

Data Maintenance for GMD Studies



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Group

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Outline

- Extra model data needed for GIC studies
 - Substation location and parameters
 - Transformer parameters
 - And others (shunts, DC lines, loads, gens, etc.)
- Data can be read/written in auxiliary file format (*.aux), PSLF (*.gmd) and PSS/E (*.gic) formats
- Tools for error checking
 - One-line diagram with dynamic formatting
 - Low R per distance
 - WECC example



GIC Analysis Inputs

- GIC calculations use some standard model parameters (i.e. epc/raw) such as line resistance and status of series capacitors
- Some additional parameters are needed
 - Substation geo-coordinates and grounding resistance
 - Bus-substation assignments
 - Transformer grounding configuration, coil resistance, core type, whether auto-transformer, whether three-winding transformer
 - Shunt inductor parameters
 - DC line resistance (optional)



Geographic Information

- The potentially time-varying GMD induced dc voltages depend on the storm strength and orientation and the latitude and longitude of the transmission lines
 - The electric field is integrated along the path of the transmission line
 - The geo-coordinates of the terminal substations are sufficient for uniform fields (path independence)
- Hence buses must be mapped to substations, and substations to their geo-coordinates
- Substation/geographic data can be supplied by PowerWorld for FERC 715 planning models
 - Buses mapped to substations
 - Latitude and longitude for substations



WECC Example (From 2020)

- 20HS3a1 case
- *wecc_gmd.gmd* file, exported from *MASTER_GIC_withMacros_V2_1_17_20.xlsm*
- Basic Data Maintenance Procedure
 - Open case
 - Load gmd file
 - “Validate Input Data for GIC” button – checks if any lines are longer than $\frac{1}{4}$ wavelength (776.5 miles)
 - Examine/edit data
 - Export/share updated data



