reactance value used during a contingency power flow solution. Value will be expressed in per unit on the system MVA base.	SS-9
XFMVABase	MVA base on which the transformer impedances (Rxfbase, Xxfbase, Gxfbase, Bxfbase, Gmagxfbase, Bmagxfbase) are given.	SS-9
XFNomkVbaseFrom	Transformer's Nominal Voltage base for the FROM bus	SS-6a
XFNomkVbaseTo	Transformer's Nominal Voltage base for the TO bus	SS-6a
Rxfbase	Total resistance at nominal voltage taps (typically middle tap position) from primary to secondary winding given on the transformer base reflected on the secondary winding. Refer to Figure 2 where R_{TR} represents Rxfbase. The following calculations have historically been used. $Rxfbase = \frac{Load\_Loss\ \text{kW}}{1000 \cdot Rated\_MVA}$ [1] or $Rxfbase = \frac{Z_{xfmr}}{30}$	SS-6b
Xxfbase	Total reactance at nominal voltage taps (typically middle tap position) from primary to secondary winding given on the transformer base reflected on the secondary winding. Refer to Figure 2 where X_{TR} represents Xxfbase. The following calculation has historically been used. $X_{pu,xfmr} = \sqrt{{Z_{xfmr}}^2 - R_{pu,xfmr}^2}$	SS-6b
Gxfbase	Shunt Conductance given on the transformer base. Historically neglected.	SS-6b
Bxfbase	Shunt Susceptance given on the transformer base. Historically neglected.	SS-6b
Gmagxfbase	Magnetizing Conductance given on the transformer base. Historically neglected.	SS-6b
Bmagxfbase	Magnetizing Susceptance given on the transformer base. Historically neglected.	SS-6b
TapFixedFrom	Fixed tap ratio on the FROM side on the transformer base $FixedTapFrom = \frac{236.5kV}{236.5kV} = 1.0000pu_{xfmr}$	SS-6c
TapFixedTo	Fixed tap ratio on the TO side on the transformer base $FixedTapTo = \frac{115.5kV}{112.75kV} = 1.0244pu_{xfmr}$	SS-6c
TapMaxxfbase	Maximum tap ratio on the transformer base $TapMax = \frac{247.5kV}{236.5kV} = 1.0465pu_{xfmr}$	SS-6d
TapMinxfbase	Minimum tap ratio on the transformer base $TapMin = \frac{225.5kV}{236.5kV} = 0.9535pu_{xfmr}$	SS-6d
TapStepSizexfbase	Tap ratio step size on the transformer base $Step\ Size = \frac{(247.5kV - 225.5kV)}{236.5kV \cdot 16} = 0.00581pu_{xfmr}$	SS-6e
ImpCorrTable	Impedance correction table used. Specify 0 if none used.	SS-9
LimitMVAA	Summer Normal Rating of the branch in MVA at 40°C	SS-6g
LimitMVAB	Summer Emergency Rating of the branch in MVA at 40°C	SS-6g
LimitMVAC	Winter Normal Rating of the branch in MVA at 0°C	SS-6g
LimitMVAD	Winter Emergency Rating of the branch in MVA at 0°C	SS-6g

[1] Central Station Engineers of the Westinghouse Electric Corporation. Electrical Transmission and Distribution Reference Book. Fourth Edition. Ch. 5, Section II.

Field	Description	MOD-032-01 Attachment 1
LimitMVAE	Fall Normal Rating of the branch in MVA at 30°C	SS-6g
LimitMVAF	Fall Emergency Rating of the branch in MVA at 30°C	SS-6g
LimitMVAG	Spring Normal Rating of the branch in MVA at 30°C	SS-6g
LimitMVAH	Spring Emergency Rating of the branch in MVA at 30°C	SS-6g
FaultRZero	Zero sequence resistance	SC-1c
FaultXZero	Zero sequence reactance	SC-1c
GICBlock	Specifies whether the transformer has a GIC blocking device which would prevent dc neutral current; either yes if there is one or no otherwise	SS-9
GICCoilRUser	Select to manually enter the transformer coil resistance; used in the GIC calculations	SS-9
GICCoilRFrom	Per phase resistance for transformer High side coil in Ohms	SS-9
GICCoilRTo	Per phase resistance for transformer Medium side coil in Ohms	SS-9
XFConfiguration	Transformer Configuration on High side	SS-9
XFConfiguration:1	Transformer Configuration on Medium side	SS-9
XFConfiguration:2	Transformer Configuration on Low side	SS-9
GICAutoXF	Specifies whether the transformer is an autotransformer. Value can be Unknown, yes, or no	SS-9
GICCoreType	The core type of the transformer. Value can be Unknown, Single Phase, Three Phase Shell, 3-Legged Three Phase, or 5-Legged Three Phase.	SS-9

Table 4:

5.5.1.2. Three Winding Transformer Data

Field	Description	MOD-032-01 Attachment 1
Label	Unique label identifier for this object. Syntax: Station # kV/kV i.e., BEACON 1 230/115kV	SS-9
MVABasePriSec	MVA BasePrimary-Secondary (RbasePriSec and XbasePriSec are given on this MVA Base).	SS-9
MVABaseSecTer	MVA Base Secondary-Tertiary (RbaseSecTer and XbaseSecTer are given on this MVA Base).	SS-9
MVABaseTerPri	MVA Base Tertiary-Primary (RbaseTerPri and XbaseTerPri are given on this MVA Base).	SS-9
RbasePriSec	Per unit resistance Primary-Secondary on MVABasePriSec	SS-6b
XbasePriSec	Per unit reactance Primary-Secondary on MVABasePriSec	SS-6b
RbaseSecTer	Per unit resistance Secondary-Tertiary on MVABaseSecTer	SS-6b
XbaseSecTer	Per unit reactance Secondary-Tertiary on MVABaseSecTer	SS-6b
RbaseTerPri	Per unit resistance Tertiary-Primary on MVABaseTerPri	SS-6b
XbaseTerPri	Per unit reactance Tertiary-Primary on MVABaseTerPri	SS-6b
Gmagbase	Per unit magnetizing conductance (G) on MVABasePriSec	SS-6b
Bmagbase	Per unit magnetizing susceptance (B) on MVABasePriSec	SS-6b
ImpCorrTablePri ImpCorrTableSec ImpCorrTableTer	Impedance correction table used for respective winding. Specify 0 if none used.	
ControlTypePri ControlTypeSec ControlTypeTer	Control Type of the respective winding of the transformer. Choices are Fixed, LTC, Mvar, Phase. LTC means that a voltage in controlled by moving the transformer tap. Mvar means that the Mvar flow on the branch is controlled by moving the tap ratio. Phase means that the MW flow on the branch is controlled by changing the phase shift angle.	SS-9

Field	Description	MOD-032-01 Attachment 1
AutoControlPri AutoControlSec AutoControlTer	Set to either YES or NO to indicate whether automatic transformer control is available for the respective winding. If the ControlType of winding is Phase, then the choice OPF is also available to indicate that the phase angle can be an OPF control variable.	
RegBusNumPri RegBusNumSec RegBusNumTer	Regulated Bus Number for respective winding's tap	SS-6f
UseLineDropPri UseLineDropSec UseLineDropTer	Set to either YES or NO NO : Use normal voltage control based on the regulated bus and voltage setpoint. YES : Use line drop compensation voltage control on the respective winding In order to use line drop compensation on the respective winding, the regulated bus must be one of the terminals of the branch. The line drop is then calculated looking out from that branch into the rest of the system.	
RcompPri RcompSec RcompTer	Line Drop Compensation resistance value for respective winding used during a contingency power flow solution. Value will be expressed in per unit on the system MVA base.	
XcompPri XcompSec XcompTer	Line Drop Compensation reactance value used during a contingency power flow solution. Value will be expressed in per unit on the system MVA base.	
NomkVPri NomkVSec NomkVTer	Transformer Nominal kV Voltage of the respective winding	SS-6a
TapFixedPri TapFixedSec TapFixedTer	Fixed Tap on transformer voltage kV base for respective winding	SS-6c
TapMaxPri TapMaxSec TapMaxTer	Maximum total tap on transformer voltage kV base for primary	SS-6d
TapMinPri TapMinSec TapMinTer	Minimum total tap on transformer voltage kV base for respective winding	SS-6d
TapStepSizePri TapStepSizeSec TapStepSizeTer	Tap step size on transformer voltage kV base for respective winding	SS-6e
LimitMVAAPri .. LimitMVAHPri	8 limits A..H for the primary winding same as two winding transformer	SS-6g
LimitMVAASec .. LimitMVAHSec	8 limits A..H for the secondary winding same as two winding transformer	SS-6g
LimitMVAATer .. LimitMVAHTer	8 limits A..H for the secondary winding same as two winding transformer	SS-6g
PriSecFaultRZero	Zero sequence resistance	SC-1c
PriSecFaultXZero	Zero sequence reactance	SC-1c
SecTerFaultRZero	Zero sequence resistance	SC-1c
SecTerFaultXZero	Zero sequence reactance	SC-1c
TerPriFaultRZero	Zero sequence resistance	SC-1c
TerPriFaultXZero	Zero sequence reactance	SC-1c
GICBlock	Specifies whether the transformer has a GIC blocking device which would prevent dc neutral current; either Yes if there is one or No otherwise	SS-9
GICCoilRUser	Select to manually enter the transformer coil resistance; used in the GIC calculations	SS-9
GICCoilRFrom	Per phase resistance for transformer High side coil in Ohms	SS-9

Field	Description	MOD-032-01 Attachment 1
GICCoilRTo	Per phase resistance for transformer Medium side coil in Ohms	SS-9
XFConfiguration	Transformer Configuration	SS-9
GICAutoXF	Specifies whether the transformer is an autotransformer. Value can be Unknown, Yes, or No	SS-9
GICCoreType	The core type of the transformer. Value can be Unknown, Single Phase, Three Phase Shell, 3-Legged Three Phase, or 5-Legged Three Phase.	SS-9

Table 5:

5.5.2. Dynamic

See Section 5.3.2.

5.6. Shunt Data

Shunt data shall be used to represent the following devices explicitly for power system modeling:

- Mechanically switched shunt capacitors and reactors
- Static VAR compensators
- STATCOMs
- Thyristor-switched shunt capacitors and reactors.

The requested data is listed in the below tables. The description for each field shall be followed.

Level of Detail: Each BES shunt connected device. Multiple stages of devices shall be represented as Blocks within the same object record.

Field	Description	MOD-032-01 Attachment 1
Label	Unique label identifier for this object. Syntax: Station Type (R or C) ShuntID/ i.e., NOXON RAPIDS REACTOR STATION R2	SS-9
ShuntMode	Specify the type of control mode for this shunt. The choices are Fixed, Discrete, Continuous, Bus Shunt or SVC. Note that in this table it is expected that none of the entries will be Bus Shunt as those are stored in another table.	SS-7c
ContinuousUse	Set to YES to use the ContinuousMvarNomMax and ContinuousMvarNomMin when the ShuntMode is set to Discrete or Continuous	SS-8
ContinousMvarNomMax	Minimum Nominal Mvar of the continuous element. This value is used with Discrete or Continuous ShuntMode when ContinuousUse = YES. It is also used when ShuntMode = SVC if the SVCType = SVSMO1 or SVSMO3	SS-8
ContinousMvarNomMin	Minimum Nominal Mvar of the continuous element. This value is used with Discrete or Continuous ShuntMode when ContinuousUse = YES. It is also used when ShuntMode = SVC if the SVCType = SVSMO1 or SVSMO3	SS-8
BlockNumberStep1	Number of equal nominal Mvar steps for block 1	SS-7a
BlockMvarPerStep1	Nominal Mvar per step for block 1	SS-7a
BlockNumberStep2	Number of equal nominal Mvar steps for block 2	SS-7a
BlockMvarPerStep2	Nominal Mvar per step for block 2	SS-7a
BlockNumberStep3	Number of equal nominal Mvar steps for block 3	SS-7a
BlockMvarPerStep3	Nominal Mvar per step for block 3	SS-7a
BlockNumberStep4	Number of equal nominal Mvar steps for block 4	SS-7a

