**GIC System Model Procedure Manual ERCOT Public**



GIC System Model Procedure Manual

Version 1

ROS Approved: June 9, 2016

ERCOT *June 9, 2016*

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Document Revisions

|  |  |  |  |
| --- | --- | --- | --- |
| Date | Version | Description | Author(s) |
| 06/09/2016 | Version 1 | First Edition | PGDTF |
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**DRAFT Planning Geomagnetic Disturbance Task Force (PGDTF) Procedure Manual ERCOT Public**

# Purpose

The purpose of the GIC System Model Procedure Manual is to facilitate and guide the development and maintenance of the Geomagnetically Induced Current (GIC) system model which will be used by ERCOT to calculate per phase GICs and Mvar losses for each modeled transformer.

On a periodic basis, the Planning Geomagnetic Disturbance Task Force (PGDTF) will review this manual for needed updates. Any member of the PGDTF can submit proposed changes. The PGDTF will strive to develop consensus on the proposed changes. If consensus cannot be achieved, alternative proposed changes will be developed with an explanation of the alternatives and will be provided to the Reliability and Operations Subcommittee (ROS) for its consideration. A red-lined version and a final version will be provided to the ROS for its review and approval.

# Definitions and Acronyms

In the event of a conflict between any definitions or acronyms included in this manual and any definitions or acronyms established in the ERCOT Protocols, the definitions and acronyms established in the ERCOT Protocols take precedence.

* 1. **Definitions**

GMD Geomagnetic Disturbance (GMD) is a geomagnetic storm caused by Coronal Mass Ejection (CME), which are associated with enormous changes and disturbances in the coronal [magnetic field](https://en.wikipedia.org/wiki/Magnetic_field) of the Sun. If CMEs contact the Earth, they create a disruption in the Earth’s magnetic field. GMDs have the potential to impact the power grid. This is due to GMD-related changes in the Earth’s magnetic field inducing quasi-dc electric fields in the earth (with frequencies usually much below 1 Hz) with the electric field’s magnitude and direction GMD event dependent. These electric fields in-turn cause Geomagnetically Induced Currents (GICs) in the high voltage grid. These quasi-dc currents can then cause half cycle saturation in the power transformers, resulting in increased transformer reactive power losses.

IDEV A script file recognized by the PSS®E application used for transporting and applying network model changes in PSS®E.

* 1. **Acronyms**

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dc Direct Current

EPPRE ERCOT-prescribed process applicable to Resource Entities that defines the method of data submittal for Resource Entities.

IMM Information Model Manager

PAR Phase Angle Regulator

PGDTF Planning Geomagnetic Task Force USGS United States Geological Survey

# Data Requirements for GIC System Model

* 1. **General**
		1. **Software**

PSS®E will be used by ERCOT to build the GIC system models. Models will not be created in any other format by ERCOT. The PSS®E version used will follow the version used by the Steady State Working Group with the exception of using PSS®E 34 for initial model build.

* + 1. **GIC System Model – General**

ERCOT shall provide a workbook to TSPs for the submission of data for the GIC system model. TSPs shall provide the GIC system model data to ERCOT using the provided workbook as shown in Appendix B by the schedule published by the PGDTF.

For the 200 kV system and above, actual data should be used for the GIC system model. Typical data based upon actual data can be used if actual data is not available.

For the 69 kV and 138 kV systems, actual data should be used for the GIC system model to the extent possible. Typical data based upon actual data can be used if actual data is not available. Default data as specified by this Procedure Manual can be used if actual or typical data is not reasonably available.

The PGDTF will select the latest update to the SSWG base cases, updated if required to reflect known and significant changes, to be used as the starting base cases for the GIC system model as listed below.

* + - * The System Peak case will be represented by the SSWG three year out Summer Peak case.
			* The Off-peak case will be represented by the three year out SSWG MIN case.

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Series capacitors are used in the bulk power system to re-direct power flow and improve system stability. Series capacitors present very high impedance to the flow of GIC. NERC has recommended two modeling methods in their GIC application guide: model the series capacitor with a very large resistance such as 1 megohm (MΩ); or remove the line segment representing the series capacitor from the model completely. In the ERCOT GIC system model, the PGDTF has decided to use the 1 MΩ method for all series capacitors.