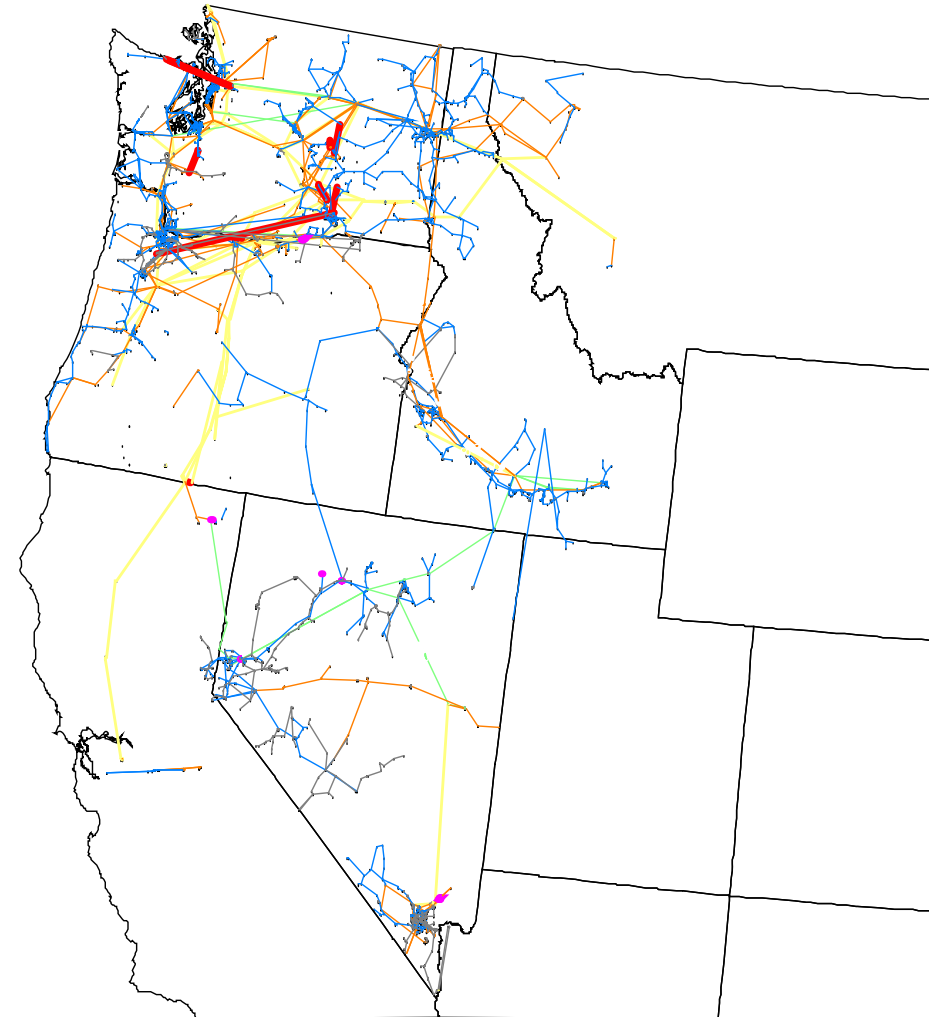
Auto-Generate One-Line Diagram

- Auto-insert state borders into a new one-line
- Auto-insert buses by longitude and latitude stored with substation records
- Auto-insert lines
- Use dynamic formatting to identify
 - Lines with resistance lower than nominal bound for distance
 - Transformers that span substations



Missing and Suspect Data Apparent!

- Limited footprint
- Red lines have low R per distance (one or both substations may be mislocated)
- Magenta shows transformers that span substations





Fargo – Ore City 115 kV

- Note discrepancies in length calculations and estimates
- One or both substations are probably mis-located OR one or both buses are probably assigned to the wrong substation

Branch Information Dialog

Line	From Bus	To Bus	Circuit
Number	43195	40805	2
Name	FARGO	ORE CITY	
Area	NORTHWEST (40)	NORTHWEST (40)	
Nominal kV	115.0	115.0	
Voltage Angle	1.01660 -12.3506	1.01526 -11.0852	
Labels ...	no labels		

Parameters | OPF | Fault Info | Area, Zone, Owner, Sub, PTDF | Custom | Stability | Geography | GIC

Geographic Location

	From Bus	To Bus	Difference (From - To)
Latitude (degrees)	45.2453	46.3069	-1.0616
Longitude (degrees)	-122.8169	-119.1139	-3.7030

Distances

	Miles	km
Distance Between From and To Buses	193.394	311.237
User Entered Line Length	6.700	10.783
Estimated Length from X and B	6.785	10.920

OK | Save | Save to Aux | Cancel | Help | Print



GIC Case Info Display with Filter

Series Cap
spanning 123
miles

Various Distance Fields and Ratios

	From Number	From Name	To Number	To Name	Circuit	Low R Distance	GIC Conductance per Phase	Low R per Distance Minimum Ohms/Phase	Length Ratio, Length Calculated/Length XB Estimated	Distance Between Subst (Miles)	Length, Estimated from X and B (Miles)	Length, Rough Estimate by Resistance (Miles)	Length
1	43195	FARGO	40805	ORE CITY	2	YES	0.7816	3.24901	28.50	193.3936	6.7851	4.5563	6.7000
2	64892	RBFLCSC2	64043	FALCON	1	YES	0.0000	0.62519		122.5856		0.0010	1.0000
3	47562	MONROE+	40843	PORT ANG	1	YES	4.6677	1.21358	10.59	72.2367	6.8196	0.6389	1.9000
4	47557	DEER_PK+	47562	MONROE+	1	YES	4.4743	1.16131	9.72	69.1255	7.1135	0.6666	2.0000
5	46021	COLECTY	48149	HEADWORK	1	YES	3.2876	0.50540	24.51	30.0832	1.2275	0.8882	1.2000
6	40377	EAGLE_LAKE+	40861	RADAR_PUMPS#	1	YES	2.3112	0.45759	13.93	27.2375	1.9549	2.0860	1.9000
7	46798	MASHEL-T	41245	MASHEL-P	1	YES	666.6667	0.38964	37.33	23.1928	0.0000	0.0000	0.1000
8	40510	HANFORD2_CO	40502	WPN_NO2_CON#	1	YES	18.9251	0.30241	133.28	18.0004	0.1351	0.1872	0.1000
9	47182	LYLE	40218	LYLE#	1	YES	262.4672	0.18445	1.61	10.9789	6.8003	3.7777	6.7000
10	46155	ROCKYFD	46103	SOAPL TP	1	YES	37.8072	0.14016	40.25	8.3430	0.2073	0.1873	0.2000
11	40687	MALIN	43960	MALIN R2	2	YES	666.6667	0.02215	10.49	6.5155	0.0000	0.0054	0.0000