Field	Description	MOD-032-01 Attachment 1
BlockMvarPerStep4	Nominal Mvar per step for block 4	SS-7a
BlockNumberStep5	Number of equal nominal Mvar steps for block 5	SS-7a
BlockMvarPerStep5	Nominal Mvar per step for block 5	SS-7a
BlockNumberStep6	Number of equal nominal Mvar steps for block 6	SS-7a
BlockMvarPerStep6	Nominal Mvar per step for block 6	SS-7a
BlockNumberStep7	Number of equal nominal Mvar steps for block 7	SS-7a
BlockMvarPerStep7	Nominal Mvar per step for block 7	SS-7a
BlockNumberStep8	Number of equal nominal Mvar steps for block 8	SS-7a
BlockMvarPerStep8	Nominal Mvar per step for block 8	SS-7a
BlockNumberStep9	Number of equal nominal Mvar steps for block 9	SS-7a
BlockMvarPerStep9	Nominal Mvar per step for block 9	SS-7a
BlockNumberStep10	Number of equal nominal Mvar steps for block 10	SS-7a
BlockMvarPerStep10	Nominal Mvar per step for block 10	SS-7a
SVCType	When ShuntMode = SVC, then this specifies the type of the SVC. Choices are None, SVSMO1, SVSMO2, and SVSMO3	SS-8
SVCXcomp	SVC control compensating reactance. This works very similarly to line drop compensation for both generator and transformer control.	SS-8
SVCMvarNomMaxSH	Maximum of Nominal Mvar range in which remote shunts are not switched. Value is expressed in nominal Mvar which represent what the Mvar would be at 1.0 per unit voltage.	SS-8
SVCMvarNomMinSH	Minimum of Nominal Mvar range in which remote shunts are not switched. Value is expressed in nominal Mvar which represent what the Mvar would be at 1.0 per unit voltage.	SS-8
SVCstsb	YES/NO status. For SVCType = SVSMO1 and SVSMO2, set this to YES to enable the Slow B Control. For SVCType = SVSMO3, set this to YES to enable the Ireset or deadband control	SS-8
SVCMvarNomMaxSB	Maximum of Nominal Mvar range for SVCType = SVSMO1 and SVSMO2 for Slow B Control. Not used with SVCType = SVSMO3	SS-8
SVCMvarNomMinSB	Minimum of Nominal Mvar range for SVCType = SVSMO1 and SVSMO2 for Slow B Control. Not used with SVCType = SVSMO3	SS-8
SVCVrefmax	Voltage Range Maximum for the Slow B Control used with SVCType = SVSMO1 and SVSMO2.	SS-8
SVCVrefmin	Voltage Range Minimum for the Slow B Control used with SVCType = SVSMO1 and SVSMO2.	SS-8
SVCdvdb	Voltage Sensitivity for a change in Injection. Units are Per unit Voltage / Per unit B	SS-8
CTGRegHigh	Lowest high voltage threshold for automatic insertion	SS-7b
CTGRegLow	Highest low voltage threshold for automatic insertion	SS-7b

Table 6: Shunt Data Requirements

6. Generator Owner Data Requirements

6.1. Substation Data

The requested data is listed in the tables provided in Section 5.2. The description for each field shall be followed.

Level of Detail: Each BES station owned by each Generator Owner.

6.2. Generator Data

The requested data is listed in the below table for steady state data and Section 6.2.2 for dynamic data. The description for each field shall be followed.

Level of Detail: Data shall be provided for generators which meet the following WECC Generator Unit Model Validation Guideline.

- If the individual generator unit capacity is 10MVA or larger and is connected to the transmission system at 60kV or higher then steady-state data and dynamics data should be submitted for each generator.
- If the aggregated generator unit capacity is 20MVA or larger and is connected to the transmission system at 60kV or higher and is not a collector–based generation facility, then steady-state data and dynamics data should be submitted for each generator. (Wind and solar farms are an example of a collector-based generation facility.)
- If the aggregated generation capacity is 20MVA or larger and is connected to the transmission system at 60kV or higher and is a collector–based generation facility, then steady-state data and dynamics data should be submitted for the aggregated generation capacity as a single-unit generator model. An example of the equivalent representation is shown in Figure 3. Wind and solar farms are an example of a collector-based generation facility.

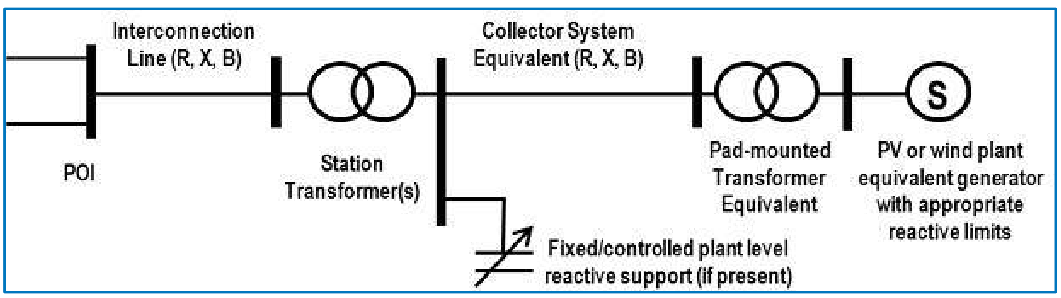

Figure 3: Generator Equivalence Model

- All other generating facilities shall either be netted with bus load and steady-state data should be submitted according to Section 8.1.

6.2.1. Steady State

Field	Description	MOD-032-01 Attachment 1
Label	Unique label identifier for this object. Syntax: Station “UN” UnitID. i.e. NOXON RAPIDS HED UN5	SS-9
VoltSet	Desired per unit voltage setpoint at the regulated bus	SS-3d from TOP

Field	Description	MOD-032-01 Attachment 1
RegBusNum	Number of regulated bus	SS-9
RegFactor	Remote regulation factor. When multiple buses have generation that control the voltage at a single bus, this determines the ratio in which the Mvar output is shared.	SS-9
MWMax	Generator's maximum MW limit (step 5 of Verification specifications within MOD-24-2 Attachment 1). Provide the maximum of the following: • Peak Summer – ambient temperature 40°C, July 15 to August 15 • Peak Winter – ambient temperature 0°C, December 15 to January 31 • For hydroelectric generators, report the instantaneous capacity at maximum water flow.	SS-3a
MWMin	Generator's minimum MW limit	SS-3a
AVR	Set to YES or NO to specify if the generator is available for AVR	SS-9
MvarMax	Generator's maximum Mvar limit	SS-3b
MvarMin	Generator's minimum Mvar limit	SS-3b
UseCapCurve	Indicates if the generator should use its Mvar capability curve if it has one defined. (See table below for description of capability curve data requirements.)	SS-9
WindContMode	Special Var limit modes of either "None", "Boundary Power Factor" or "Constant Power Factor". When not equal to None, the Var limit magnitudes are determined from the real power output and the Wind Control Mode Power Factor value. For Boundary mode, the maximum limit is positive, and the minimum limit is negative. For Constant mode, minimum limit = maximum limit, a positive Wind Control Mode Power Factor means the limits have the same sign as the real power, and a negative Wind Control Mode Power Factor means the limits are the opposite sign as the real power.	SS-9
WindContModePF	This is the power factor value used with the Wind Control Mode. Magnitude of the value must be between 0.01 and 1.00. Negative values are important when the Wind Control Mode is "Constant Power Factor".	SS-9
UseLineDrop	Field describing if the generator uses line drop/reactive current compensation control	SS-9
Rcomp	Generator's Line Drop Compensation resistance in per unit on the system MVA Base	SS-9
Xcomp	Generator's Line Drop Compensation reactance in per unit on the system MVA Base	SS-9
MVABase	Generator's MVA base	SS-3e
GenSeqR+	Machine Positive Sequence Resistance in per unit on Generator MVA Base	SC-1a
GenSeqR-	Machine Negative Sequence Resistance in per unit on Generator MVA Base	SC-1b
GenSeqR0	Machine Zero Sequence Resistance in per unit on Generator MVA Base	SC-1c
GenSeqX+	Machine Positive Sequence Reactance in per unit on Generator MVA Base	SC-1a
GenSeqX-	Machine Negative Sequence Reactance in per unit on Generator MVA Base	SC-1b
GenSeqX0	Machine Zero Sequence Reactance in per unit on Generator MVA Base	SC-1c
GovRespLimit	Specifies how governors respond in transient stability simulation. The choices are Normal, Down Only, or Fixed.	SS-9

Field	Description	MOD-032-01 Attachment 1
UnitTypeCode	Two-Character Field describing what kind of machine the generator is. The choices are informed by the Energy Information Agency of US Department of Energy. There is an EIA Form 860 for the Annual Electric Generator Report. The choices are the first two characters of the following list. Also note that in square brackets are the integer code that will be written to an EPC file. UN (Unknown) [0] BA (Energy Storage, Battery) [99] BT (Turbines Used in a Binary Cycle, including those used for geothermal applications) [99] CA (Combined Cycle Steam Part) [2] CC (Combined Cycle Generic) [4] CE (Compressed Air Storage) [99] CP (Energy Storage, Concentrated Solar Power) [99] CS (Combined Cycle Single Shaft) [13] CT (Combined Cycle Combustion Turbine Part) [3] DC (represents DC ties) [40] ES (Energy Storage, Other) [99] FC (Fuel Cell) [99] FW (Energy Storage, Flywheel) [99] GT (Gas Turbine) [11] HA (Hydrokinetic, Axial Flow Turbine) [99] HB (Hydrokinetic, Wave Buoy) [99] HK (Hydrokinetic, Other) [99] HY (Hydro) [5] IC (Internal Combustion) [6] IT (Internal Combustion Turbo Charged) [7] JE (Jet Engine) [12] MP (Motor/Pump) [41] NB (ST - Boiling Water Nuclear Reactor) [99] NG (ST - Graphite Nuclear Reactor) [99] NH (ST - High Temperature Gas Nuclear Reactor) [99] NP (ST - Pressurized Water Nuclear Reactor) [99] OT (Other) [99] PS (Hydro Pumped Storage) [5 same as HY] PV (Photovoltaic) [31] SC (Synchronous Condenser) [14] ST (Steam Turbine) [1] W1 (Wind Turbine, Type 1) [21] W2 (Wind Turbine, Type 2) [22] W3 (Wind Turbine, Type 3) [23] W4 (Wind Turbine, Type 4) [24] WS (Wind Turbine, Offshore) [20 same WT] WT (Wind Turbine) [20]	SS-3g
BANumber	It is possible for the terminal bus to belong to a different balancing authority than the device belongs. This is the Balancing Authority number of the Generator. When reading this field, if a balancing authority does not already exist with this number, then a new balancing authority will automatically be created.	SS-9

Table 7: Steady State Data Requirements

The below table describes a single reactive capability curve entry. Each generator should provide at a minimum two table entries: 1) minimum and maximum MVAr at maximum MW and 2) minimum and maximum MVAr at minimum MW. (SS-3b)

Field	Description	MOD-032-01 Attachment 1
Label	Unique label identifier for this object. Syntax: Station "UN" UnitID. i.e., NOXON RAPIDS HED UN5	SS-9
MW	*KEY3* MW output at which MvarMin and MvarMax are specified (rounded to the nearest 0.001MW)	SS-9
MvarMax	Maximum Mvar output at respective MW output	SS-3b
MvarMin	Minimum Mvar output at respective MW output	SS-3b

Table 8: Reactive Capability Data Requirements

6.2.2. Dynamic

Generator dynamic data shall be provided by Generator Owners according to TP-SPP-12 – Generator Data Verification.

6.3. Shunt Data

The requested data is listed in the tables provided in Section 5.6. The description for each field shall be followed.

Level of Detail: Each BES shunt connected device. Multiple stages of devices shall be represented as Blocks within the same object record.

6.4. Generator Step Up Transformer Data

The requested data is listed in the tables provided in Section 5.5. The description for each field shall be followed. (SS-3f)

Level of Detail: Each BES transformer. Transformers with three windings where the third winding does not have a connected device (other than station service) can be represented as a two-winding transformer.

6.5. Generator Lead Line data

The requested data is listed in the tables provided in Section 5.3. The description for each field shall be followed.

Level of Detail: Each generator lead line exceeding 0.1 miles shall be provided.

6.6. Station Service Load data

The requested data is listed in the tables provided in Section 8.1. The description for each field shall be followed. (SS-3c)

Level of Detail: Station service at modeled generation facilities with station service load greater than or equal to 1MW.

7. Resource Planner Data Requirements

The requested data for future generators is listed in the tables provided in Section 6. The description for each field shall be followed.

Level of Detail: Each future generator, generator step up transformer, generator lead line and station service which meets the level of detail specified in Section 6.

8. Distribution Provider Data Requirements

8.1. Load Data

The Transmission Planner function will fulfill the requirements of Distribution Provider for modeling load. See Section 9.5.

8.2. Distribution Transformer Data

(Future requirement)

The requested data is listed in the tables provided in Section 5.5. The description for each field shall be followed. (SS-3f)

Level of Detail: Each distribution transformer used to change voltage from transmission level to distribution level. Transformers with three windings where the third winding does not have a connected device (other than station service) can be represented as a two-winding transformer.

9. Transmission Planner Data Requirements

Data collected from the applicable entities through the process outlined in Section 3 will be used by the Transmission Planning function to develop a power system model. The following sections outline the complete data set necessary to represent each object type in a power system model. Transmission Planning personnel are expected to have sufficient expertise in using power system modeling and analysis software and expertise in the present process to develop interconnection-wide base cases to understand the application of the following sections.

