

Planning Geomagnetic Disturbance Task Force (PGDTF)

Procedure Manual

Version DRAFT v2

Document Revisions

|  |  |  |  |
| --- | --- | --- | --- |
| Date | Version | Description | Author(s) |
| 03/29/16 | Draft v1 | First draft of Section 4  | ERCOT |
| 04/29/16 | Draft v2 |  | 04/29/16 PGDTF |

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*To Be Developed*

# 1 Introduction

#  ERCOT Planning Geomagnetic Disturbance Task Force Scope

## The purpose of the Planning Geomagnetic Task Force (PGDTF) is to develop and maintain the Geomagnetic Induced Current (GIC) system model which will be used by ERCOT to calculate per phase GICs and Mvar losses for each modeled transformer.

#  Activities of the PGDTF

 Following are the activities of the PGDTF.

* The PGDTF, in conjunction with ERCOT, creates and maintains the GIC system model.
* The PGDTF supports ERCOT and the Transmission Planners in the completion of the Geomagnetic Disturbance Vulnerability Assessment.
* The PGDTF supports ERCOT and the Transmission Planners in the development of the Corrective Action Plans.
* The PGDTF provides a forum for the discussion of planning and modeling topics related to Geomagnetic Disturbances.
* The PGDTF responds to assignments from the Reliability and Operations Subcommittee.

# Administrative Procedures

## Membership

## PGDTF membership consists of representatives from each Transmission Planner (TP), ERCOT, and other interested Transmission and/or Distribution Service Providers (TDSPs), Qualified Scheduling Entities (QSEs) and Resource Entities (Generator Owners (GOs)). Meetings of the PGDTF shall be open to all interested parties.

## Duties of Chair and Vice-Chair

## The Chair and Vice-Chair positions shall be nominated by the PGDTF for approval by ROS to a term not to exceed 12 months on a one year rolling basis. The Vice-Chair shall act as Chair in the absence of the Chair.

## Meetings

## The PGDTF shall meet as often as necessary to perform their duties and functions. Some meetings may be declared closed and limited to ERCOT, Transmission Planners, Transmission Owners, and Generator Owners.

## All PGDTF meetings shall be called by the Chair and/or Vice-Chair and all such meeting notices shall be sent and posted to the ERCOT website at least one week prior to the meeting.

## The Chair shall preside at all meetings and is responsible for preparation of agendas for such meetings which will be posted to the ERCOT website in advance of the meeting. In the absence of the Chair and the Vice-Chair, the group shall select another PGDTF member to preside at the meeting. The Chair, or the presiding member, shall be guided by input from the membership in the conduct of the meetings. Notes of PGDTF meetings shall be recorded and distributed, along with other communications to all members of the PGDTF. Additionally, such information will be posted on the ERCOT website as authorized by the PGDTF and author of document.

## Reports to ROS

## The Chair or Vice-Chair shall provide reports on the group’s activities to the ROS at its scheduled meetings or outside of the meetings if urgency dictates.

# 3 Definitions and Acronyms

# Roles and Responsbilties *(NERC TPL-007-1 R1)*

# PGDTF has identified the following roles and responsibilities as required under NERC TPL-007-1:

 Transmission Planners and/or Transmission owners will:

* Maintain System and GIC System models within its responsible area needed for the GMD Vulnerability Assessment *(R2)*.
* Conduct a thermal impact assessment of applicable power transformers as required under NERC TPL-007-1. *(R6)*
* Develop, in coordination with ERCOT, Corrective Action Plan(s) as needed per NERC TPL-007-1 *(R7)*.

 Resource Entities will:

* Provide GIC model data as required under the ERCOT-prescribed process applicable to Resource Entities for inclusion into the Network Operations Model *(R2).*
* Conduct a thermal impact assessment of applicable power transformers as required under NERC TPL-007-1. *(R6)*
* Develop, in coordination with ERCOT, Corrective Action Plan(s) as needed per NERC TPL-007-1 *(R7)*.