* 1. **Substation Data**

The format for the Substation Data record is shown in Appendix B. This Substation Data record will be provided by the facility owner.

|  |  |  |
| --- | --- | --- |
| **Field** | **Description** | **Source** |
| Substation | Station Number – A unique station numbering system separate but similar to the bus numbering system. | TSPs will model station/bus relationship for their facilities in accordance withAppendix A.ERCOT will model station/bus relationship for Resource Entity (RE) facilities in accordance with Appendix A. |
| List of Buses | Comma separated list of Bus Numbers that belong in this station. | TSPs will model station/bus relationship for their facilities in accordance withAppendix A.ERCOT will model station/bus relationship for RE facilities in accordance with Appendix A. |
| NAME | Station Name | ERCOT will provide long or short name for RE stations.TSPs will provide long or short name for their stations. |
| LATITUDE | Station Latitude in degrees | ERCOT will provide for RE stations.TSPs will provide this data for their stations. |
| LONGITUDE | Station Longitude in degrees | ERCOT will provide for RE stations.TSPs will provide this data for their stations. |
| RG | Substation dc grounding resistance (ohms) for stationswith high side wye grounded transformers and shunt reactors. | ERCOT will provide for RE stations.TSPs will provide this data for their stations. |
| EARTH MODEL | Name of the Earth Model | EARTH MODEL is USGS standard earth |

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|  |  |  |
| --- | --- | --- |
| (v34) |  | conductivity models available at USGS’swebsite<http://geomag.usgs.gov/conductivity/>. |

* 1. **Transformer Data Including Generator Step-Up (GSU)**

The format for the Transformer Data is shown in Appendix B.

The transformer specified by buses BUSI, BUSJ, BUSK and CKT must exist in power flow data. Also the winding bus order must be same as in power flow data.

|  |  |  |
| --- | --- | --- |
| **Field** | **Description** | **Source** |
| BUSI | The bus number of the bus to which Winding 1 is connected. It must be same Winding 1 bus for the same transformer power flowdata. No default allowed. | This number comes from SSWG base case. |
| BUSJ | The bus number of the bus to which Winding 2 is connected. It must be same Winding 2 bus for the same transformer power flow data. No default allowed. | This number comes from SSWG base case. |
| BUSK | The bus number of the bus to which Winding3 is connected. It must be same Winding 3 bus for the same transformer power flow data. No default allowed. | This number comes from SSWG base case. |
| CKT | One- or two-character non-blank alphanumeric circuit identifier | This comes from SSWG base case. |
| WRI | dc resistance of Winding 1 in ohms/phase. WRI = 0.0 by default. When WRI is not specified, power flow data resistance is used to determine WRI. | REs will provide thisvalue through EPPRE, and TSPs will provide this value through the workbook. |
| WRJ | dc resistance of Winding 2 in ohms/phase. WRJ = 0.0 by default. When WRJ is not specified, power flow data resistance is used to determine WRJ. | REs will provide this value through EPPRE, and TSPs will providethis value through theworkbook. |
| WRK | dc resistance of Winding 3 in ohms/phase. WRK = 0.0 by default. When WRK is not specified, power flow data resistance is used to determine WRK. | REs will provide this value through EPPRE, and TSPs will provide this value through the |

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|  |  |  |
| --- | --- | --- |
|  |  | workbook. |
| GICBDI | GIC blocking device in neutral of Winding 1.= 0, no GIC blocking device present= 1, GIC blocking device presentFor an autotransformer, if either GICBDI=1 or GICBDJ=1, thatautotransformer is treated as it has GIC blocking device present.GICBDI = 0 by default. | REs will provide this value through EPPRE, and TSPs will provide this value through the workbook. |
| GICBDJ | GIC blocking device in neutral of Winding 2.= 0, no GIC blocking device present= 1, GIC blocking device presentFor an autotransformer, if either GICBDI=1 or GICBDJ=1, thatautotransformer is treated as it has GIC blocking device present.GICBDJ = 0 by default. | REs will provide this value through EPPRE, and TSPs will provide this value through the workbook. |
| GICBDK | GIC blocking device in neutral of Winding 3.= 0, no GIC blocking device present= 1, GIC blocking device present GICBDK = 0 for two winding transformers GICBDK = 0 by default. | REs will provide this value through EPPRE, and TSPs will provide this value through the workbook. |
| VECGRP | Alphanumeric identifier specifying vectorgroup based on transformerwinding connections and phase angles. VECGRP is 12 blanks by default.If vector group is specified in power flow data that data will be usedand it is not needed to be specified here. As far as GIC calculationsare concerned, winding grounding connection information is used; its clock angles are not used.* Specify VECGRP considering the winding order I, J, K defined on this record.
* For autotransformers, bus with lower base bus voltage is treated as

common winding bus.* For three winding autotransformers, windings on bus I and bus J form autotransformer.