9.1. Substation Data

Field	Description	Desired Value	Source
Name	*SECONDARY KEY1* Name of the station. A string of any length is permitted.	The substation name shall not include the voltage class unless it is specifically stated as part of the official substation name.	TO/GO
Number	*KEY1* Number	48000-49999 480000-499999	TP
Latitude	Geographic Latitude in decimal degrees.		TO/GO
Longitude	Geographic Longitude in decimal degrees.		TO/GO
DataMaintainerAssign	Name of the DataMaintainer specifically assigned to this object.	“Avista”	TP
IDExtra	Three- or four-letter abbreviation for station		TO/GO
RGround	Resistance [in Ohms] between the substation neutral and ground.		TO/GO

Table 9: Substation Data Requirements

9.2. Bus Data

Field	Description	Desired Value	Source
AllLabels	A comma-delimited list of unique label identifiers for this object.		TO, TP
Number	*KEY1* Number	48000-49999 480000-499999	TP
Name	Name	Follow the naming convention used in the field	TP
NomkV	The nominal kV voltage specified as part of the input file.	230, 115, 13.8, etc	TP
Slack	YES or NO. Set to YES to indicate that this bus should be the island slack bus.	“NO”	TP
NomG	Nominal MW from extra shunt admittance at the bus (Mvar when operating at 1.0 per unit voltage). Positive values represent *load*. This is meant to represent fictitious injections such as created by an equivalencing routine or the state estimator mismatch as read from a state estimator solution.	“0”	TP
NomB	Nominal Mvar from extra shunt admittance at the bus (Mvar when operating at 1.0 per unit voltage). Positive values represent *generation*. This is meant to represent fictitious injections such as created by an equivalencing routine or the state estimator mismatch as read from a state estimator solution.	“0”	TP
Vpu	The per unit voltage magnitude. A value of 1.0 means the actual kV is equal to the nominal kV	NA	Software
Vangle	Voltage: Angle (degrees)	NA	Software
DCLossMultiplier	Only used when solving a DC power flow using the DC approximation solution option. This then specifies a multiplier at the bus used during the DC power flow solution. All loads at the bus will be artificially increased by this multiplier when calculating load MWs during the DC power flow.	1	TP
AreaNumber	Number of the Area. Must be a positive integer value. Must be specified, so blank values are not permitted. When reading this field, if an area does not already exist with this number, then a new area will automatically be created.	40	TP
ZoneNumber	Number of the Zone. Must be a positive integer value. Must be specified, so blank values are not permitted. When reading this field, if a zone does not already exist with this number, then a new zone will automatically be created.	Shall be used to distinguish the designated regions within Avista’s BAA as indicated on Avista’s System Data 60-115-230kV Interconnected System One Line Diagram • 440 AVA: Borderline on BPA • 441 AVA: Coeur d’Alene	TP

Field	Description	Desired Value	Source
		• 442 AVA: • 443 AVA: • 444 AVA: Lewiston/Clarkston • 445 AVA: Big Bend • 446 AVA: Palouse • 447 AVA: Spokane • 448 AVA: Pend Oreille PUD • 449 AVA:	
BANumber	Number of the Balancing Authority. Must be a positive integer value. Must be specified, so blank values are not permitted. When reading this field, if a balancing authority does not already exist with this number, then a new balancing authority will automatically be created.	29	TP
OwnerNumber	Number of the Owner to which the bus is assigned	Refer to WECC Master Tie Line File	TP
SubNumber	Substation Number. Must be a positive integer value. When reading this field, if a substation does not already exist with this number, then a new zone will automatically be created.	48000-49999 480000-499999	TP
Monitor	Set to YES to specify that this bus should be monitored. Set to NO to not monitor this bus.	Refer to TP-SPP-06	TP
LimitSet	Name of the Limit Set to which the bus belongs	Refer to TP-SPP-06	TP
UseSpecificLimits	Set to YES to specify specific limits for this bus in the format. When set to NO the limits will be obtained from the LimitSet objects instead	Refer to TP-SPP-06	TP
LimitLowA	A low voltage limit of the bus in per unit	Refer to TP-SPP-06	TP
LimitLowB	B low voltage limit of the bus in per unit	Refer to TP-SPP-06	TP
LimitLowC	C low voltage limit of the bus in per unit	Refer to TP-SPP-06	TP
LimitLowD	D low voltage limit of the bus in per unit	Refer to TP-SPP-06	TP
LimitHighA	A high voltage limit of the bus in per unit	Refer to TP-SPP-06	TP
LimitHighB	B high voltage limit of the bus in per unit	Refer to TP-SPP-06	TP
LimitHighC	C high voltage limit of the bus in per unit	Refer to TP-SPP-06	TP
LimitHighD	D high voltage limit of the bus in per unit	Refer to TP-SPP-06	TP
Latitude	Geographic Latitude in decimal degrees.	Populate from Substation Record	TP
Longitude	Geographic Longitude in decimal degrees.	Populate from Substation Record	TP
TopologyBusType	Type of electrical connection point. Choices are BusBarSection, Junction, Internal_3WND, and Ground.		TP
Priority	Integer priority used when choosing the primary node within a Superbus. Higher numbers have priority over lower numbers.		TP
EMSType	Record type read from an EMS system	NA	TP
EMSID	String ID for node used in EMS systems	NA	TP
DataMaintainerAssign	Name of the DataMaintainer specifically assigned to this object. This can be blank	Blank – inherit from Substation object	TP

Field	Description	Desired Value	Source
	as well. For objects which inherit their DataMaintainer this will still be blank. Note: For the internal bus of a three-winding transformer, this value cannot be specified, and any entry here will be ignored. The DataMaintainer will always be inherited from the three-winding transformer record.		

Table 10: Bus Data Requirements

9.3. Transmission Line (Branch) Data

Field	Description	Desired Value	Source
AllLabels	A comma-delimited list of unique label identifiers for this object.		TO/TP
BusNumFrom	*KEY1* Number of the from bus. When reading record, see special note in Section 2.4.	48000-49999 480000-499999	TP
BusNumTo	*KEY2* Number of the TO bus. When reading record, see special note in Section 2.4.	48000-49999 480000-499999	TP
Circuit	*KEY3* Two-character ID of the branch. This identifier must be unique regardless of whether the branch is a transformer or a non-transformer.		TP
BranchDeviceType	Field can have the following entries: Line, Transformer, Series Cap, Breaker, Disconnect, ZBR, Fuse, Load Break Disconnect, or Ground Disconnect. This enumeration of device types comes from the Common Information Model (CIM) specification, except that a ZBR is called a Jumper in CIM. In general, a user may toggle between these various device types except for a Transformer. Once an object is specified as a transformer it may not be turned back into another branch device type.		TP
ConsolidateAllow	YES or NO. Set to YES to allow this branch to be consolidated in the integrated topology processing	"YES" - All devices except bus tie breakers "NO" – Bus tie breakers	TP
Status	Status of the branch. Set to either OPEN or CLOSED		TP
StatusNormal	Normal status of the branch. Set to either OPEN or CLOSED		TO/GO
ByPass	Set to YES to bypass the branch and treat it as a minimum series impedance (0.0000001 + j0.00001)	"NO"	TP
MeteredEnd	Specify either FROM or TO. Represents the end of the transmission line which is metered when used as a tie-line between areas, zones, or balancing authorities. The end of the line which is not metered will be responsible for the losses on the line.		TP
R	Series Resistance of the branch in per unit on the system MVABase and the nominal kV of the from		TO/GO

Field	Description	Desired Value	Source
	bus		
X	Series Reactance of the branch in per unit on the system MVABase and the nominal kV of the from bus		TO/GO
B	Shunt Susceptance of the branch in per unit on the system MVABase and the nominal kV of the from bus		TO/GO
G	Shunt Conductance of the branch in per unit on the system MVABase and the nominal kV of the from bus	"0"	TP
LineLength	Length of the line in miles.		TO/GO
Monitor	Set to YES to specify that this branch should be monitored. Set to NO to not monitor this branch.	Refer to TP-SPP-06	TP
LimitSet	Name of the Limit Set to which the branch belongs	Refer to TP-SPP-06	TP
LimitAMPA	Summer Normal Rating of the branch in AMP at 40°C		TO/GO
LimitAMPB	Summer Emergency Rating of the branch in AMP at 40°C		TO/GO
LimitAMPC	Winter Normal Rating of the branch in AMP at 0°C		TO/GO
LimitAMPD	Winter Emergency Rating of the branch in AMP at 0°C		TO/GO
LimitAMPE	Fall Normal Rating of the branch in AMP at 30°C		TO/GO
LimitAMPF	Fall Emergency Rating of the branch in AMP at 30°C		TO/GO
LimitAMPG	Spring Normal Rating of the branch in AMP at 30°C		TO/GO
LimitAMPH	Spring Emergency Rating of the branch in AMP at 30°C		TO/GO
LimitMVAI	I Rating of the branch in MVA	"0"	TP
LimitMVAJ	J Rating of the branch in MVA	"0"	TP
LimitMVAK	K Rating of the branch in MVA	"0"	TP
LimitMVAL	L Rating of the branch in MVA	"0"	TP
LimitMVAM	M Rating of the branch in MVA	"0"	TP
LimitMVAN	N Rating of the branch in MVA	"0"	TP
LimitMVAO	O Rating of the branch in MVA	"0"	TP
OwnerNum1	Owner Number 1. May also be listed as blank to indicate that the owner is the same as the owner of from bus.		TP
OwnerPerc1	Owner 1 Percent		TP
OwnerNum2	Owner Number 2		TP
OwnerPerc2	Owner 2		TP
OwnerNum3	Owner Number 3		TP
OwnerPerc3	Owner 3		TP
OwnerNum4	Owner Number 4		TP
OwnerPerc4	Owner 4		TP
OwnerNum5	Owner Number 5		TP
OwnerPerc5	Owner 5		TP
OwnerNum6	Owner Number 6		TP
OwnerPerc6	Owner 6		TP
OwnerNum7	Owner Number 7		TP
OwnerPerc7	Owner 7		TP
OwnerNum8	Owner Number 8		TP
OwnerPerc8	Owner 8		TP

Field	Description	Desired Value	Source
EMSType	Record type read from an EMS system		TP
EMSID	String ID for branch used in EMS systems		TP
EMSLineID	String ID for group container in EMS system		TP
EMSCBTyp	String ID for switch type in EMS System		TP
EMSID2From	String ID for the FROM bus side measurement object in EMS System		TP
EMSID2To	String ID for the TO bus side measurement object in EMS System		TP
DataMaintainerAssign	Name of the DataMaintainer specifically assigned to this object. This can be blank as well. For objects which inherit their DataMaintainer this will still be blank.	Blank – Inherit from Substation object	TP
FaultRZero	Zero sequence resistance of the branch in per unit on the system MVABase and the nominal kV of the from bus		TO/GO
FaultXZero	Zero sequence reactance of the branch in per unit on the system MVABase and the nominal kV of the from bus		TO/GO
ConductorType	Conductor size, material, and code name. i.e., 795 ACSS Drake		TO/GO
TowerConfiguration	Typical structure type		TO/GO

Table 11: Transmission Line Data Requirements

9.4. Transformer Data

Impedance values provided on transformer test reports are given on the transformer bases. Conversion of the values to system base should be left up to the software programs. PowerWorld, PSS/E and PSLF model transformer impedance on the “TO” side of the model. The software programs convert parameters entered in transformer base to the system base values. If the fixed tap ratio is something other than unity, the side of the model the impedance is modeled on is very important. Multiplying by the square of the turns ratio (or inverse of turns ratio depending on direction) is required to transpose the impedance model from the “FROM” side to the “TO” side. Using the following table, which utilizes the software to perform necessary calculations, reduces the potential for base conversion errors and miscalculations of parameters related to tap positions. For consistency, the high voltage winding should be modeled at the “FROM” side of the transformer. This convention will also correctly account for the load tap changing ability of autotransformers.

If test reports are not available, the resistance calculation can be made with the assumption that the inductive reactance (i.e., X) to resistance (i.e., R) ratio is equal to 30 which is approximately equivalent to the total impedance to resistance ratio of 30. This assumption has been compared to the average results given from the test reports and proves to be an adequate representation. Note that the charging susceptance (i.e., B) associated with a transformer is negligible and therefore it is assumed to be zero.

Refer to Section 12 for example transformer test reports and sample calculations.