 ERCOT will:

* Maintain System and GIC System models within its responsible area needed for the GMD Vulnerability Assessment *(R2)*.
* Conduct a regional GMD Vulnerability Assessment once every 60 months *(R4)*.
* Distribute the results of the regional GMD Vulnerability Assessment *(R4 & R5).*
* Coordinate Corrective Action Plan(s) developed by Transmission Planners, Transmission Owners and Resource Entities as needed per NERC TPL-007-1 *(R7).*

Criteria for acceptable System steady state voltage performance during GMD Conditions *(NERC TPL-007-1 R3)*

ERCOT and PGDTF has determined that the following steady state voltage performance during GMD conditions will be as follows:

[Identify voltage performance here]

Voltage limits between emergency limits established by SSWG.

Line and Transformer ratings under emergency limits established by SSWG.

# 4 Data Requirements for GIC System Model

## 4.1 General

### Software

PSSE will be used by the ERCOT Planning Coordinator and Transmission Planners to build the GIC system models. Models will not be created in any other format by ERCOT. The PSSE version used will follow the version used by the Steady State Working Group with the exception of using PSSE 34 for initial model build.

### GIC System Models – General

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.

A SSWG base case updated to reflect known changes will be used as the starting base case for the GIC system model. Studies shall include both System peak and Off-peak Load within the Near-term Planning Horizon. *(R4.1)*

* **The System Peak case will be represented by the SSWG 2 or 3 year out Summer Peak case.**
* **The Off-peak case will be represented by the 3 year out SSWG MIN case.**

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 recommends two modeling methods in their GIC application guide. One method is to model the series capacitor with a very large resistance (1 megohm), and another method is to remove the line connecting the series capacitor from the model completely. In the ERCOT GIC system model, use the 1 megohm method for all series capacitors.

Substation Data

The format for the Substation record is defined in Appendix B.

I, NAME, UNIT, LATITUDE, LONGITUDE, RG

This Substation Data record will be provided by the facility owner.

|  |  |  |
| --- | --- | --- |
| **Field** | **Description** | **Source** |
| I | Station Number – This value will be from the ERCOT database based on keeping the same station number for a given station name each time a case is built | TPs will model station/bus relationship for their facilities in accordance with Appendix A.ERCOT will model station/bus relationship for GO facilities in accordance with Appendix A. |
| NAME | Station  | ERCOT will provide long or short name for GO stations.TPs will provide long or short name for their stations. |
| UNIT | Unit for geophysical location will always equal 0 | Unit = 0 |
| LATITUDE | Station Latitude  | ERCOT will provide for existing stations for TPs who request ERCOT to do so and for existing and future GO stations.TPs may provide this data for their existing stations, and will provide it for their future stations. |
| LONGITUDE | Station Longitude  | ERCOT will provide for existing stations for TPs who request ERCOT to do so and for existing and future GO stations.TPs may provide this data for their existing stations, and will provide it for their future stations. |
| RG | Substation grounding dc resistance (in Ohms)  | Facility owner will provide.  |
| EARTHMD (v34) | Name of the Earth Model | EARTHMD is USGS standard earth conductivity models available at USGS’s website <http://geomag.usgs.gov/conductivity/>. |

Bus Substation Data

This data set consists of two data -- BUSNUM and SUBNUM, where BUSNUM is the bus number for a bus that exists in power flow network data for an SSWG case, and SUBNUM is the substation number for a substation to which the bus with “BUSNUM” belongs to with the range in Appendix A.

The format for Bus Substation Data is defined in Appendix B.

ERCOT will provide bus-substation mapping for GO substations, and TPs will provide for TP substations.