Winding connection designations | REs will provide this value through EPPRE, and TSPs will provide this value through the workbook. |

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|  |  |  |
| --- | --- | --- |
|  | * First Symbol: for High Voltage: Always capital letters. D=Delta, Y=Wye, Z=Interconnected star, N=Neutral
* Second Symbol: for Low voltage: Always Small letters. d=Delta, y=wye, z=Interconnected star, n=Neutral.
* Third Symbol: Phase displacement expressed as the clock hour number (1,6,11)
* 0 =0° that the LV phasor is in phase with the HV phasor
* 1 =30° lagging (LV lags HV with 30°) because rotation is anti-clockwise.
* 11 = 330° lagging or 30° leading (LV leads HV with 30°)
* 5 = 150° lagging (LV lags HV with 150°)
* 6 = 180° lagging (LV lags HV with 180°)

Steps for finding vector group in PSS®E:1. Open PSS®E.
2. Open a case.
3. Select Branch tab and then select “**2- Winding**” or “**3-Winding tab**”.
4. Right Click on the transformer that you would like to add vector group to.
5. Select “**Network Data Record**” from pop-up.
6. Click the “**…**” button next to the Vector Group blank.
7. Fill in transformer data in the pop-up screen and click “**OK**”.
8. PSS®E will fill in the vector group blank with correct notation.
 |  |
| CORE | Number of cores in transformer core design. This information is used to calculate transformer reactive power loss from GIC flowing its winding.= -1 for three phase shell form= 0 for unknown core design | REs will provide this value through EPPRE, and TSPs will provide this value through the workbook. |

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|  |  |  |
| --- | --- | --- |
|  | = 1 for single core design= 3 for three phase 3-legged core form= 5 for three phase 5-legged core form CORE = 0 by default |  |
| KFACTOR | A factor to calculate transformer reactive | REs will provide this |
| power loss from GIC flowing in its winding |
| (Mvar/Ampere). KFACTOR = 0.0 by default. |
| KFACTOR is obtained from the |
| manufacturer of the transformer. If the |
| manufacturer transformer KFACTOR is not |
| available, the default KFACTOR = 0.0 is |
| specified. |
| If KFACTOR = 0.0, then the below |
| KFACTORS are used by the program: |
| For known transformer core designs the |
| following KFACTORs are used by the |
| program: | value through EPPRE, |
| Three Phase Shell Form – 0.3300 | and TSPs will provide |
| Single Phase (Separate Cores) – 1.1800 | this value through the |
| Three Phase 3-Legged – 0.2900 | workbook. |
| Three Phase 5-Legged – 0.6600 |
| Three Phase 7-Legged – 0.6600 |
| For unknown core designs: |
| Windings Highest Voltage |
| KFACTOR |
| Unknown core, <= 200 kV |
| 0.6 |
| Unknown core, > 200 kV and <= 400 kV |
| 0.6 |
| Unknown core, > 400 kV |
| 1.1 |
| GRDRI | Winding 1 grounding dc resistance in ohms. GRDRI = 0.0 by default (no grounding resistance). | REs will provide thisvalue through EPPRE, and TSPs will provide this value through the workbook. |
| GRDRJ | Winding 2 grounding dc resistance in ohms. | REs will provide this |

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|  |  |  |
| --- | --- | --- |
|  | GRDRJ = 0.0 by default (no grounding resistance). | value through EPPRE, and TSPs will provide this value through the workbook. |
| GRDRK | Winding 3 grounding dc resistance in ohms. GRDRK = 0.0 by default (no grounding resistance). | REs will provide thisvalue through EPPRE, and TSPs will provide this value through the workbook. |
| TMODEL | Transformer Model in GIC dc Network= 0, two and three winding and autotransformer model as defined by its vector group= 1, Transformer as T model in dc network. TMODEL = 0 by default.TMODEL = 1 only for Phase Angle Regulator (PAR) connections where series winding has split tap which is represented as T model in GIC calculation dc network. | REs will provide this value through EPPRE, and TSPs will provide this value through the workbook. |

* 1. **Bus Fixed Shunt (Shunt Reactor) Data**

The format for the Bus Fixed Shunt Reactor Data is shown in Appendix B.