9.4.1. Two Winding Transformer

Field	Description	Desired Value	Source
AllLabels	A comma-delimited list of unique label identifiers for this object. The syntax for this field is described in detail in Section 2.3.4.		TO/TP
BusNumFrom	*KEY1* Number of the FROM bus	48000-49999 480000-499999	TP
BusNumTo	*KEY2* Number of the TO bus	48000-49999 480000-499999	TP
Circuit	*KEY3* Two-character ID of the branch. This identifier must be unique regardless of whether the branch is a transformer or a non-transformer.		TP
BranchDeviceType	Will always be Transformer	“Transformer”	TP
Status	Status of the branch. Set to either OPEN or CLOSED		TP
StatusNormal	Normal status of the branch. Set to either OPEN or CLOSED		TO/GO
ByPass	Set to YES to bypass the branch and treat it as a minimum series impedance (0.0000001 + j0.00001). Note this should not be used with a Transformer Branch, but in some circumstances while using software it may be convenient to have this field.	“NO”	TP
MeteredEnd	End of the transmission line which is metered when used as a tie-line between areas, zones, or balancing authorities. The end of the line which is not metered will be responsible for the losses on the line.		TP
ControlType	Control Type of the transformer. Choices are Fixed, LTC, Mvar, Phase. LTC means that a voltage in controlled by moving the transformer tap. Mvar means that the Mvar flow on the branch is controlled by moving the tap ratio. Phase means that the MW flow on the branch is controlled by changing the phase shift angle.		TO/GO
AutoControl	Set to either YES or NO to indicate whether automatic transformer control is available for this branch. If the ControlType = Phase, then the choice OPF is also available to indicate that the phase angle can be an OPF control variable.		TO/GO
RegBusNum	Regulated Bus Number. Only used for the ControlType = LTC		TO/GO
UseLineDrop	Set to either YES or NO NO : Use normal voltage control based on the regulated bus and voltage setpoint. YES : Use line drop compensation voltage control always, including in the power flow solution. In order to use line drop compensation, the regulated bus must be one of the terminals of the branch. The line drop is then calculated looking out from that branch into the rest of the system.		TO/GO
Rcomp	Line Drop Compensation resistance value used during a contingency power flow solution. Value will be expressed in per unit on the system MVA base.		TO/GO
Xcomp	Line Drop Compensation reactance value used during a contingency power flow solution. Value will be expressed in per unit on the system MVA base.		TO/GO
RegMax	Maximum desired regulated value for control		TP
RegMin	Minimum desired regulated value for control		TP

Field	Description	Desired Value	Source
RegTargetType	Target Type for the control when going outside of the RegMax and RegMin values. Choices are 1. Middle 2. Max/Min	"Middle"	TP
XFMVABase	MVA Base on which the transformer impedances (Rxfbase, Xxfbase, Gxfbase, Bxfbase, Gmagxfbase, Bmagxfbase) are given.		TO/GO
XFNomkVbaseFrom	Transformer's Nominal Voltage base for the FROM bus		TO/GO
XFNomkVbaseTo	Transformer's Nominal Voltage base for the TO bus		TO/GO
Rxfbase	Resistance given on the transformer base		TO/GO
Xxfbase	Reactance given on the transformer base		TO/GO
Gxfbase	Shunt Conductance given on the transformer base		TO/GO
Bxfbase	Shunt Susceptance given on the transformer base		TO/GO
Gmagxfbase	Magnetizing Conductance given on the transformer base		TO/GO
Bmagxfbase	Magnetizing Susceptance given on the transformer base		TO/GO
TapFixedFrom	Fixed tap ratio on the FROM side on the transformer base		TO/GO
TapFixedTo	Fixed tap ratio on the TO side on the transformer base		TO/GO
TapMaxxfbase	Maximum tap ratio on the transformer base		TO/GO
TapMinxfbase	Minimum tap ratio on the transformer base		TO/GO
TapStepSizexfbase	Tap ratio step size on the transformer base		TO/GO
Tapxfbase	Present tap ratio on the transformer base	NA	Software
Phase	Phase Shift Angle	NA	Software
ImpCorrTable	Impedance correction table used. Specify 0 if none used.		TO/GO
LineLength	Length of the branch. Field has limited value for a transformer but is included to be helpful as branches all have a LineLength.	"0"	TP
Monitor	Set to YES to specify that this branch should be monitored. Set to NO to not monitor this branch.	Refer to TP-SPP-06	TP
LimitSet	Name of the Limit Set to which the branch belongs	Refer to TP-SPP-06	TP
LimitMVAA	A Rating of the branch in MVA		TO/GO
LimitMVAB	B Rating of the branch in MVA		TO/GO
LimitMVAC	C Rating of the branch in MVA		TO/GO
LimitMVAD	D Rating of the branch in MVA		TO/GO
LimitMVAE	E Rating of the branch in MVA		TO/GO
LimitMVAF	F Rating of the branch in MVA		TO/GO
LimitMVAG	G Rating of the branch in MVA		TO/GO
LimitMVAH	H Rating of the branch in MVA		TO/GO
LimitMVAI	I Rating of the branch in MVA	"0"	TP
LimitMVAJ	J Rating of the branch in MVA	"0"	TP
LimitMVAK	K Rating of the branch in MVA	"0"	TP
LimitMVAL	L Rating of the branch in MVA	"0"	TP
LimitMVAM	M Rating of the branch in MVA	"0"	TP
LimitMVAN	N Rating of the branch in MVA	"0"	TP
LimitMVAO	O Rating of the branch in MVA	"0"	TP
OwnerNum1	Owner Number 1.		TP
OwnerPerc1	Owner 1 Percent		TP

Field	Description	Desired Value	Source
OwnerNum2	Owner Number 2		TP
OwnerPerc2	Owner 2		TP
OwnerNum3	Owner Number 3		TP
OwnerPerc3	Owner 3		TP
OwnerNum4	Owner Number 4		TP
OwnerPerc4	Owner 4		TP
OwnerNum5	Owner Number 5		TP
OwnerPerc5	Owner 5		TP
OwnerNum6	Owner Number 6		TP
OwnerPerc6	Owner 6		TP
OwnerNum7	Owner Number 7		TP
OwnerPerc7	Owner 7		TP
OwnerNum8	Owner Number 8		TP
OwnerPerc8	Owner 8		TP
EMSType	Record type read from an EMS system		TP
EMSID	String ID for branch used in EMS systems		TP
EMSLineID	String ID for group container in EMS system		TP
EMSCBTyp	String ID for switch type in EMS System		TP
EMSID2From	String ID for the FROM bus side measurement object in EMS System		TP
EMSID2To	String ID for the TO bus side measurement object in EMS System		TP
DataMaintainerAssign	Name of the DataMaintainer specifically assigned to this object. This can be blank as well. For objects which inherit their DataMaintainer this will still be blank. Note: For the windings a three-winding transformer, this value cannot be specified, and any entry here will be ignored. The DataMaitainer will always be inherited from the three-winding transformer record.	Blank – Inherit from Substation object	TP
FaultRZero	Zero sequence resistance of the branch in per unit on the system MVABase and the nominal kV of the from bus	SC-1c	TO/GO
FaultXZero	Zero sequence reactance of the branch in per unit on the system MVABase and the nominal kV of the from bus	SC-1c	TO/GO
GICBlock	Specifies whether the transformer has a GIC blocking device which would prevent dc neutral current; either yes if there is one or no otherwise		TO/GO
GICCoilRUser	Select to manually enter the transformer coil resistance; used in the GIC calculations		TO/GO
GICCoilRFrom	Per phase resistance for transformer High side coil in Ohms		TO/GO
GICCoilRTo	Per phase resistance for transformer Medium side coil in Ohms		TO/GO
XFConfiguration	Transformer Configuration		TO/GO
GICAutoXF	Specifies whether the transformer is an autotransformer. Value can be either Unknown, Yes or No		TO/GO
GICCoreType	The core type of the transformer. Value can be Unknown, Single Phase, Three Phase Shell, 3-Legged Three Phase, or 5-Legged Three Phase.		TO/GO

Table 12: Two Winding Transformer Data Requirements

9.4.2. Three Winding Transformer

Three winding transformers are represented by an equivalent model shown in the figure below. In this model the intermediate bus is labeled a “star” bus and shall be set to a nominal voltage of 1kV as it is a fictitious bus only used for modeling purposes. Test reports will provide impedance values between two specific windings. These values then need to be converted to fit into the equivalent model.

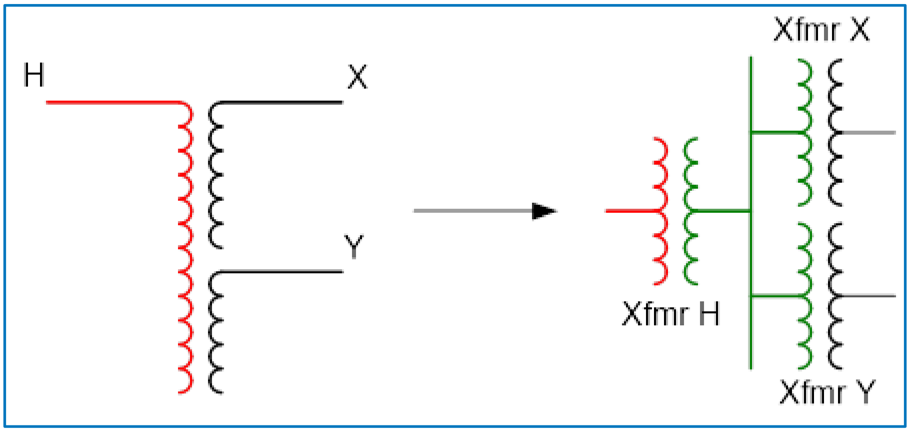

Figure 4: Three Winding Transformer Equivalence Model

Field	Description	Desired Value	Source
AllLabels	A comma-delimited list of unique label identifiers for this object. The syntax for this field is described in detail in Section 2.3.4.		TO/TP
BusIDPri	*KEY1* Number of the primary bus. When reading record, see special note in Section 2.4.	48000-49999 480000-499999	TP
BusIDSec	*KEY2* Number of the secondary bus. When reading record, see special note in Section 2.4.	48000-49999 480000-499999	TP
BusIDTer	*KEY3* Number of the tertiary bus. When reading record, see special note in Section 2.4.	48000-49999 480000-499999	TP
Circuit	*KEY4* Two-character ID of the branch		TP
BusIDStar	Number of the star bus.	48000-49999 480000-499999	TP
StatusPri StatusSec StatusTer	Status of the primary, secondary and tertiary winding. Either OPEN or CLOSED		TP
MeteredEndPri MeteredEndSec MeteredEndTer	Specify either FROM or TO. FROM means the terminal of the primary, secondary, or tertiary of the 3WXformer, while TO means the internal star bus. This indicates the end of the branch which is metered when used as a tie-line between areas, zones, or balancing authorities.		TP
MVABasePriSec	MVA BasePrimary-Secondary (RbasePriSec and XbasePriSec are given on this MVA Base). If a zero or negative value is specified for this field, then the value is set equal to the System MVA Base		TO/GO
MVABaseSecTer	MVA Base Secondary-Tertiary (RbaseSecTer and XbaseSecTer are given on this MVA Base). If a zero or negative value is specified, then the value is set equal to MVABasePriSec		TO/GO

Field	Description	Desired Value	Source
MVABaseTerPri	MVA Base Tertiary-Primary (RbaseTerPri and XbaseTerPri are given on this MVA Base). If a zero or negative value is specified, then the value is set equal to MVABasePriSec		TO/GO
RbasePriSec	Per unit resistance Primary-Secondary on MVABasePriSec		TO/GO
XbasePriSec	Per unit reactance Primary-Secondary on MVABasePriSec		TO/GO
RbaseSecTer	Per unit resistance Secondary-Tertiary on MVABaseSecTer		TO/GO
XbaseSecTer	Per unit reactance Secondary-Tertiary on MVABaseSecTer		TO/GO
RbaseTerPri	Per unit resistance Tertiary-Primary on MVABaseTerPri		TO/GO
XbaseTerPri	Per unit reactance Tertiary-Primary on MVABaseTerPri		TO/GO
Gmagbase	Per unit magnetizing conductance (G) on MVABasePriSec		TO/GO
Bmagbase	Per unit magnetizing susceptance (B) on MVABasePriSec		TO/GO
ImpCorrTablePri ImpCorrTableSec ImpCorrTableTer	Impedance correction table used for respective winding. Specify 0 if none used.		TO/GO
ControlTypePri ControlTypeSec ControlTypeTer	Control Type of the respective winding of the transformer. Choices are Fixed, LTC, Mvar, Phase. LTC means that a voltage in controlled by moving the transformer tap. Mvar means that the Mvar flow on the branch is controlled by moving the tap ratio. Phase means that the MW flow on the branch is controlled by changing the phase shift angle.		TO/GO
AutoControlPri AutoControlSec AutoControlTer	Set to either YES or NO to indicate whether automatic transformer control is available for the respective winding. If the ControlType of winding is Phase, then the choice OPF is also available to indicate that the phase angle can be an OPF control variable.		TO/GO
RegBusNumPri RegBusNumSec RegBusNumTer	Regulated Bus Number for respective winding's tap		TO/GO
UseLineDropPri UseLineDropSec UseLineDropTer	Set to either YES or NO NO : Use normal voltage control based on the regulated bus and voltage setpoint. YES : Use line drop compensation voltage control on the respective winding In order to use line drop compensation on the respective winding, the regulated bus must be one of the terminals of the branch. The line drop is then calculated looking out from that branch into the rest of the system.		TO/GO
RcompPri RcompSec RcompTer	Line Drop Compensation resistance value for respective winding used during a contingency power flow solution. Value will be expressed in per unit on the system MVA base.		TO/GO
XcompPri XcompSec XcompTer	Line Drop Compensation reactance value used during a contingency power flow solution. Value will be expressed in per unit on the system MVA base.		TO/GO