Transformer Data Including Generator Step-Up

The format for the Transformer Data is defined 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** |
| I | The bus number of the bus to which Winding 1 is connected. It mustbe same Winding 1 bus for the same transformer power flow data. Nodefault allowed. | This number comes from SSWG base case. |
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|
| J | The bus number of the bus to which Winding 2 is connected. It mustbe same Winding 2 bus for the same transformer power flow data. Nodefault allowed. | This number comes from SSWG base case. |
|
|
| K | The bus number of the bus to which Winding 3 is connected. It mustbe same Winding 3 bus for the same transformer power flow data. Nodefault 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. | GOs will provide this value through RARF, and TPs 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. | GOs and TP will provide this value through RARF and workbook, respectively. |
| 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. | GOs and TPs will provide this value through RARF and workbook, respectively. |
| 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, that autotransformer is treated as it has GIC blocking device present.GICBDI = 0 by default. | GOs and TPs will provide this value through RARF and workbook, respectively. |
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| 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, that autotransformer is treated as it has GIC blocking device present.GICBDJ = 0 by default. | GOs and TPs will provide this value through RARF and workbook, respectively. |
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| GICBDK | GIC blocking device in neutral of Winding 3.= 0, no GIC blocking device present= 1, GIC blocking device presentGICBDK = 0 for two winding transformersGICBDK = 0 by default. | GOs and TPs will provide this value through RARF and workbook, respectively. |
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| VECGRP | Alphanumeric identifier specifying vector group 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; itsclock 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 ascommon winding bus.• For three winding autotransformers, windings on bus I and bus J form autotransformer.Winding connection designations* 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 PSSE:1. Open PSSE
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. PSSE will fill in the vector group blank with correct notation
 | REs and TSPs will provide this data through RARF and NMMS respectively. |
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| 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= 1 for single core design= 3 for three phase 3-legged core form= 5 for three phase 5-legged core formCORE = 0 by default | GOs and TPs will provide this value through RARF and workbook, respectively. |
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| KFACTOR | A factor to calculate transformer reactive 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:Three Phase Shell Form – 0.3300Single Phase (Separate Cores) – 1.1800Three Phase 3-Legged – 0.2900Three Phase 5-Legged – 0.6600Three Phase 7-Legged – 0.6600For unknown core designs:Windings Highest Voltage KFACTORUnknown core, <= 200 kV 0.6Unknown core, > 200 kV and <= 400 kV 0.6Unknown core, > 400 kV 1.1 | GOs and TPs will provide this data through RARF and workbook, respectively. |
|
| GRDWRI | Winding 1 grounding dc resistance in ohmsGRDWRI = 0.0 by default (no grounding resistance) | GOs and TPs will provide this data through RARF and workbook, respectively. |
|
| GRDWRJ | Winding 2 grounding dc resistance in ohmsGRDWRJ = 0.0 by default (no grounding resistance) | GOs and TPs will provide this data through RARF and workbook, respectively. |
|
| GRDWRK | Winding 3 grounding dc resistance in ohmsGRDWRK = 0.0 by default (no grounding resistance) | GOs and TPs will provide this data through RARF and workbook, respectively. |
|
| 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 defaultTMODEL = 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 and TSPs will provide this data through RARF and workbook, respectively. |
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Bus Fixed Shunt Data

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

Only in-service bus fixed shunts are modeled in GIC DC network.

|  |  |  |
| --- | --- | --- |
| **Field** | **Description** | **Source** |
| I | Bus number of the bus to which fixed shunt is connected. 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 identifier | This value comes from SSWG base case.  |
| R | dc resistance in ohms/phase. It must be > 0. No default allowed. Fixed bus shunt records with R=0 will be ignored. | GOs and TPs will provide this data through RARF and workbook, respectively.  |
| RG | Grounding dc resistance in ohms. RG = 0.0 by default (no grounding resistance) | GOs and TPs will provide this data through RARF and workbook, respectively.  |

Transmission Line Models

The format for Branch Data (v34) is defined in Appendix B.

|  |  |  |
| --- | --- | --- |
| **Field** | **Description** | **Source** |
| I | Branch from bus number. No default allowed. |  This number comes from SSWG base case. |
| J | 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. |  GOs and TPs will provide this data through RARF and workbook, respectively.  |
| INDVP | Real part of total branch GMD induced electric field in volts. |   |
| INDVQ | Imaginary part of total branch GMD induced electric field in volts. |   |

User Earth Model Data

User Earth Model Data Activity GIC models US and Canada Earth Models. However, if any other Earth Model is required then use this data to define such an earth model.