Sub-Spanning Xfrs

Transformer Controls (Filter:sub spanning ..) X Buses

Filter: Advanced Branch sub spanning xfr

	From Number	From Name	From Sub Num	To Number	To Name	To Sub Num	Circuit
1	18012	CRSTL2PS	18012	18014	CRYSTAL	18014	2
2	18012	CRSTL2PS	18012	180524	CRYSTAL2		2
3	18013	CRSTL3PS	18013	18014	CRYSTAL	18014	3
4	18013	CRSTL3PS	18013	180526	CRYSTAL3		3
5	18452	CRSTL N	18452	26123	CRYSTAL		2
6	18452	CRSTL N	18452	26123	CRYSTAL		2
7	64905	MARBLE	64905	38136	MARBLE		1
8	48059	CAB GORG	48059	48061	CABGOR12	48061	1
9	48059	CAB GORG	48059	48063	CABGOR34	48061	1
10	48516	COYO G2	43123	48519	COYO M2		1
11	48518	COYO S2	43123	48519	COYO M2		1
12	60115	CLIFF	60115	60116	SHSNFALS	60116	1
13	60177	JUSTICE	60177	60175	KING	60175	1
14	64017	BRDRTNPS	64017	64018	BRDRTWN	64018	1
15	64116	TRACY E	64115	64028	CLARKMT3	64028	1
16	64116	TRACY E	64115	64029	CLARKMT4	64028	1
17	64058	HIL TOP	64058	640518	HIL TOP1		1
18	64230	NEVBD501	64081	64081	NEVBD501	64230	1
19	64231	NEVBD502	64082	64082	NEVBD502	64231	1
20	64095	SLVR PKX	64095	64094	SLVER PK	64094	1
21	64094	SLVER PK	64094	64096	SLVR PS	64096	1
22	64113	TRACY	64114	64278	TRACY		1
23	64138	WINN SUB	64138	64174	WINN BPA	64174	1
24	64842	RSRV REG	64842	64151	REESE RV	64151	1
25	64279	TRACY	64114	64278	TRACY		1
26	64328	LEWIS	64483	64483	LEWIS	64328	1
27	64800	NVGEOUSU	64800	64801	NVGEOG1	64801	1
28	180525	CRYSTAL2	18012	180524	CRYSTAL2		2
29	180527	CRYSTAL3	18013	180526	CRYSTAL3		3
30	640519	HIL TOP1	64058	640518	HIL TOP1		1

Some of these just have one terminal unassigned





Justice-King 230/138 kV Transformer

- The windings of the transformer are assigned to separate substations
- The subs are in very close proximity, so perhaps the planning model approximates by lumping a low impedance connection into the transformer

Branch Information Dialog

Transformer	From Bus	To Bus	Circuit
Number	60177	60175	1
Name	JUSTICE	KING	
Area	IDAHO (60)	IDAHO (60)	
Nominal kV	230.0	138.0	
Voltage Angle	1.01624 -17.9913	1.02896 -18.7202	
Labels ...	no labels		

Find By Number
Find By Name
Find ...
 From End Metered

Parameters Transformer OPF Fault Info Area, Zone, Owner, Sub, PTDF Custom Stability Geography GIC

Area, Zones, Substations and PTDFs

Area, Zones, Substations and PTDFs	From Bus	To Bus	From Bus Dialogs	To Bus Dialogs
Area	IDAHO (60)	IDAHO (60)	Area	Area
Zone	ZoneIP Southern (613)	ZoneIP Southern (613)	Zone	Zone
Substation	JUSTICE (60177)	KING (60175)	Substation	Substation
Super Area	not assigned to super area	not assigned to super area	Super Area	Super Area
PTDF (%)	0.00	0.00	Bus	Bus
Data Maintainer				

Owners

Default Owner (Same as From Bus)