Field	Description	Desired Value	Source
RegMaxPri RegMaxSec RegMaxTer	Maximum desired regulated value for control using the respective winding		TO/GO
RegMinPri RegMinSec RegMinTer	Minimum desired regulated value for control using the respective winding		TO/GO
RegTargetTypePri RegTargetTypeSec RegTargetTypeTer	Target Type for the control when going outside of the RegMax and RegMin values. Choices are: 1. Middle 2. Max/Min		TO/GO
NomkVPri NomkVSec NomkVTer	Transformer Nominal kV Voltage of the respective winding		TO/GO
TapFixedPri TapFixedSec TapFixedTer	Fixed Tap on transformer voltage kV base for respective winding		TO/GO
TapMaxPri TapMaxSec TapMaxTer	Maximum total tap on transformer voltage kV base for primary		TO/GO
TapMinPri TapMinSec TapMinTer	Minimum total tap on transformer voltage kV base for respective winding		TO/GO
TapStepSizePri TapStepSizeSec TapStepSizeTer	Tap step size on transformer voltage kV base for respective winding		TO/GO
TapPri TapSec TapTer	Total Tap on transformer voltage kV base for respective winding	NA	Software
PhasePri PhaseSec PhaseTer	Phase shift for respective winding	NA	Software
OwnerNum1	Owner Number 1.		TP
OwnerPerc1	Owner 1 Percent		TP
OwnerNum2	Owner Number 2		TP
OwnerPerc2	Owner 2		TP
OwnerNum3	Owner Number 3		TP
OwnerPerc3	Owner 3		TP
OwnerNum4	Owner Number 4		TP
OwnerPerc4	Owner 4		TP
OwnerNum5	Owner Number 5		TP
OwnerPerc5	Owner 5		TP
OwnerNum6	Owner Number 6		TP
OwnerPerc6	Owner 6		TP
OwnerNum7	Owner Number 7		TP
OwnerPerc7	Owner 7		TP
OwnerNum8	Owner Number 8		TP
OwnerPerc8	Owner 8		TP
MonitorPri MonitorSec MonitorTer	Set to YES to specify that this respective winding should be monitored. Set to NO to not monitor this respective winding.	Refer to TP-SPP-06	TP
LimitSetPri LimitSetSec LimitSetTer	Name of the Limit Set to which the respective winding belongs	Refer to TP-SPP-06	TP

Field	Description	Desired Value	Source
LimitMVAAPri .. LimitMVAOPri	15 limits A..H for the primary winding		TO/GO
LimitMVAASec .. LimitMVAOSec	15 limits A..H for the secondary winding		TO/GO
LimitMVAATer .. LimitMVAOTer	15 limits A..H for the secondary winding		TO/GO
DataMaintainerAssign	Name of the DataMaintainer specifically assigned to this object. This can be blank as well. For objects which inherit their DataMaintainer this will still be blank.	Blank – Inherit from Substation object	TP

Table 13: Three Winding Transformer Data Requirements

9.5. Load Data

9.5.1. Steady State

Load is used to represent an aggregation of distribution load.

Level of Detail: Each load service point from the Transmission System. The aggregation is typically to the transmission voltage level at each station. A separate load record shall be used to represent load service at the same station for different transmission customers.

Assume all load is in service. (MOD-032-1, Att. 1 SS-2b)

Field	Description	Desired Value	Source
AllLabels	A comma-delimited list of unique label identifiers for this object. The syntax for this field is described in detail in Section 2.3.4.		TP
BusNum	*KEY1* Number of the bus. When reading record, see special note in Section 2.4.	48000-49999 480000-499999	TP
ID	*KEY2* 2-character load identification field. Used to identify multiple loads at a single bus	Load modeling generator station service shall have Load ID set to ‘SS.’	TP
Status	The status of the load (Open or Closed)		TP
AGC	Set to YES to permit this load to be automatically controlled by various software tools	Set to ‘NO’ for loads which should not be changed in load scaling operations of power flow software.	TP
SMW	Constant Real Power in MW	Refer to TP-SPP-07	TP, SS-2a
SMvar	Constant Reactive Power in Mvar	Refer to TP-SPP-07	TP, SS-2a
IMW	Constant Current Real Power in nominal MW (linearly dependent on per unit voltage)	“0”	TP
IMvar	Constant Current Reactive Power in nominal Mvar (linearly dependent on per unit voltage)	“0”	TP
ZMW	Constant Impedance Real Power in nominal MW (dependent on square of per unit voltage)	“0”	TP

Field	Description	Desired Value	Source
ZMvar	Constant Impedance Reactive Power in nominal Mvar (linearly on square of per unit voltage)	"0"	TP
DistStatus	Status of the Distributed Generation associated with the load record (OPEN or CLOSED)		TP
DistMWInput	Constant MW of the distributed generation associated with the load record		TP
DistMvarInput	Constant Mvar of the distributed generation associated with the load record		TP
Interruptible	Either YES or NO. Presently this field is informational only.		TP
MWMax	When automatically dispatched this is the maximum MW demand of the load.		TP
MWMin	When automatically dispatched this is the minimum MW demand of the load.		TP
LoadModelGroup	Name of the LoadModelGroup to which the load belongs	Seven-character identifiers of the climate zone and load type – the first three characters represent the climate zone, underscore, and three characters representing the substation/feeder type. Details are included in the LID_Instructions and Composite Load Model Implementation documents.	TP
AreaNumber	Number of Area to which the load is assigned. This can be different than the area of the terminal bus. When reading this field, if an area does not already exist with this number, then a new area will automatically be created.	"40"	TP
ZoneNumber	Number of Zone to which the load is assigned. This can be different than the area of the terminal bus. When reading this field, if a zone does not already exist with this number, then a new zone will automatically be created.	Shall be used to distinguish the designated regions within Avista's BAA • 440 AVA: Borderline on BPA • 441 AVA: Coeur D'Alene • 442 AVA: • 443 AVA: • 444 AVA: Lewiston/Clarkston • 445 AVA: Big Bend • 446 AVA: Palouse • 447 AVA: Spokane • 448 AVA: Pend Oreille PUD • 449 AVA:	TP

Field	Description	Desired Value	Source
BANumber	Number of Balancing Authority to which the load is assigned. This can be different than the area of the terminal bus. When reading this field, if a balancing authority does not already exist with this number, then a new balancing authority will automatically be created.	40 or 29	TP
OwnerNumber	Number of the Owner to which the load is assigned		TP
EMSType	Record type read from an EMS system		TP
EMSID	String ID for load used in EMS systems		TP
DataMaintainerAssign	Name of the DataMaintainer specifically assigned to this object. This can be blank as well. For objects which inherit their DataMaintainer this will still be blank.	Blank – inherit from Substation object	TP

Table 14: Steady State Load Data Requirements

9.5.2. Dynamic

9.5.2.1. Load Characteristic

WECC utilizes the PSLF CMPLDW dynamic composite load model to represent the dynamic performance of loads. WECC staff populates the CMPLDW parameters for each WECC approved base case using tools developed by MVWG. Avista is responsible for populating the LoadModelGroup field (converted to Long ID in PSLF) in the steady state data submittal for WECC approved base cases. The LoadModelGroup format is determined based on the climate zone and feeder type the load is intended to represent. All Avista load is in the Northwest Inland (NWI) climate zone. Refer to the most recent WECC MVWG documentation for designation of the feeder type.

9.5.2.2. Relay Models (PRC-006-5, R6)

The following procedure should be followed annually in the second quarter to model (database maintenance) under frequency load shedding and generator low frequency ride thru relays:

1. Avista TOP leads the NWPP/WECC program within Avista for load shedding, and it provides to Planning the updated Attachment A of PRC-006-WECC-CRT, usually in April. Attachment A is an Excel spreadsheet with numerous Tabs; Tab 2 and Tab 4a being of interest to Transmission Planning. Planning will, in turn, populate Tab 3 and Tab 4b.
2. Tab 2 – Detail Load: this tab presents blocks of load to shed on select feeders based on frequency and time. The data is based on a case noted at the top of the Tab, typically the current year Heavy Winter case.
    a. If Tab 2 has been populated based on a Heavy Winter case, open the Year One Heavy Winter Planning case in PowerWorld Simulator and scale the “Avista” area load to match the system peak load noted at the top of Tab 2.
    b. Navigate within Model Explorer to Transient Stability, Load Relays, and LSDT9. Set the Area/Zone/Owner/Data Maintainer filtering as required to

show the “Avista” load relays in the LSDT9 table. The table has two values of interest:

i. MW – shows the scaled forecasted load for the case under study
ii. frac# – this is the fraction of load that will trip if frequency and time conditions for the relay are met

c. For each block and load in LSDT9, calculate the frac value necessary that when multiplied by the forecasted load equals the Load Shed MW value provided in Tab 2. The percentage of load to drop for each relay (ie. frac1) will depend on how the representation of load in the case matches the feeders and load being tripped by the UFLS scheme in Tab 2. Differences in the case load vs. Tab 2 load are handled by adjusting the frac value of the individual loads such that the load shed in the load shed block matches the Tab 2 value. Frac values above 1.0 are not permitted.

d. Update the frac values in the case and with the newly calculated values. Populate the load shed relay model parameters with the current values in the Dynamic Model for Substations section of Tab 3 – Load PSLF dyd data. Copy/paste from the previous years’ table values will save time.

e. Verify the TLIN1 requirements, per block, in Tab 2 and update the case as necessary. Populate the transmission line relay model parameters in the Dynamic Model for Lines section of Tab 3.

3. Tab 4a – Generator: this tab presents the generator frequency tripping/ride thru schedule. For each generator listed, populate a LHFRT dynamic model in the case with the corresponding frequency tripping settings and populate Tab 4b – Gen PSLF dyd data with the generator model information.
4. To test the models, open a recent WECC approved base case. Load the newly developed UFLS models and generator protection models into the program. A significant amount of generation must be dropped to have the UFLS models react.
5. Return the updated Attachment A spreadsheet to Transmission Operations who will return it to NWPP.
6. Prepare a .dyd file with all updated modeling information and send it to WECC for inclusion in the Master Dynamics File (MDF).
7. Update the PRC-006-5 RSAW and OneNote with the latest information: copies of emails, Attachment A, updated .dyd file, etc.

9.6. Large Motors

Motors larger than 10MVA (synchronous or non-synchronous) should be modeled explicitly, with their respective unit transformers. The Transmission Planner function is responsible for developing the necessary steady state and dynamic models to adequately portray the performance of the motors being modeled. Typical information can be gathered from the customer, or owner of the motors, to assist in the development of the models.

9.7. Generator

Field	Description	Desired Value	Source
AllLabels	A comma-delimited list of unique label identifiers for this object. The syntax for this field is described in detail in Section 2.3.4.		GO/TP
BusNum	*KEY1* Number of the bus. When reading record, see special note in Section 2.4.	48000-49999 480000-499999	TP
ID	*KEY2* 2-character generator identification field. Used to identify multiple generators at a single bus		TP
Status	The status of the generator (Open or Closed)	Refer to TP-SPP-07	TP
VoltSet	Desired per unit voltage setpoint at the regulated bus		GO
RegBusNum	Number of regulated bus		GO
RegFactor	Remote regulation factor. When multiple buses have generation that control the voltage at a single bus, this determines the ratio in which the Mvar output is shared.		GO
AGC	Set to YES or NO to specify if the generator is available for AGC		TP
PartFact	Generator's participation factor. Used during Area Interchange Control when set to AGC is set to Part AGC. Also used during post-contingency make-up power. Also used for sensitivity calculations when using Areas, Zones, or Super Areas.		TP
MWSetPoint	This is what the generator's MW output is if it is presently in service. If the generator is in service, this is the same as the MW field. Iif the generator is out of service, then the MW field would return 0.0.	Refer to TP-SPP-07	TP
MWMax	Generator's maximum MW limit		GO
MWMin	Generator's minimum MW limit		GO
MWMaxEcon	Generator's maximum MW limit		TP
MWMinEcon	Generator's minimum MW limit		TP
EnforceMWLimit	Set to YES to specify if the generator's MW limits are enforced	YES	TP
AVR	Set to YES or NO to specify if the generator is available for AVR		GO
Mvar	Generator's present Mvar output	NA	Software
MvarMax	Generator's maximum Mvar limit		GO
MvarMin	Generator's minimum Mvar limit		GO
UseCapCurve	Indicates if the generator should use its Mvar capability curve if it has one defined.		GO