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 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 defined 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. |  |
| BETAFTER | Earth Model scaling factor used when calculating branch induced electric field for Benchmark GMD event. BETAFTR=1 by default |  |
| DESC | Description of the earth model. NAME maybe up to 72 characters. This is for information purpose only. DESC = “ by default |  |
| RESISTIVITY1 | Layer 1 Resistivity in ohm-m. No default allowed. |  |
| THICKNESS1 | Layer 1 Thickness in km. No default allowed. |  |
| RESISTIVITYn | Nth Layer Resistivity in ohm-m. No default allowed. Up to 25 layers are allowed. |  |
| THICKNESSn | Nth Layer Thickness in km. No default allowed. Up to 25 layers are allowed. |  |

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

### Modeling Refinements

 Non-Uniform Source Fields

 Non-Uniform Earth Structure

 Including Neighboring Systems

### Maintenance of GIC System Model (IMM, Workbook and RARF)

The input data from GOs is submitted to ERCOT through RARF documents which will follow ERCOT processes and be converted to NOMCR and stored and maintained in NMMS (IMM). The input data from TPs is submitted to the ERCOT using designated workbook provided by ERCOT. Based on the appropriate SSWG cases and the input data from GOs and TPs, ERCOT, in conjunction with the PGDTF, will develop a new GIC base cases ERCOT will deliver the new GIC base cases to all TPs through emails (PGDTF email list), and post the cases on the ERCOT MIS website (we can discuss if it is necessary). TPs will review the GIC base cases and may submit any modifications in the approved format to ERCOT if necessary. ERCOT is in charge of maintenance of GIC base cases and GIC input files, and will deliver the change files (\*.idv) to all TPs through email and by posting them on the ERCOT MIS website.

### GIC Data for Existing Equipment

For existing equipment that has been modeled in SSWG cases, TPs and GOs can submit or update the GIC parameters through the workbook and RARF documents, respectively.

### GIC Data for Planned Equipment (may not need) ? No place in MOD for Transmission Co. owned equipment, Pre-RARF for RE owned equipment

For the planned equipment that has not been modeled in SSWG cases, REs can submit the GIC parameters through pre-RARF documents. However, TSPs may have to submit the GIC parameters through emails since no place in IMM (MOD) can accommodate the GIC parameters.

## 4.2 GIC Data for Equipment Owned by Transmission Owners

### 4.2.1 GIC Data Requirements for Existing Equipment

### 4.2.2 Updates to Existing GIC Data

## 4.3 GIC Data for Equipment Owned by Generator Owners

### 4.3.1 GIC Data Requirements for Existing Equipment

###  Updates to Existing GIC Data

### 4.4 Missing or Problematic GIC Data

# 5 Overview of PGDTF Activities

##  Updating PGDTF Data and Cases

### Schedule for GIC Data Updates and GIC System Model

### PGDTF Data Updates

### PGDTF Data Screening

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### Voltage Instability Identification in Stability Studies

### Cascading Identification in Stability Studies

### Uncontrolled Islanding Identification in Stability Studies

## Post Case Screening Activities

### Distribution of Screening Results and the GIC System Data File

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##  Other PGDTF Activities

### Data Recording Requirements

### Triggering Requirements

### Data Reporting Requirements

### Maintenance and Testing Requirements

### Event Simulation

### Procedure Manual Revision Guidelines

## On a periodic basis, PGDTF will review the Procedure Manual for needed updates. Any member of 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 provided to the Reliability and Operations Subcommittee (ROS) for its consideration. A red-lined version and a final version will be provided to ROS for its review and approval.

# 6 APPENDICES

# Appendix A - Station Number Range

| **STATION RANGE** | **TDSP** | **ACRONYM** | **MODELING****ENTITY** | **PSSE 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 |
| 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 |  |

# Appendix B – Data Entry Templates

SUBSTATION DATA ENTRY TEMPLATE



TRANSFORMER DATA ENTRY TEMPLATE



FIXED SHUNT DATA ENTRY TEMPLATE



BRANCH DATA ENTRY TEMPLATE



EARTH MODEL DATA ENTRY TEMPLATE