Only in-service bus fixed shunt reactors connected to transmission level substation buses are modeled in GIC dc network. Shunt reactors connected to an autotransformer tertiary winding are magnetically de-coupled from the GIC flow occurring in the transmission system, and should be excluded. All reactor bank data must be submitted in fixed shunt format.

|  |  |  |
| --- | --- | --- |
| **Field** | **Description** | **Source** |
| BUS | Bus number of the bus to which shunt reactor isconnected. It must be present in power flow network data. No default allowed. | This number comes from SSWG base case. |
| ID | One- or two-character non-blank alphanumeric shunt reactor identifier | This value comes from SSWG base case. |
| RFXSH | dc resistance in ohms/phase. It must be > 0. No default allowed. Bus shunt reactor records with R=0 will be ignored. | REs will provide this value through EPPRE, and TSPs will provide this value through the workbook. |
| RGRDFXSH | Grounding dc resistance in ohms. RG = 0.0 by default (no grounding resistance) | REs will provide thisvalue through EPPRE, and TSPs |

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will provide this value through the workbook.

* 1. **Transmission Line Models**

The format for Branch Data (v34) is shown in Appendix B. Using PSS®E’s conversion of branch resistances from SSWG base case to dc resistances for the GIC system model is acceptable.

|  |  |  |
| --- | --- | --- |
| **Field** | **Description** | **Source** |
| BUSI | Branch from bus number. No default allowed. | This number comes from SSWG base case. |
| BUSJ | Branch to bus number. No default allowed. | This number comes from SSWG base case. |
| CKT | One- or two-character non-blank alphanumeric branch circuit identifier | This value comes from SSWG base case. |
| RBRN | Branch dc resistance in ohms/phase. RBRN = 0.0 by default. When RBRN is not specified or RBRN=0.0, power flow data branch resistance is used as is. As stated in above, in the ERCOT GIC system model, use the 1 megaohm method for all series capacitors (RBRN = 1,000,000). | REs will provide this value if available through EPPRE, and TSPs will provide this value if availablethrough the workbook. |
| INDVP | Real part of total branch GMD induced electric field in volts. | REs will provide this value if available through EPPRE, and TSPs will provide this value if availablethrough the workbook. |
| INDVQ | Imaginary part of total branch GMD induced electric field in volts. | REs will provide this value if available through EPPRE, and TSPs will provide this value if availablethrough the workbook. |

* 1. **User Earth Model Data**

The USGS Earth Model entered in the Substation Data tab generally should be used and no entry is required in this tab. If the USGS Earth Model is not desired, then a new user Earth Model can be created using this tab and entered on the Substation Data tab.

A total of up to 50 user earth models are allowed. Also, each earth model may have up to 25 layers. Use as many records needed to specify the data. The thickness of

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the last layer is infinity. This is specified as any value less than 0.0 (=-999.0 for example). The thickness value less than 0.0 is also used as end of earth model data.

The format for Earth Model Data (v34) is shown in Appendix B.

|  |  |  |
| --- | --- | --- |
| **Field** | **Description** | **Source** |
| NAME | NAME may be up to 12 characters. This name should be different than the Standard US and Canada Earth Models. No default allowed. | REs willprovide this value through EPPRE, and TSPs will provide this value through the workbook. |
| BETA FACTER | Earth Model scaling factor used when calculating branch induced electric field for Benchmark GMD event. BETAFTR=1 by default | REs willprovide this value through EPPRE, and TSPs will provide this value through the workbook. |
| DESCRIPTION | Description of the earth model. NAME maybe up to 72 characters. This is for information purpose only. DESC = “ by default | REs willprovide this value through EPPRE, and TSPs will provide this value through the workbook. |
| RESISTIVITY LAYER 1 | Layer 1 Resistivity in ohm-m. No default allowed. | REs willprovide this value through EPPRE, and TSPs will provide this value through the workbook. |
| THICKNESS LAYER 1 | Layer 1 Thickness in km. No default allowed. | REs willprovide this value through EPPRE, and TSPs will provide this value through the workbook. |

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|  |  |  |
| --- | --- | --- |
| RESISTIVITY LAYER n | Nth Layer Resistivity in ohm-m. No default allowed. Up to 25 layers are allowed. Repeat for multiple layers. | REs willprovide this value through EPPRE, and TSPs will provide this value through the workbook. |
| THICKNESS LAYER n | Nth Layer Thickness in km. No default allowed. Up to 25 layers are allowed. Repeat for multiple layers. | REs willprovide this value through EPPRE, and TSPs will provide this value through the workbook. |

The thickness of the last layer is infinity. This is specified as any value less than 0 (= -999.0 for example).