Field	Description	Desired Value	Source
WindContMode	Special Var limit modes of either "None", "Boundary Power Factor" or "Constant Power Factor". When not equal to None, the Var limit magnitudes are determined from the real power output and the Wind Control Mode Power Factor value. For Boundary mode, the maximum limit is positive, and the minimum limit is negative. For Constant mode, minimum limit = maximum limit, a positive Wind Control Mode Power Factor means the limits have the same sign as the real power, and a negative Wind Control Mode Power Factor means the limits are the opposite sign as the real power.		GO
WindContModePF	This is the power factor value used with the Wind Control Mode. Magnitude of the value must be between 0.01 and 1.00. Negative values are important when the Wind Control Mode is "Constant Power Factor".		GO
UseLineDrop	Field describing if the generator uses line drop/reactive current compensation control		GO
Rcomp	Generator's Line Drop Compensation resistance in per unit on the system MVA Base		GO
Xcomp	Generator's Line Drop Compensation reactance in per unit on the system MVA Base		GO
MVABase	Generator's MVA base		GO
GenR	Machine Internal Resistance in per unit on Generator MVA Base		GO
GenSeqR+	Machine Positive Sequence Resistance in per unit on Generator MVA Base		GO
GenSeqR-	Machine Negative Sequence Resistance in per unit on Generator MVA Base		GO
GenSeqR0	Machine Zero Sequence Resistance in per unit on Generator MVA Base		GO
GenSeqX+	Machine Positive Sequence Reactance in per unit on Generator MVA Base		GO
GenSeqX-	Machine Negative Sequence Reactance in per unit on Generator MVA Base		GO
GenSeqX0	Machine Zero Sequence Reactance in per unit on Generator MVA Base		GO
GenZ	Machine Internal Reactance in per unit on Generator MVA Base		GO
StepR	Internal Step up: R (resistance)	“0”	TP
StepX	Internal Step up: X (reactance)	“0”	TP
StepTap	Internal Step up: Tap Ratio	“1”	TP
GovRespLimit	Specifies how governors respond in transient stability simulation. The choices are Normal, Down Only, or Fixed		GO

Field	Description	Desired Value	Source
UnitTypeCode	Two-character field describing what kind of machine the generator is. The choices are informed by the Energy Information Agency of US Department of Energy. There is an EIA Form 860 for the Annual Electric Generator Report. The choices are the first two characters of the following list. Also note that in square brackets are the integer code that will be written to an EPC file. UN (Unknown) [0] BA (Energy Storage, Battery) [99] BT (Turbines Used in a Binary Cycle, including those used for geothermal applications) [99] CA (Combined Cycle Steam Part) [2] CC (Combined Cycle Generic) [4] CE (Compressed Air Storage) [99] CP (Energy Storage, Concentrated Solar Power) [99] CS (Combined Cycle Single Shaft) [13] CT (Combined Cycle Combustion Turbine Part) [3] DC (represents DC ties) [40] ES (Energy Storage, Other) [99] FC (Fuel Cell) [99] FW (Energy Storage, Flywheel) [99] GT (Gas Turbine) [11] HA (Hydrokinetic, Axial Flow Turbine) [99] HB (Hydrokinetic, Wave Buoy) [99] HK (Hydrokinetic, Other) [99] HY (Hydro) [5] IC (Internal Combustion) [6] IT (Internal Combustion Turbo Charged) [7] JE (Jet Engine) [12] MP (Motor/Pump) [41] NB (ST - Boiling Water Nuclear Reactor) [99] NG (ST - Graphite Nuclear Reactor) [99] NH (ST - High Temperature Gas Nuclear Reactor) [99] NP (ST - Pressurized Water Nuclear Reactor) [99] OT (Other) [99] PS (Hydro Pumped Storage) [5 same as HY] PV (Photovoltaic) [31] SC (Synchronous Condenser) [14] ST (Steam Turbine) [1] W1 (Wind Turbine, Type 1) [21] W2 (Wind Turbine, Type 2) [22] W3 (Wind Turbine, Type 3) [23] W4 (Wind Turbine, Type 4) [24] WS (Wind Turbine, Offshore) [20 same WT] WT (Wind Turbine) [20]		GO

Field	Description	Desired Value	Source
AreaNumber	It is possible for the terminal bus to belong to a different area than the device belongs. This is the Area number of the Generator. When reading this field, if an area does not already exist with this number, then a new area will automatically be created.		TP
ZoneNumber	It is possible for the terminal bus to belong to a different zone than the device belongs. This is the Zone number of the Generator. When reading this field, if a zone does not already exist with this number, then a new zone will automatically be created.	Shall be used to distinguish the designated regions within Avista's BAA • 440 AVA: Borderline on BPA • 441 AVA: Coeur D'Alene • 442 AVA: • 443 AVA: • 444 AVA: Lewiston/Clarkston • 445 AVA: Big Bend • 446 AVA: Palouse • 447 AVA: Spokane • 448 AVA: Pend Oreille PUD • 449 AVA:	TP
BANumber	It is possible for the terminal bus to belong to a different balancing authority than the device belongs. This is the Balancing Authority number of the Generator. When reading this field, if a balancing authority does not already exist with this number, then a new balancing authority will automatically be created.		GO
OwnerNum1	Owner Number 1		TP
OwnerPerc1	Owner 1		TP
OwnerNum2	Owner Number 2		TP
OwnerPerc2	Owner 2		TP
OwnerNum3	Owner Number 3		TP
OwnerPerc3	Owner 3		TP
OwnerNum4	Owner Number 4		TP
OwnerPerc4	Owner 4		TP
OwnerNum5	Owner Number 5		TP
OwnerPerc5	Owner 5		TP
OwnerNum6	Owner Number 6		TP
OwnerPerc6	Owner 6		TP
OwnerNum7	Owner Number 7		TP
OwnerPerc7	Owner 7		TP
OwnerNum8	Owner Number 8		TP
OwnerPerc8	Owner 8		TP
EMSType	Record type read from an EMS system		TP
EMSID	String ID for generator used in EMS systems		TP
DataMaintainerAssign	Name of the DataMaintainer specifically assigned to this object. This can be blank as well. For objects which inherit their DataMaintainer this will still be blank.	Blank – inherit from Substation object	TP

Table 15: Generator Data Requirements

9.8. Shunt

Field	Description	Desired Value	Source
AllLabels	A comma-delimited list of unique label identifiers for this object. The syntax for this field is described in detail in Section 2.3.4.		TP/TO
BusNum	*KEY* Number of the Bus. When reading record, see special note in Section 2.4.	48000-49999 480000-499999	TP
ID	*KEY2* 2 character identification field. Used to identify multiple shunts at a single bus. Note these identifiers must be unique across all shunt objects regardless of ShuntMode.	“C” or “R”	TP
Status	Status of the shunt. Set to either OPEN or CLOSED		TP
StatusBranch	Object string referencing a branch in the system using the format of Section 2.3. The shunt will be considered out of service whenever the linked branch is out of service. This is a method of defining a line shunt if your model does not presently have breakers explicitly defined.	Blank	TP
ShuntMode	Specify the type of control mode for this shunt. The choices are Fixed, Discrete, Continuous, Bus Shunt or SVC. Note that in this table it is expected that none of the entries will be Bus Shunt as those are stored in another table.		TO
AutoControl	Set to either YES, NO, or FORCE to indicate whether automatic control is available for this shunt. NO : means it is not controlled YES : means it is available for control if the Area field AutoControlShunt = YES and the global option to enable shunts to move is enabled FORCE : means it is available for control and it ignores the Area field AutoControlShunt and the global option regarding shunt control.		TP
VoltageControlGroup	Name of the voltage control group to which the shunt belongs.		TP
MWNom	Nominal MW value of the shunt at 1.0 per unit voltage. The shunt is modeled as an impedance with the actual MW be this value multiplied by the square of the per unit voltage.	“0”	TP
MvarNom	Nominal Mvar value of the shunt at 1.0 per unit voltage. The shunt is modeled as an impedance, therefore the actual Mvar will then be this value multiplied by the square of the per unit voltage.	NA	Software
RegBusNum	Bus number of the regulated bus		TP
RegHigh	Shunt will try to keep regulated value below this value		TP

Field	Description	Desired Value	Source
RegLow	Shunt will try to keep regulated value above this value		TP
RegTarget	When the regulated value goes outside of the Low-High desired range, the control logic will attempt to bring it back to this target value		TP
RegTargetHighUse	Set to YES or NO. Default value is NO which means that the RegTarget value is used for both low and high excursions. If set to YES, then low excursions will use RegTarget, while high excursions will use RegTargetHigh.	NO	TP
RegTargetHigh	When the regulated value goes above of the RegHigh value, the control logic will attempt to bring it back to this target value		TP
RegFactor	Amount of Mvar support that this switched shunt will provide if the bus that it is regulating is being regulated by more than one switched shunt.		TP/ Software
RegulationType	Choices are either Volt, Gen Mvar, Wind Mvar, or Custom Control		TP
CustomControlModelExpressionName	When using Custom Control RegulationType, this is the name of the Model Expression which described the desired Mvar output of the shunt.		TP
InnerPowerFlow	Set to YES to allow the switched shunt to operate during the solution of the power flow equations. Default value is NO meaning that the shunt will be moved during the voltage control loop.	NO	TP
FullCapacitySwitch	Default Value is NO. Set to YES to signify that this this shunt may operate only at highest Nominal Mvar possible or at lowest Nominal Mvar possible. This is only done when (ShuntMode = Discrete) or when both (ShuntMode = SVC) AND (SVCType = SVSMO2)	NO	TP
ContinuousUse	Set to YES to use the ContinuousMvarNomMax and ContinuousMvarNomMin when the ShuntMode is set to Discrete or Continuous		TO
ContinousMvarNomMax	Minimum Nominal Mvar of the continuous element. This value is used with Discrete or Continuous ShuntMode when ContinuousUse = YES. It is also used when ShuntMode = SVC if the SVCType = SVSMO1 or SVSMO3		TO
ContinousMvarNomMin	Minimum Nominal Mvar of the continuous element. This value is used with Discrete or Continuous ShuntMode when ContinuousUse = YES. It is also used when ShuntMode = SVC if the SVCType = SVSMO1 or SVSMO3		TO
BlockNumberStep1	Number of equal nominal Mvar steps for block 1		TO

Field	Description	Desired Value	Source
BlockMvarPerStep1	Nominal Mvar per step for block 1		TO
BlockNumberStep2	Number of equal nominal Mvar steps for block 2		TO
BlockMvarPerStep2	Nominal Mvar per step for block 2		TO
BlockNumberStep3	Number of equal nominal Mvar steps for block 3		TO
BlockMvarPerStep3	Nominal Mvar per step for block 3		TO
BlockNumberStep4	Number of equal nominal Mvar steps for block 4		TO
BlockMvarPerStep4	Nominal Mvar per step for block 4		TO
BlockNumberStep5	Number of equal nominal Mvar steps for block 5		TO
BlockMvarPerStep5	Nominal Mvar per step for block 5		TO
BlockNumberStep6	Number of equal nominal Mvar steps for block 6		TO
BlockMvarPerStep6	Nominal Mvar per step for block 6		TO
BlockNumberStep7	Number of equal nominal Mvar steps for block 7		TO
BlockMvarPerStep7	Nominal Mvar per step for block 7		TO
BlockNumberStep8	Number of equal nominal Mvar steps for block 8		TO
BlockMvarPerStep8	Nominal Mvar per step for block 8		TO
BlockNumberStep9	Number of equal nominal Mvar steps for block 9		TO
BlockMvarPerStep9	Nominal Mvar per step for block 9		TO
BlockNumberStep10	Number of equal nominal Mvar steps for block 10		TO
BlockMvarPerStep10	Nominal Mvar per step for block 10		TO
SVCType	When ShuntMode = SVC, then this specifies the type of the SVC. Choices are None, SVSMO1, SVSMO2, and SVSMO3		TO
SVCXcomp	SVC control compensating reactance. This works very similarly to line drop compensation for both generator and transformer control.		TO
SVCMvarNomMaxSH	Maximum of Nominal Mvar range in which remote shunts are not switched. Value is expressed in nominal Mvar which represent what the Mvar would be at 1.0 per unit voltage.		TO
SVCMvarNomMinSH	Minimum of Nominal Mvar range in which remote shunts are not switched. Value is expressed in nominal Mvar which represent what the Mvar would be at 1.0 per unit voltage.		TO
SVCstsb	YES/NO status. For SVCType = SVSMO1 and SVSMO2, set this to YES to enable the Slow B Control. For SVCType = SVSMO3, set this to YES to enable the Ireset or deadband control		TO
SVCMvarNomMaxSB	Maximum of Nominal Mvar range for SVCType = SVSMO1 and SVSMO2 for Slow B Control. Not used with SVCType = SVSMO3		TO

