

GIC System Model Procedure Manual

**Version 7.0**

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Table of Contents

[1. Introduction 1](#_Toc535252870)

[2. Definitions and Acronyms 1](#_Toc535252871)

[2.1. Definitions 1](#_Toc535252872)

[2.2. Acronyms 2](#_Toc535252873)

[3. GIC Case Build Procedures 2](#_Toc535252874)

[3.1. Timeline and Submission Template 2](#_Toc535252875)

[3.1. GIC Case Naming Convention 3](#_Toc535252876)

[3.2. SSWG Case Selection 3](#_Toc535252877)

[3.3. Off-Cycle Updates 3](#_Toc535252878)

[4. TSP and RE Data Submission Responsibilities 3](#_Toc535252879)

[5. GIC Case Posting 4](#_Toc535252880)

[6. Modeling Methodology 4](#_Toc535252881)

[6.1. Bus Information 4](#_Toc535252882)

[6.2. Substation Data 4](#_Toc535252883)

[6.3. Vector Group Convention 4](#_Toc535252884)

[6.4. Series Capacitors 4](#_Toc535252885)

[6.5. Autotransformers 5](#_Toc535252886)

[6.6. Switched Shunts 6](#_Toc535252887)

[6.7. Fixed Shunt Data 6](#_Toc535252888)

[6.8. Additional Buses 7](#_Toc535252889)

[6.9. Transmission Line Data 7](#_Toc535252890)

[7. Data Submission 7](#_Toc535252891)

[8. PGDTF Roster 7](#_Toc535252892)

Introduction

The Planning Geomagnetic Disturbance Task Force (PGDTF) is a task force that reports to The Reliability and Operations Subcommittee. The purpose of the PGDTF is to formalize the requirements and criteria for performing GMD Vulnerability Assessments.

The GIC System Model Procedure Manual provides guidance on how the geomagnetically induced current (GIC) models will be developed and maintained. The GIC System Model is a direct current resistance model of the transmission system used to calculate geomagnetically induced currents and reactive power losses.

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.

In the event of any conflicts between this manual and the ERCOT Nodal Protocols, the Protocols shall control in all respects.

# 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 Nodal Protocols and Planning Guide, the definitions and acronyms established in the ERCOT Nodal Protocols and Planning Guide take precedence.

## Definitions

Near-Term Transmission The transmission planning period that covers year

Planning Horizon one through five.

GMD Geomagnetic Disturbance (GMD) is a geomagnetic storm caused by Coronal Mass Ejection (CME), which is 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 and harmonics.

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

GIC DC Model Direct current resistance model of the transmission system used to calculate geomagnetically induced currents and reactive power losses.

GIC AC Model The base AC power flow case used to create the GIC DC Model. It will be created from the selected SSWG case, and include any changes necessary to synchronize the GIC AC Model with the GIC DC Model.

GIC System Model The GIC System Model that is composed of both the GIC DC Model and GIC AC Model. The GIC System Model refers to both models necessary to run a GIC study. The GIC System Model consists of a summer peak load model and a minimum load model.

## Acronyms

AC Alternating Current

DC Direct Current

ERCOT The Electric Reliability Council of Texas

GIC Geomagnetically Induced Current

PGDTF Planning Geomagnetic Disturbance Task Force

SSWG Steady State Working Group

RARF Resource Asset Registration Form

RE Resource Entity

# GIC System Model

The GIC System Model will represent the entire ERCOT system. The GIC System Model shall include all Bulk Electric System facilities as defined by NERC, all facilities with transmission equipment operating at or above 69 kV, and all equipment located in a generation facility. All equipment should be modeled using actual data. In the case that actual system data for the GIC DC Model is not available, typical data based on actual data or data converted from the GIC AC Model may be used.

# GIC System Model Build Procedures

ERCOT will be the responsible party for maintaining the GIC System Model in conjunction with the assistance of the Transmission Service Providers (TSPs) and Resource Entities (REs) and determining when a GIC System Model build is needed. ERCOT will provide market participants notification of when the build is intended to start, a schedule of the proposed build timeline, and posting of interim and final GIC System Model.

The primary software that will be used by ERCOT to build the GIC System Model(s) will be PSS®E.

## Timeline and Submission Template

Prior to each GIC System Model build, ERCOT will provide a schedule to the PGDTF that includes GIC data submission timeline and information on when each GIC data type will be collected during the GIC System Model build.

For each pass, ERCOT will provide the necessary templates and information needed to update the GIC System Model. This information will be posted on MIS and returned in the ERCOT designated secure data transmission method.

## GIC Case Naming Convention

Once the SSWG base case(s) has been modified to reflect the necessary GIC System Model changes by TSPs and ERCOT, it will be called the:

* (Current Year)GIC\_AC Model\_(Case Year)\_(SUM/MIN)

Each pass of the GIC DC Model will adhere to the following naming convention:

* (Current Year)GIC\_DC\_Model\_(Case Year)\_(SUM/MIN)\_Pass\_X

The final published GIC DC Model will adhere to the following naming convention:

* (Current Year)GIC\_DC\_Model\_(Case Year)\_(SUM/MIN)\_Final

## SSWG Case Selection

Prior to the commencement of the GIC System Model build, the latest available SSWG cases will be selected as the starting basis of the GIC System Model.