# Model Refinements

* 1. **Maintenance of GIC System Model (IMM, Workbook and EPPRE)**

The input data from REs is submitted to ERCOT through the EPPRE which will be stored and maintained in NMMS (IMM). The input data from TSPs is submitted to ERCOT using the designated workbook shown in Appendix B provided by ERCOT. Based on the PGDTF selected SSWG base cases and the input data from REs and TSPs, ERCOT, in conjunction with the PGDTF, will develop new GIC system models. ERCOT will deliver the new GIC system models including the \*.sav and \*.GIC files to all TSPs by posting them on the ERCOT MIS Certified Transmission Service Provider Information page. TSPs will review the GIC system models, and may submit any modifications in the approved format (PSS®E) to ERCOT if necessary. ERCOT is responsible for the maintenance of GIC system models and GIC input files, and will deliver the change files (\*.idv) to all TSPs through email and by posting them on the ERCOT MIS Secure Area.

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# Appendix A - Station Number Range

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **STATION****RANGE** | **TSP** | **ACRONYM** | **MODELING****ENTITY** | **PSS®E****AREA NO** |
| 1 - 799 | **BRAZOS ELECTRIC POWER COOP.** | TBREC | TBREC | 11 |
| 33000 - 36999 |
| 32050 - 32999 | **BRYAN, CITY OF** | TBTU | TBTU | 22 |
| 900 - 934 | **DENTON MUNICIPAL UTILITIES,****CITY OF** | TDME | TDME | 19 |
| 800 - 899 | **GARLAND, CITY OF** | TGAR | TGAR | 20 |
| 935 - 955 | **GREENVILLE ELECTRIC UTILITY****SYSTEM** | TGEUS | TGEUS | 21 |
| 956 - 999 | **TEXAS MUNICIPAL POWER AGENCY** | TTMPA | TTMPA | 12 |
| 9500 - 9699 |
| 1000 - 4999 | **ONCOR** | TONCOR | TONCOR | 1 |
| 10000 - 31999 |
| 32000 - 32049 | **COLLEGE STATION, CITY OF** | TCOLGS | TCOLGS | 23 |
| 37000 - 39999 | **TEXAS NEW MEXICO POWER CO.** | TTNMP | TTNMP | 17 |
| 40000 - 49999 | **CENTERPOINT** | TCNPE | TCNPE | 4 |
| 5000 - 5499 | **CPS ENERGY** | TCPSE | TCPSE | 5 |
| 50000 - 54999 |
| 5500 - 5899 | **SOUTH TEXAS ELECTRIC COOP** | TSTEC | TSTEC | 13 |
| 55000 - 58999 |
| 5910 - 5919 | **SOUTH TEXAS POWER PLANT** | TCNPE | TCNPE | 10 |
| 7000 – 789970000 - 78999 | **LCRA TRANSMISSION SERVICES****CORPORATION (TSC)** | TLCRA | TLCRA | 7 |
| In TLCRA | **BANDERA ELECTRIC COOP** | TBDEC | TLCRA |  |
| In TLCRA | **BLUEBONNET ELECTRIC COOP** | TBBEC | TLCRA |  |
| In TLCRA | **CENTRAL TEXAS ELECTRIC COOP** | TCTEC | TLCRA |  |
| In TLCRA | **GUADALUPE VALLEY ELECTRIC****COOP** | TGVEC | TLCRA |  |
| In TLCRA | **NEW BRAUNFELS UTILITIES** | TNBRUT | TLCRA |  |
| In TLCRA | **PEDERNALES ELECTRIC COOP** | TPDEC0 | TLCRA |  |
| In TLCRA | **SAN BERNARD ELECTRIC COOP** | TSBEC | TLCRA |  |
| 79000-79499 | **CROSS TEXAS TRANSMISSION** | TCROS | TCROS | 30 |
| 8000 – 899980000 - 89999 | **AMERICAN ELECTRIC POWER - TCC** | TAEPTC | TAEPTC | 8 |
| 79500-79699 | **SHARYLAND** | TSLND1 | TSLND1 | 18 |
| 9000 – 939990000 - 93999 | **AUSTIN ENERGY** | TAEN | TAEN | 9 |
| 5920 - 5929 | **EAST HIGH VOLTAGE DC TIE** |  | TAEPTC | 16 |
| 5930 - 5989 | **PUBLIC UTILITY BOARD OF BROWNSVILLE** | TBPUB | TBPUB | 15 |
| 59300 - 59899 |
| 59900 - 59999 | **WIND ENERGY TRANSMISSION****TEXAS** | WETT | WETT | 29 |
| 6000 - 6699 | **AMERICAN ELECTRIC POWER- TNC** | TAEPTN | TAEPTN | 6 |
| 60000 - 67999 |
| 69000 - 69999 |
| In TAEPTN | **COLEMAN COUNTY ELECTRIC****COOP** | TCOLMN | TGSEC | 25 |
| In TAEPTN | **CONCHO VALLEY ELECTRIC COOP** | TCVEC2 | TGSEC | 25 |
| In TAEPTN | **RIO GRANDE ELECTRIC COOP** | TRGEC1 | AEPTN |  |
| In TAEPTN | **SOUTHWEST TEXAS ELECTRIC****COOP** | TSWEC1 | TGSEC | 25 |
| In TAEPTN | **TAYLOR ELECTRIC COOP.** | TECX | TGSEC | 25 |
| 6096 - 6096 | **NORTH HIGH VOLTAGE DC** |  | AEPTN | 14 |