Field	Description	Desired Value	Source
SVCMvarNomMinSB	Minimum of Nominal Mvar range for SVCType = SVSMO1 and SVSMO2 for Slow B Control. Not used with SVCType = SVSMO3		TO
SVCVrefmax	Voltage Range Maximum for the Slow B Control used with SVCType = SVSMO1 and SVSMO2.		TO
SVCVrefmin	Voltage Range Minimum for the Slow B Control used with SVCType = SVSMO1 and SVSMO2.		TO
SVCdvdb	Voltage Sensitivity for a change in Injection. Units are Per unit Voltage / Per unit B		TO
AreaNumber	It is possible for the terminal bus to belong to a different area than the device belongs. This is the Area number of the Shunt. When reading this field, if an area does not already exist with this number, then a new area will automatically be created.		TP
ZoneNumber	It is possible for the terminal bus to belong to a different zone than the device belongs. This is the Zone number of the Shunt. When reading this field, if a zone does not already exist with this number, then a new zone will automatically be created.	Shall be used to distinguish the designated regions within Avista's BAA • 440 AVA: Borderline on BPA • 441 AVA: Coeur d'Alene • 442 AVA: • 443 AVA: • 444 AVA: Lewiston/Clarkston • 445 AVA: Big Bend • 446 AVA: Palouse • 447 AVA: Spokane • 448 AVA: Pend Oreille PUD • 449 AVA:	TP
BANumber	It is possible for the terminal bus to belong to a different balancing authority than the device belongs. This is the Balancing Authority number of the Shunt. When reading this field, if a balancing authority does not already exist with this number, then a new balancing authority will automatically be created.		TP
OwnerNum1	Owner Number 1		TP
OwnerPerc1	Owner 1		TP
OwnerNum2	Owner Number 2		TP
OwnerPerc2	Owner 2		TP
OwnerNum3	Owner Number 3		TP
OwnerPerc3	Owner 3		TP

Field	Description	Desired Value	Source
OwnerNum4	Owner Number 4		TP
OwnerPerc4	Owner 4		TP
EMSType	Record type read from an EMS system		TP
EMSID	String ID for shunt used in EMS systems		TP
DataMaintainerAssign	Name of the DataMaintainer specifically assigned to this object. This can be blank as well. For objects which inherit their DataMaintainer this will still be blank.	Blank – inherit from Substation object	TP
CTGRegHigh	Lowest high voltage threshold for automatic insertion	SS-7b	TO
CTGRegLow	Highest low voltage threshold for automatic insertion	SS-7b	TO

Table 16: Shunt Data Requirements

10. WECC Data Submission

Avista Transmission Planning will make available models for its Planning Coordinator area reflecting data collected according to TP-SPP-04 to WECC to support creation of interconnection-wide cases. (MOD-032-1, R4)

The methods used to make the models available to WECC will follow the procedures outlined by the specific data request from WECC. The following section provides a guideline for preparing the data for typical submissions to WECC. It is expected the personnel with Avista Transmission Planning are actively engaged in the appropriate committees at WECC to be knowledgeable in the data collection process.

10.1. Pre-Run Data Submittal

1. WECC will provide a data request via email stating a scenario to be represented in the compilation of a WECC approved base case
2. Western Power Pool (WPP), acting as Area Coordinator will forward the data request email to all data representatives in Area 40 - Northwest. The email will also contain a reference case[2] from which the base case will be created. If no changes to the reference case are made by any entity, the reference case will be used to represent Area 40 in the WECC approved base case.
3. Transmission Planning creates a new folder labeled by the case name within the Case Building folder on the shared drive.
4. Documents, files, emails, and notes shall be maintained in electronic format in Microsoft OneNote saved at in an appropriate location. All information should be in printout format, other than aux files, within OneNote. Refer to previously completed cases for examples of information to include.
    a. Create a new page for the case being worked on and copy the case description sheet to this page.
    b. Create a subpage and label it “Pre-run.” Keep all notes and printouts of emails used during the pre-run stage of the process.

[2] A reference case is a previously approved WECC case used as the starting point for the case of interest.

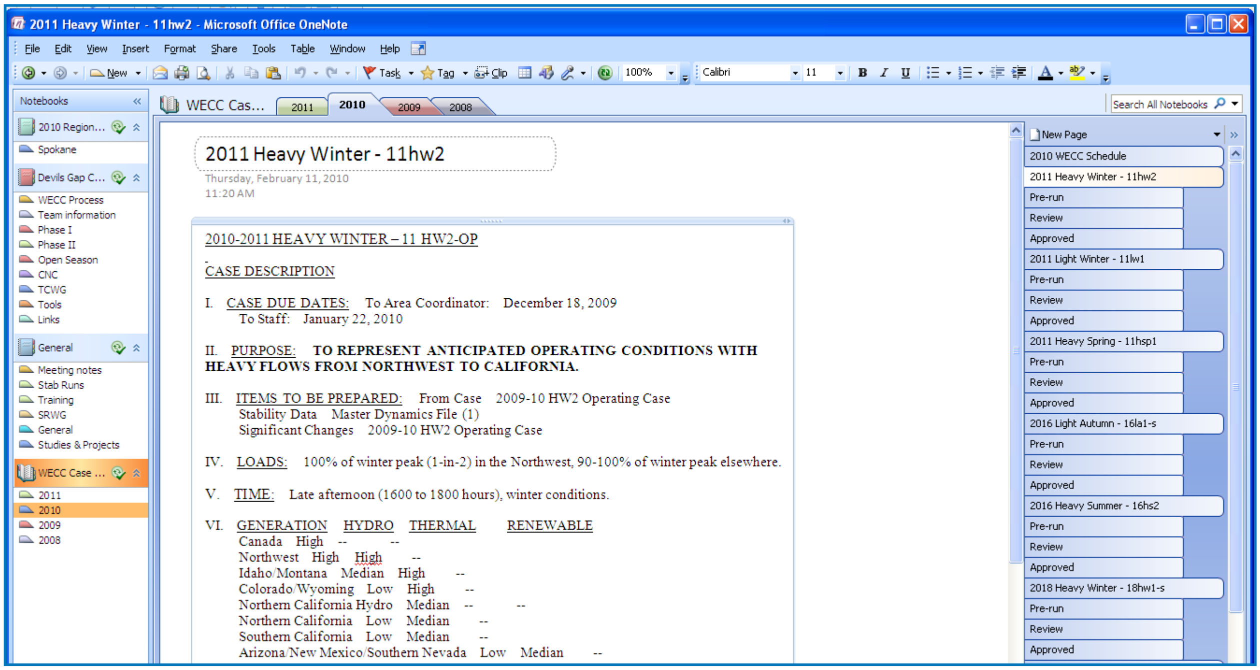

Figure 5: Microsoft OneNote Example

5. Review Data Request Letter from WECC to determine case description and due dates.
6. Save the reference case provided by the Area Coordinator in the new folder. (Download from WPP website through their secure FTP access)
7. Update Reference case with the latest Avista Master topology
    a. Create the Difference Aux
        i. Open the reference case file in PowerWorld
        ii. Set Simulator's base case to the reference case
        iii. Go to the Tools tab, click the Difference Case icon, and choose Set Present as Base
        iv. Open the current Avista Master Case from the Case Building directory on the Transmission Planning drive
        v. Set the Area/Zone filters to change only those facilities within Avista's Zones
        vi. Go to the Difference Case icon and select Present Topological Differences from Base to show what facilities will be Removed/Added/Changed
        vii. At the bottom of the display, click Save To then Complete Model
        viii. From the Confirm Options dialogue, ensure All Lists is selected, click on Use Only Area/Zone/Owner Filters, deselect the Assume base Area/Zones… option, deselect the Include ClearPowerFlowSolutionAidValues Script Command option, choose the Complete Network Model format, and click OK
        ix. Save the export as RefCaseName_AVA_Update.aux
    b. Editing the Difference Aux

i. The exported aux file needs to be edited in a text editor ensuring it does not Add/Remove/Change facilities belonging to another owner, like BPA
ii. With the Master Case still open and showing the Difference Tool, and the newly created aux file open in a text editor (Notepad++ is ideal), look for facility differences that do not belong to Avista and delete the line from the aux file.

8. Set loads to desired levels by doing the following with the Master Case:
   a. Save a copy of the “AVA-[Case Year]-Forecast.xls” Load Forecasting spreadsheet in the Pre-Run folder and open it up.
   b. In the “PowerWorld Sheet” tab, choose the season and year of the case from the dropdown boxes.

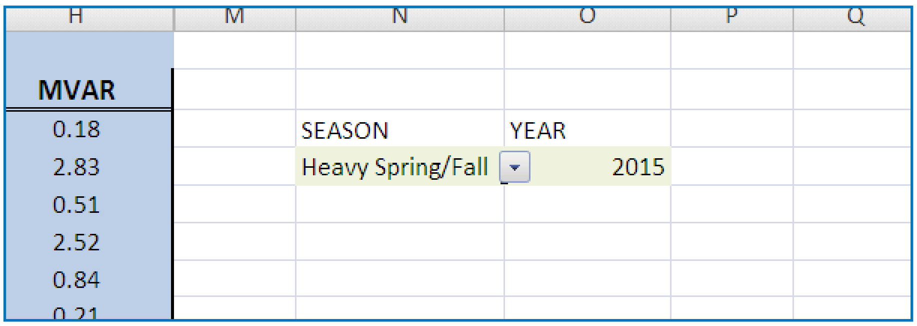

Figure 6: Excel Data Selection Example

   c. Make sure ‘Automatic’ is selected under “Calculation Options” or Excel will not change values to match your selection.
   d. In PowerWorld, go to Model Explorer and open the Load Records tab under the Network folder. Right-click anywhere in the Loads sheet and paste the load data; the location of the right-click is not critical as PowerWorld will recognize the load data being pasted.
   e. Once the loads are pasted into PowerWorld,use the AUX File Export Format Description tool to save the required load information in aux file format for documented record of the load values used to create the WECC base case. Select the “Base Case Submittal Export” format from the dropdown list next to “Name” in the popup window and click the Create AUX File with Specified Format button. Save as “AVA-‘case’-Loads.aux” in the Pre-run folder.

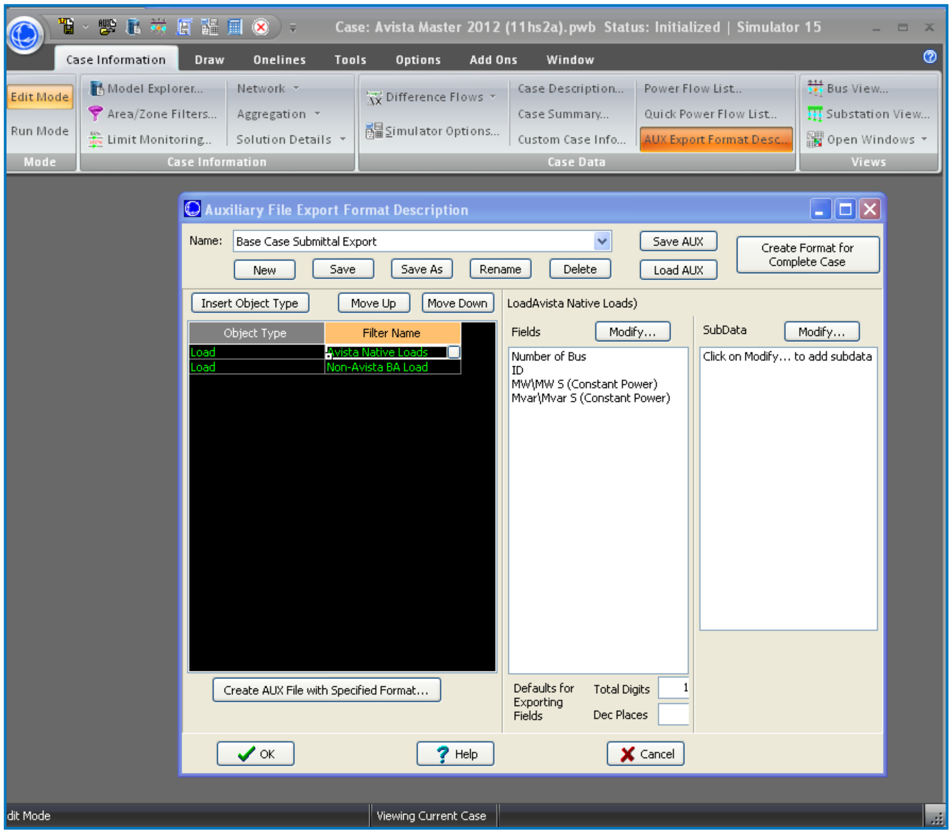

Figure 7: PowerWorld Auxiliary File Export Window

9. Copy WECC_Case-AVA-MasterAux.aux file from the Aux Files folder into case working directory. This file will be used to document all modifications applied to the reference case to create the desired case information which will be submitted to WECC.
10. Open the file for editing and do the following:
    a. Some aux files, like the winter star point changes, may need to be commented for the particular reference case.
    b. Case names, like for the load aux, need to be changed to the working reference case name.
    c. Note the aux files referenced in the MasterAux and copy these files to the Pre-run directory. Presently, the following files should always be included:
        i. Topology fixes
            1. Avista_ReferenceCase_Updates.aux – created above
        ii. Scenario variations
            1. For winter cases, star-point on Devil's Gap – Stratford needs to be moved.
            2. Generator dispatch aux file
            3. Voltage Regulation dispatch aux file
                a. Use Light Summer aux for Heavy Spring cases
            4. Loads aux file created in step 9. (Name will probably need to be changed to correct name so that aux file created will be opened.)