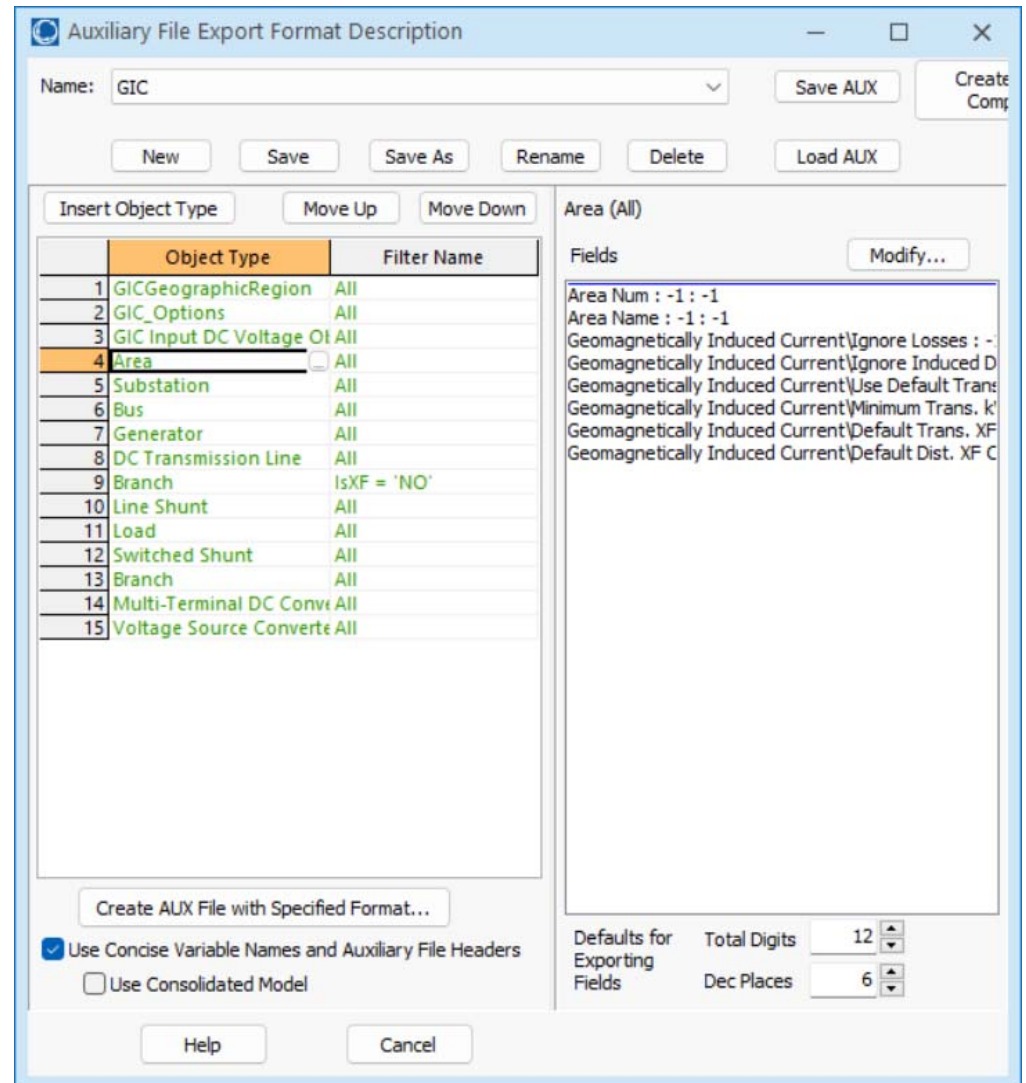
Owner	Percentage	Number	Name
Owner 1	100.000	11	Idaho Power Company
Owner 2			
Owner 3			
Owner 4			
Owner 5			
Owner 6			
Owner 7			
Owner 8			

OK Save Save to Aux Cancel Help Print



Export GIC Data to Aux File

- Auxiliary File Export Format





Export GIC Data to PSLF gmd

- Optionally apply Area/Zone filter to save only your data (PSS/E gic only; needs to be extended to PSLF gmd format)

GIC Analysis Form

Calculation Mode

- Single Snapshot
- Time Varying Series Voltage Inputs
- Time Varying Electric Field Inputs
- Spatially Uniform Time-Varying E-Field

Calculate GIC Values Clear GIC Values Include GIC in

Update Line Voltages (Should be True Unless Explicitly Entered)