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **STATION RANGE** | **TSP** | **ACRONYM** | **MODELING ENTITY** | **PSS®E AREA NO** |
| 6700 - 6749 | **TEX-LA ELECTRIC COOP** | XTEXLA | TEXLATSP | 3 |
| 6800 - 6949 | **RAYBURN COUNTRY ELECTRIC****COOP** | TRAYBN | TRAYBN | 2 |
| In TRAYBN | **GRAYSON COUNTY ELECTRIC****COOP** | TGEC | TRAYBN | 2 |
| In TRAYBN | **LAMAR ELECTRIC COOP** | TLAHOU | TRAYBN | 2 |
| In TRAYBN | **FARMERS ELECTRIC COOP** | TFECE | TRAYBN | 2 |
| In TRAYBN | **TRINITY VALLEY ELECTRIC COOP** | TTRINY | TRAYBN | 2 |
| In TRAYBN | **FANNIN COUNTY ELECTRIC****COOPERATIVE** | TFCEC | TRAYBN | 2 |
| N/A | **GOLDENSPREAD ELECTRIC COOP** | TGSEC | TGSEC | 25 |
| IN TAEPTN | **LIGHTHOUSE ELECTRIC COOP** | TLHEC | TGSEC | 25 |
| 68000 - 68999 | **LONE STAR TRANSMISSION** | TLSTR | TLSTR | 27 |
| 9400-9450 | **LYNTEGAR ELECTRIC COOP** | TLYEC | TGSEC | 25 |
| 9451-9470 | **TAYLOR ELECTRIC COOP** | TTAYLEC | TGSEC | 25 |
| 9471-9490 | **BIG COUNTRY ELECTRIC COOP** | TBCEC1 | TGSEC | 25 |
| 9491-9499 | **CITY OF GOLDSMITH** | TGOLDS | TGOLDS | 26 |
| 9700 – 9999 | **ERCOT** | TERCOT | TERCOT | 900 - 999 |
| 94000 – 99999 |
| 100000 -199999 |
| In TAEPTC | **RIO GRANDE ELECTRIC COOP** | TRGEC2 | TRGEC2 |  |
| 600-601 | **BRIDGEPORT ELECTRIC** | TBRIDG | TBTU |  |

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# Appendix B – Data Entry Templates