11. Open reference case in PowerWorld and run the WECC_Case-AVA-MasterAux.aux file. Review the PowerWorld log and the resulting case and check the case for errors.
12. Open the Replog.xlsx file and check for Avista issues
13. Reply to Area Coordinator request email. Attach the required aux files and provide description in the email to what the aux files will do. Also provide any guidance on what neighboring data submitters should look for if something specific was noticed. Avista cannot submit any data to the Area Coordinator that is not their responsibility.

10.2. Review Data Submittal

1. WECC will provide an action request email to review a WECC base case prior to it being approved.
2. Create new folder labeled by the case names within the Case Building folder on the share drive.
3. Create a subpage in the case OneNote notebook and label it "Review." Keep all notes and printouts of emails used during the review stage of the process.
4. Download case from WPP FTP site and save in folder above.
5. Open case in PowerWorld.
6. Browse case for errors, desired flows, load, and generation levels, and ensure all changes submitted in the pre-run process were incorporated.
7. If changes are necessary, create an aux file to fix the changes. Test that the file works appropriately in PowerWorld.
8. Have Case Signoff sheets filled out. Scan and save file in the case Review folder. Also copy into OneNote notebook.
9. Send copy of signoff sheets to the Area Coordinator and include description of any desired changes and the necessary files to make the changes.

11. Planning Case Development

Avista Transmission Planning should develop and maintain base cases (Planning Cases) biannually to model its Transmission Planner and Planning Coordinator areas as well as the regional Transmission System. The Planning Cases will be used to perform studies as needed to complete Planning Assessments, Corrective Action Plans, Large Generator Interconnection Requests Studies, and various other studies. The resulting Planning Cases will represent a normal System condition (N-0). The following section provides a guideline for preparing Planning Cases.

1. Use WECC Approved Base Case as starting point.
2. Update topology data for Avista's Planning Coordinator area to reflect most up to date information.
3. Correct any data issues within neighboring Planning Coordinator areas.
4. Set generator dispatch to desired scenario.
5. Set loads to desired values for scenario.

6. Adjust additional Area generation to balance Area slack generator. Changing Area interchange values may be helpful.
7. Review and update voltage control set points for the specific scenario being represented.
8. Load all dynamics data including the most up to date data for Avista's Planning Coordinator area.
9. Load all related contingency data (steady state and transient.)
10. Validate case in the Transient Stability Analysis Tool
    a. Run auto correction. This will correct time step issues among other things. The default time step is 0.5 cycles. Changing the time step from the default will require reloading the dynamics data and re-validating.

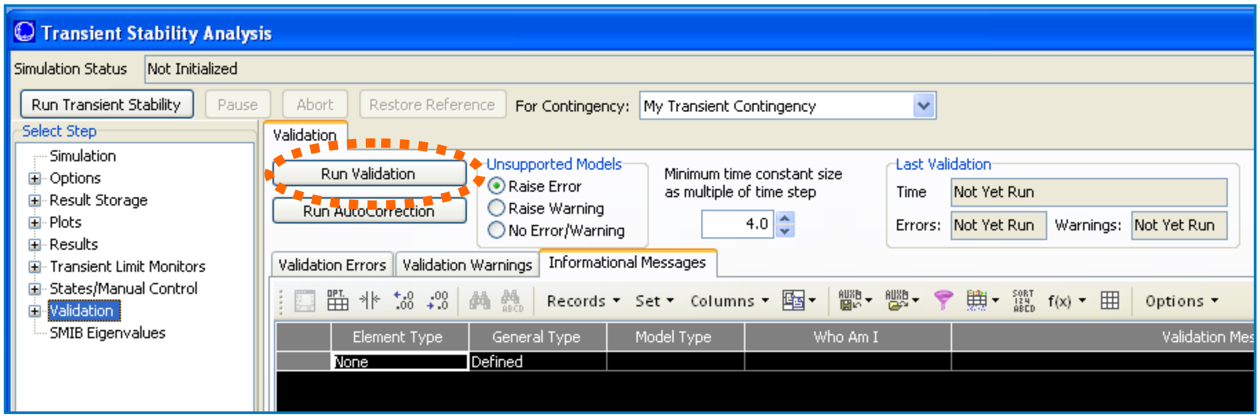

Figure 8: PowerWorld Transient Stability Analysis Validation Control

    b. Check Validation Errors and correct as necessary. Often Governor models show up with errors which can be mitigated by simply turning those models off.
    c. Try running a flat line no disturbance simulation to see if there are modeling issues to be addressed. If the results are not stable, review the Results from RAM – Solution Details. Buses showing mismatch may have models causing problems. Try turning the model off and rerunning simulations.

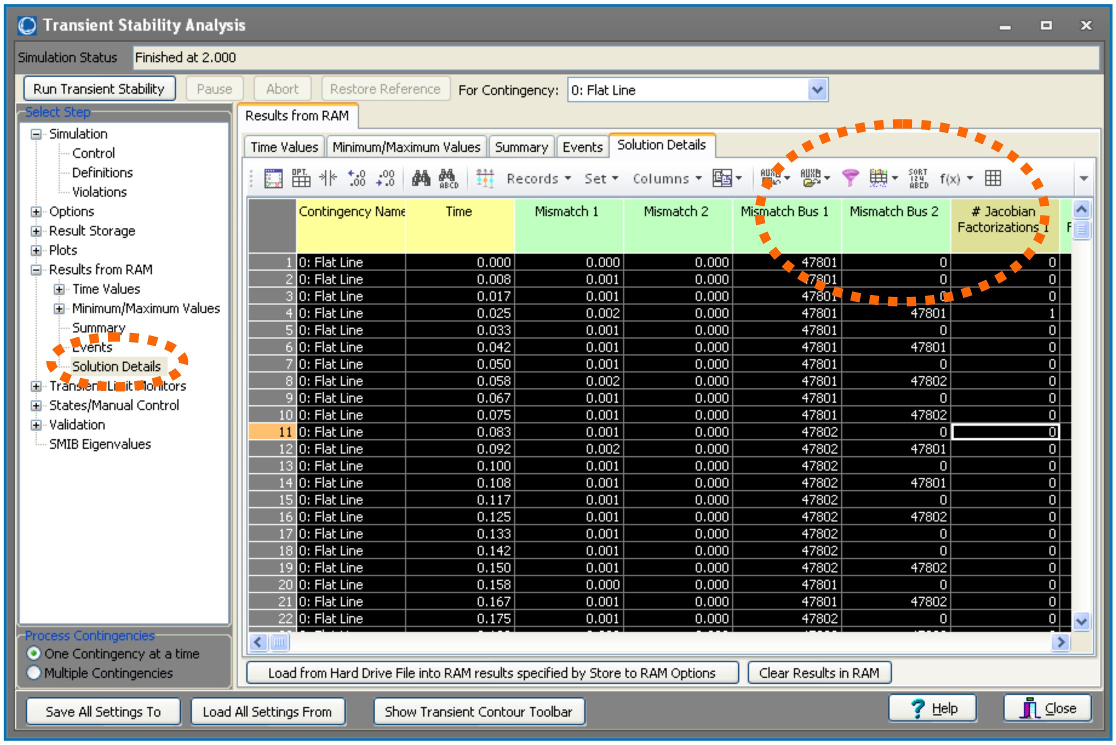

Figure 9: PowerWorld Solution Details Window

11. Document all modifications and additional data used to create the Planning Case in aux files for easy replication of the process.

12. Appendix – Sample Data

12.1. Sample Transformer Test Report

VA TECH Ferranti-Packard de México, S.A. DE C.V Page 1

Report of Transformer Tests

Customer: AVISTA CORPORATION Cust. Order #: 030412 FPT Order # BOULDER SUBSTATION FP S/N: **TP - 542**

Test Date: JUNE 04 - JULY 01. 2004 Cooling: OA / FA1 / FA2 Hz: 60 Phases: 3 Insulating Fluid: OIL Temp rise: 55°C // 65°C

Winding	HIGH VOLTAGE	LOW VOLTAGE	TERTIARY VOLTAGE
MVA	150 / 200 / 250 // 280.0	150 / 200 / 250 // 280.0	33.3 / 44.4 / 55.5 // 62.2
kV	236.5 / 136.543 (Y)	112.75 / 65.096 (Y)	13.80 (Δ)
Taps,OC	±4.65 % in 16 Steps	+4.88 - 5.23 % in 4 Steps	------

Resistance, Exciting Current, Losses and Impedance

Based on normal rating, unless otherwise stated. Losses and regulation are based on wattmeter measurements.

For three-phase transformers the resistances are the sum of the three phases in series.

SERIAL NUMBER	Resistance in ohms at 75°C			% exciting current at 100% rated voltage @MVA: 150	No-load kW at 100% rated voltage 20°C	HV: 236.5 KV LV: 112.75 KV 250.0 MVA		HV: 236.5 KV TV: 13.8 KV 250.0 MVA		LV: 112.75 KV TV: 13.8 KV 250.0 MVA	
	HV (H-X)	LV (X - H0X0)	T.V.			Load loss kW, 75°C	% IZ	Load loss kW, 75°C	% IZ	Load loss kW, 75°C	% IZ
TP-542	0.410514	0.124594	0.039977	0.0508	74.16	267.79	7.01	1919.71	48.04	1856.12	39.03
	Calculated			0.16	73.5	302.08	7.13	2136.60		2098.04	
	Guarantee				**74.0**	**311.11**	**6.8**		**45.0**		**37.0**
	% Regulation at 75°C, H.V. TAP N, L.V. TAP 3				100 % PF			90 % PF		80 % PF	
	150 / 250 MVA, Lagging				0.15 / 0.35			1.96 / 3.35		2.63 / 4.45	

Temperature Rises Average rise in degrees C, corrected to instant of shutdown, with windings connected and loaded as follows, until constant temperature rise was reached.

Winding	kV	MVA	Amperes	Rise of winding by resistance, °C	Guarantee °C	Fluid rise, °C Average	Fluid rise, °C Top	Ambient Temperature, °C Ingoing water	Ambient Temperature, °C Room	Rise	USG/min	Pounds pressure
HV	225.5	150.0	384.05	37.69	55.0	30.17	37.66		25.98			
LV	106.85	150.0	810.51	37.62	55.0	30.17	37.66		26.00			
HV	225.5	280.0	716.89	49.92	65.0	33.41	48.78		29.60			
LV	106.85	280.0	1512.94	50.78	65.0	33.41	48.78		29.98			
TV	13.8	62.2	2602.3	44.06	65.0	33.41	48.78		30.75			

Dielectric Tests

	Winding	Impulse Tests Full wave level kV	Impulse Tests Chopped Wave level kV	Applied Voltage Tests Applied Voltage kV	Applied Voltage Tests Duration (seconds)
Lightning Impulse	H.V.	751.7	825.7	---	---
	L.V.	450.7	495.4	---	---
	H.V. (H0)	150.8	---	---	---
	T.V.	109.8	121.2	---	---
				---	---
Switching Impulse	---	---	---	---	---
	---	---	---	---	---
Applied Voltage	H.V.	---	---	50.0	60.0
	L.V.	---	---	50.0	60.0
	T.V.	---	---	34.0	60.0
		---	---		
		---	---		

Remarks:

I hereby certify that this is a true report based on factory tests made in accordance with the latest transformer test code IEEE Std C57.12.90 of the American National Standards Institute; and that the transformer withstood the above tests.

Signed ______ Test Laboratory Date 25/08/2004 Signed ______ Quality Assurance Date 25/08/2004

Figure 10: Sample Transformer Test Report

12.2. Sample Calculations

$$\text{From test report} \begin{cases} Load\_Loss = 267.79\text{kW} \\ Rated\_MVA = 250\text{MW} \\ Z_{xfmr} = 0.0701\text{pu}_{xfmr} \end{cases} \tag{1}$$

$$Rxfbase = \frac{267.79\text{kW}}{1000 \cdot 250\text{MVA}} = 0.00107\text{pu}_{xfmr} \tag{2}$$

$$Xxfbase = \sqrt{[0.0701\text{pu}_{xfmr}]^2 - 0.00107^2} = 0.07009\text{pu}_{xfmr} \tag{3}$$

$$TapFixedFrom = \frac{236.5kV}{236.5kV} = 1.0000pu_{xfmr}$$

$$TapFixedTo = \frac{115.5kV}{112.75kV} = 1.0244pu_{xfmr} \tag{4}$$

$$TapMinxfbase = \frac{225.5kV}{236.5kV} = 0.9535pu_{xfmr}$$

$$TapMaxxfbase = \frac{247.5kV}{236.5kV} = 1.0465pu_{xfmr} \tag{5}$$

$$TapStepSizexfbase = \frac{(247.5kV - 225.5kV)}{236.5kV \cdot 16} = 0.00581pu_{xfmr} \tag{6}$$