Select Step

- Field/Voltage Input
- Options
 - DC Current Calculation
 - AC Power Flow Model
- Tables and Results
 - Areas
 - Buses
 - Generators
 - DC Lines
 - Lines
 - Line Shunts
 - Loads
 - Switched Shunts
 - Substations
 - Transformers
 - Multi-Section Lines
 - System Summary
 - G-Matrix
 - Multi-Terminal DC Lines
 - VSC DC Lines
- Sensitivity Analysis
- Non-Uniform Electric Field Sc
 - Geomagnetic Latitude Sc
 - Earth Resistivity Scaling
 - Earth Resistivity Scaling

Field/Voltage Input

Voltage Input Parameters

Electric Field Model Parameters

Maximum Field: 3.11 Volts/km

Storm Direction: 90.0 Degrees

Also Calculate Maximum Direction Values

Restrict Lines to which to m

Minimum Line Length

Calculate Voltages for E

Calculate Voltages for L

Geomagnetic Latitude Scaling Function: No Scaling

Earth Resistivity Scaling Region Set: No Resistivity Scaling

Save Setting to Aux Load AUX

- Save supplemental file (*.gic, *.gmd)
- Load supplemental file (*.gic, *.gmd)
- Open Bus Include Subsystem File
- Save Bus Include Subsystem File
- PSSE Save Using AreaZone Filters



Editing GIC Data from the Model Explorer

- Can be done with or without the Simulator GIC add-on
- Only need to add the relevant object fields to the display
- Example for Shunts

	Number of Bus	Name of Bus	ID	Resistance Per Phase in Ohms	Scale Conductance	Neutral Resistance (Ohms)
1	10010	AMBROSIA	b1	0.00000	NO	0.00000
2	10116	GUADLUPE	b1	2.03080	NO	0.65000
3	10116	GUADLUPE	b2	3.00000	NO	0.65000
4	10116	GUADLUPE	v2	0.00000	NO	0.00000
5	10177	LOS_CHAV	b1	0.00000	NO	0.00000
6	10177	LOS_CHAV	b2	0.00000	NO	0.00000
7	10206	MIMBRES	b	0.00000	NO	0.00000
8	10206	MIMBRES	b2	0.00000	NO	0.00000
9	10206	MIMBRES	b3	0.00000	NO	0.00000
10	10227	NORTHNM	b1	0.00000	NO	0.00000
11	10227	NORTHNM	b2	0.00000	NO	0.00000
12	10230	NORTON_1	b	0.00000	NO	0.00000
13	10255	PRAGER	b	0.00000	NO	0.00000
14	10266	REEVES_2	b	0.00000	NO	0.00000
15	10293	SANDIA_1	b1	0.00000	NO	0.00000
16	10293	SANDIA_1	b2	0.00000	NO	0.00000
17	10295	SANDIA_1	b1	0.00000	NO	0.00000
18	10295	SANDIA_1	b2	0.00000	NO	0.00000
19	10318	SJUAN_G1	b	0.00000	NO	0.00000
20	10357	VALENCIA	b	0.00000	NO	0.00000
21	10370	WESTMS_1	b	0.00000	NO	0.00000
22	10371	WESTMS_2	b	0.00000	NO	0.00000
23	10382	YAHTAHEY	b	0.00000	NO	0.00000
24	10382	YAHTAHEY	b2	0.00000	NO	0.00000
25	10386	ZIA_1	b3	0.00000	NO	0.00000
26	10386	ZIA_1	b1	0.00000	NO	0.00000
27	10386	ZIA_1	b2	0.00000	NO	0.00000
28	10386	ZIA_1	b4	0.00000	NO	0.00000
29	10387	ZIA_1	b1	0.00000	NO	0.00000
30	10387	ZIA_1	b2	0.00000	NO	0.00000
31	10390	RIOPUERC	v2	0.00000	NO	0.00000
32	10511	SANDIA_2	b1	0.00000	NO	0.00000



More Information

- Related Knowledge Base entries
 - <https://www.powerworld.com/knowledge-base/aux-export-format-description-for-gic-data>
 - <https://www.powerworld.com/knowledge-base/add-gic-related-object-data-fields-to-displays>