## SUBSTATION DATA ENTRY TEMPLATE

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Substation Data and Bus Groups |  |  |  |  |  |  |
| Notes | (1) Edit/Change data items Name, Latitude, Longitude, Rg and Comment. |  |  |  |  |
|  | (2) Edit/Specify only known data item values. |  |  |  |  |  |
|  | (3) For data items with allowed default value, blank (not specified) value will be asigned as default value in PSSE GIC module. |
|  | (4) Do NOT change format of the worksheet. |  |  |  |  |  |
|  |  | No default | No default | No default | 0.1 | No default | <--- Default Values |  |  |
| Substation | List of Buses | Name | Latitude (deg) | Longitude(deg) | Rg(ohm) | Earth Model | Comment |  |  |
| 1 | 1, 2 |  |  |  |  |  |  |  |  |
| 2 | 3, 4 |  |  |  |  |  |  |  |  |
| 3 | 5, 20 |  |  |  |  |  |  |  |  |
| 4 | 6, 7, 8 |  |  |  |  |  |  |  |  |
| 5 | 12, 13, 14 |  |  |  |  |  |  |  |  |
| 6 | 15, 16 |  |  |  |  |  |  |  |  |
| 7 | 17, 18, 19 |  |  |  |  |  |  |  |  |
| 8 | 11 |  |  |  |  |  |  |  |  |

**TRANSFORMER DATA ENTRY TEMPLATE**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Transformer Data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Notes | (1) Edit/Change data items WRI, WRJ, WRK, CKT, GICBDI, GICBDJ, GICBDK, VECGRP, CORE, KFACTOR, GRDRI, GRDRJ, GRDRK, TMODEL and Comment. |  |  |  |  |  |  |
|  | (2) Edit/Specify only known data item values. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | (3) When wri, wrj and wrk are not specified, they are calculated from transformer AC resistance values in power flow data. |  |  |  |  |  |  |  |  |
|  | (4) For data items with allowed default value, blank (not specified) value will be asigned as default value in PSSE GIC module. |  |  |  |  |  |  |  |  |
|  | (5) Do NOT change format of the worksheet. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | from Rac | from Rac | from Rac | 0 | 0 | 0 | No default | 0 | 0 | 0 | 0 | 0 | 0 | <--- Default Values |
| BUSI | BUSJ | BUSK | CKT | WRI (ohm/ph) | WRJ (ohm/ph) | WRK (ohm/ph) | GICBDI | GICBDJ | GICBDK | VECGRP | CORE | KFACTOR | GRDRI (ohm) | GRDRJ (ohm) | GRDRK (ohm) | TMODEL | Comment |  |
| 2 | 1 | 0 | 1 |  |  |  |  |  |  | YNd1 |  |  |  |  |  |  | T1 |  |
| 4 | 3 | 0 | 1 |  |  |  |  |  |  | YNyn0 |  |  |  |  |  |  | T2 |  |
| 4 | 3 | 0 | 2 |  |  |  |  |  |  | YNa0 |  |  |  |  |  |  | T12 |  |
| 4 | 3 | 0 | 3 |  |  |  |  |  |  | YNyn0 |  |  |  |  |  |  | T13 |  |
| 4 | 3 | 0 | 4 |  |  |  |  |  |  | YNa0 |  |  |  |  |  |  | T14 |  |
| 5 | 20 | 0 | 1 |  |  |  |  |  |  | YNyn0 |  |  |  |  |  |  | T8 |  |
| 5 | 20 | 0 | 2 |  |  |  |  |  |  | YNyn0 |  |  |  |  |  |  | T9 |  |
| 6 | 7 | 0 | 1 |  |  |  |  |  |  | YNd1 |  |  |  |  |  |  | T6 |  |
| 6 | 8 | 0 | 1 |  |  |  |  |  |  | YNd1 |  |  |  |  |  |  | T7 |  |
| 12 | 13 | 0 | 1 |  |  |  |  |  |  | YNd1 |  |  |  |  |  |  | T10 |  |
| 12 | 14 | 0 | 1 |  |  |  |  |  |  | YNd1 |  |  |  |  |  |  | T11 |  |
| 16 | 15 | 0 | 1 |  |  |  |  |  |  | YNa0 |  |  |  |  |  |  | T5 |  |
| 15 | 16 | 0 | 2 |  |  |  |  |  |  | YNa0 |  |  |  |  |  |  | T15 |  |
| 17 | 18 | 0 | 1 |  |  |  |  |  |  | YNd1 |  |  |  |  |  |  | T3 |  |
| 17 | 19 | 0 | 1 |  |  |  |  |  |  | YNd1 |  |  |  |  |  |  | T4 |  |