* The System Peak case will be represented by at least one SSWG Summer Peak case within the Near-Term Transmission Planning Horizon.
* The Off-peak case will be represented by at least one SSWG MIN case within the Near-Term Transmission Planning Horizon.

The latest SSWG case and any applicable SSWG off-cycle IDEVs can be obtained through the Market Information System (MIS). Both cases will be updated, if required, to reflect known and significant changes.

## Off-Cycle Updates

During anytime in between case builds, ERCOT may process off-cycle updates to the GIC System Model. These updates may be supplied by ERCOT or a TSP. These off-cycle updates could include changes due to generation modeling or corrections to data issues that are discovered. Only submissions updating existing data will be accepted. Submissions incorporating new elements or deleting existing elements will not be permitted by TSPs, but ERCOT retains the discretion to make such changes if ERCOT deems such a change, either adding or deleting elements from the model, necessary.

### Generation Updates

As new generation is modeled by ERCOT, ERCOT may make an off-cycle update to the GIC System Model to account for the new equipment associated with the new generation site.

If generation is retired after the SSWG case is published and during the GIC System Model build, the retirement should be reflected in the GIC System Model. If the retirement occurs after the GIC System Model build is completed, then ERCOT may make an off-cycle update with the necessary modeling changes to reflect the generation retirement.

# TSP and RE Data Submission Responsibilities

Each TSP and RE or their designated agents are to provide the necessary data for the GIC System Model per Section 6.11 of the ERCOT Planning Guide. Any changes submitted by REs through the GIC System Model build process must also be reflected by a following change of the entities’ Resource Asset Registration Form (RARF).

When submitting changes to the GIC System Model, TSPs shall be responsible for modeling their own equipment. As ERCOT has the responsibility of modeling generation, ERCOT will model and process any changes to generation substation equipment. The source of generation substation equipment data shall come from the RARF provided by the Resource Entity (RE).

TSPs will submit data using an ERCOT supplied template. The template will contain all the necessary information needed to accurately model GICs. If changes are needed to the template, ERCOT reserves the right make changes if new data needs to be collected to accurately model the system.

In the event of a data conflict between the TSP and RE, ERCOT will attempt to resolve any modeling discrepancies. Any changes that make it into the GIC System Model and affect RE data without coming from the RARF may go into the GIC System Model. However, ERCOT will request clarification from the RE. If the RE approves of the change, it will be used in the model and a RARF update will be requested. If the RE does not agree with the proposed change, the data from the RARF will be used.

# GIC System Model Posting

The finalized GIC System Model, composed of the GIC DC Model and GIC AC model will be posted to MIS.

Any changes to the GIC System Model that are made after the GIC System Model is posted to MIS will be made as an off-cycle update and not included in the official GIC System Model until the next GIC System Model build unless ERCOT deems the change necessary. If ERCOT deems the change necessary, the official GIC System Model will be updated and reposted on MIS.

# Modeling Methodology

## Bus Information

The GIC System Model bus range assignments will adhere to the assigned SSWG bus number ranges and can be found in the SSWG Procedure Manual.

## Substation Data

The substation data will be provided by the facility owner. This includes substation bus number, substation name, latitude and longitude in decimal format, substation DC grounding resistance, and earth model information. TSPs will submit their data in the ERCOT provided template, and REs will provide their data through the RARF.

## Series Capacitors

Series capacitors are used in the bulk power system to re-direct power flow and improve system stability. Series capacitors present very high resistance 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.

## Transformers

Geomagnetically induced currents can flow through high side wye-grounded transformers to ground. Accurate transformer modeling is necessary to accurately calculate GICs.

### Vector Group Convention

Transformer vector groups (VECGRPs) must utilize acceptable PSS®E vector groups.

## Switched Shunts

Only bus connected switched shunt reactors connected to transmission level substation buses, generation buses, or transmission line connected shunt reactors are modeled in GIC DC Model. Switched 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.

For the situation where several switched shunts are modeled by one switched shunt in the GIC AC Model with multiple steps, the owner should either:

* Submit the resistance value as a parallel of all resistance as if they were all on at the same time.
* Submit change files for the GIC AC Model to separately model each step of the switched shunt in the case and submit the resistance values separately for each resulting switched shunt.

If an additional bus is added in the submitted change file, this bus must also be added to submitted template.

## Fixed Shunt

Only bus connected fixed shunt reactors connected to transmission level substation buses, generation buses, or transmission line connected shunt reactors are modeled in GIC DC Model. Fixed 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.

## Additional Buses

If a new bus is added to the GIC System Model, it must be added in both a change file to modify the GIC AC Model and in the GIC DC Model. Consistency must be maintained between the GIC DC Model and the GIC AC Model. Additionally, a comment should be made in the data submission to ERCOT noting any new busses that were added to the case.

## Transmission Line Data

Any entry are intended to update values already in the GIC AC Model and/or specify induced voltage values where applicable, e.g. steel encased cables.

# Data Submission

In order to ensure that GIC data remains protected as GIC data is considered Protected Information per ERCOT Planning Guide Section 6.11, ERCOT will designate a secure data transmission method to receive TSP GIC data submissions.

# GIC System Model Building Roster

A roster of all the companies and their representatives involved in GIC System Model building can be found on MIS. This roster is updated at the discretion of ERCOT.