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## FIXED SHUNT DATA ENTRY TEMPLATE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Bus Fixed Shunt Data |  |  |  |
| Notes | (1) Edit/Change data items BUS, ID, RFXSH, RGRDFXSH and Comment. |  |
|  | (2) Edit/Specify only known data item values. |  |  |
|  | (3) No default fixed shunts considered. Specify needed in-service fixed shunts. |
|  | (4) Do NOT change format of the worksheet. |  |  |
|  |  | No default | 0 | <--- Default Values |  |
| BUS | ID | RFXSH (ohm/ph) | RGRDFXSH (ohm) | Comment |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

**BRANCH DATA ENTRY TEMPLATE**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Branch Data |  |  |  |  |  |  |  |  |  |
| Notes | (1) Edit/Change data items BUSI, BUSJ, CKT, RBRN, INDUCEDV and Comment. |  |  |  |  |  |  |
|  | (2) Edit/Specify only known data item values. |  |  |  |  |  |  |  |
|  | (3) When RBRN is not specified, branch AC resistance from power flow data is used. |  |  |  |  |  |
|  | (4) Branch GMD Induced Electric Field, INDUCEDV = INDVP + j INDVQ. |  |  |  |  |  |  |
|  | (5) When INDUCEDV is not specified, GIC activity calculates it according to GMD event specified. |  |  |  |  |
|  | (6) When INDUCEDV is specified, it is used as GMD induced electric field on that branch. |  |  |  |  |
|  | (7) When INDVP=INDVQ=0.0, that branch is treated as underground cable, part of DC network but does not have GMD induced electric field. |
|  | (8) INDUCEDV is specified in volts. This is a voltage with positive polarity at BUSJ (To Bus). |  |  |  |  |
|  | (9) BUSI and BUSJ order should match that in PSSE power flow data. |  |  |  |  |  |  |
|  | (10) Do NOT change format of the worksheet. |  |  |  |  |  |  |  |
|  |  |  | from Rac | No default | No default | <--- Default Values |  |  |  |  |
| BUSI | BUSJ | CKT | RBRN (ohm/ph) | INDVP (V) | INDVQ (V) | Comment |  |  |  |  |  |
| 2 | 3 | 1 |  |  |  |  |  |  |  |  |  |
| 2 | 17 | 1 |  |  |  |  |  |  |  |  |  |
| 4 | 5 | 1 |  |  |  |  |  |  |  |  |  |
| 4 | 5 | 2 |  |  |  |  |  |  |  |  |  |
| 4 | 6 | 1 |  |  |  |  |  |  |  |  |  |
| 4 | 15 | 1 |  |  |  |  |  |  |  |  |  |
| 5 | 6 | 1 |  |  |  |  |  |  |  |  |  |
| 5 | 11 | 1 |  |  |  |  |  |  |  |  |  |
| 6 | 11 | 1 |  |  |  |  |  |  |  |  |  |
| 6 | 15 | 1 |  |  |  |  |  |  |  |  |  |
| 6 | 15 | 2 |  |  |  |  |  |  |  |  |  |
| 11 | 12 | 1 |  |  |  |  |  |  |  |  |  |
| 16 | 17 | 1 |  |  |  |  |  |  |  |  |  |
| 16 | 20 | 1 |  |  |  |  |  |  |  |  |  |
| 17 | 20 | 1 |  |  |  |  |  |  |  |  |  |

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## EARTH MODEL DATA ENTRY TEMPLATE

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | User Earth Model Data |  |  |  |  |  |  |
| Notes | (1) Provide each Earth Model Data columnwise and from column B. |  |  |
|  | (2) The thickness of the last layer is infinity. Specify this as any number less than 0. |  |
|  | (3) The numbers of layers allowed for each earth model are 25 or less. |  |  |
|  | (4) Model name should be unique and upto 12 characters. |  |  |  |
|  | (5) Model name should be different than standard model names defined in PSSE GIC Module. |
|  | (6) Do NOT change format of the worksheet. |  |  |  |  |
| NAME |  |  |  |  |  |  |  |  |  |
| BETA FACTOR |  |  |  |  |  |  |  |  |  |
| DESCRIPTION |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 1 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 1 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 2 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 2 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 3 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 3 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 4 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 4 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 5 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 5 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 6 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 6 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 7 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 7 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 8 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 8 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 9 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 9 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 10 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 10 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 11 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 11 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 12 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 12 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 13 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 13 |  |  |  |  |  |  |  |  |  |
| Resistivity (ohm-m) Layer 14 |  |  |  |  |  |  |  |  |  |
| Thickness (km) Layer 14 |  |  |  |  |  |  |  |  |  |

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