

**SAARC Workshop
on
Load/Power Flow Studies using PSS/E for Efficient National &
Cross Border Interconnected Power Systems in South Asia**

Agenda

**Thimphu, Bhutan
18th to 20th July 2018**

Day-1 (18-July-2018)

Time	Description
1115-1300	Session-I “Introduction to power system simulation using PSSE” <ul style="list-style-type: none"> Views in Power flow interface File types in PSSE Program settings PSSE Documentation <i>Creating a new case</i> <i>Familiarization with data types / Adding and Modifying power flow data</i>
1300-1400	<i>Lunch</i>
1400-1530	Session-II “Getting started in power flow with PSSE” <ul style="list-style-type: none"> <i>Power flow solution</i> <i>Hands-on exercise in power flow</i>
1530-1700	Session-III “Diagrams in PSSE” <ul style="list-style-type: none"> <i>Diagram view and Diagram Toolbar</i> <i>Diagram options</i> <i>Creating diagram of a subsystem</i> <i>Hands-on exercise</i>

Day-2 (19-July-2018)

Time	Description
1000-1200	Session-I “Exploring power flow solution” <ul style="list-style-type: none"> • Solution methods • Solution parameters • Viewing power flow results • Limit checking reports • Hands-on exercise: Examining power flow results
1200-1300	Session-II “Toolbars and Diagrams” <ul style="list-style-type: none"> • Usage of common toolbars • Program preferences
1300-1400	Lunch

Day-2 (19-July-2018)...contd..

Time	Description
1400-1600	Session-III “Introduction to Fault Analysis” <ul style="list-style-type: none"> • Generator and Load conversion • Setting up a sav case for fault analysis • Balanced switching options • ANSI and IEC fault analysis options • Hands-on exercise on ✓ fault level calculation at network buses ✓ Charging studies
1600 - 1700	Session- IV “Data checking in PSSE” <ul style="list-style-type: none"> • Using program features for bad data detection • Handling a blown-up power flow case • Hands-on exercise

Day-3 (20-July-2018)

Time	Description
1000-1200	Session-I “Introduction to Dynamic simulation” <ul style="list-style-type: none"> • Basic logic flow for dynamic simulation activities • Setting up a *.dyr case for dynamic simulation • Dynamics documentation • Defining channels for simulation output • Initializing a dynamics case
1200-1300	Session-II “Dynamic simulation activities” <ul style="list-style-type: none"> • Applying disturbance • Hands-on exercise on running a basic dynamic simulation
1300-1400	<i>Lunch</i>
1400-1530	Session-III “Contingency analysis” <ul style="list-style-type: none"> • Creating data files for basic contingency analysis • Transfer limits calculation in PSSE (Activity TLTG) • Contingency ranking in PSSE

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**SAARC Workshop
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Cross Border Interconnected Power Systems in South Asia**

**Session I : Introduction to power system simulation
using PSS/E**

Day-1

**Thimphu, Bhutan
18th to 20th July 2018**

Power System Simulation

Electric Power system => Largest machine every built

- Interaction amongst millions of devices and their controllers
- Simulate => Assess impact without disturbance / interruption



Generation



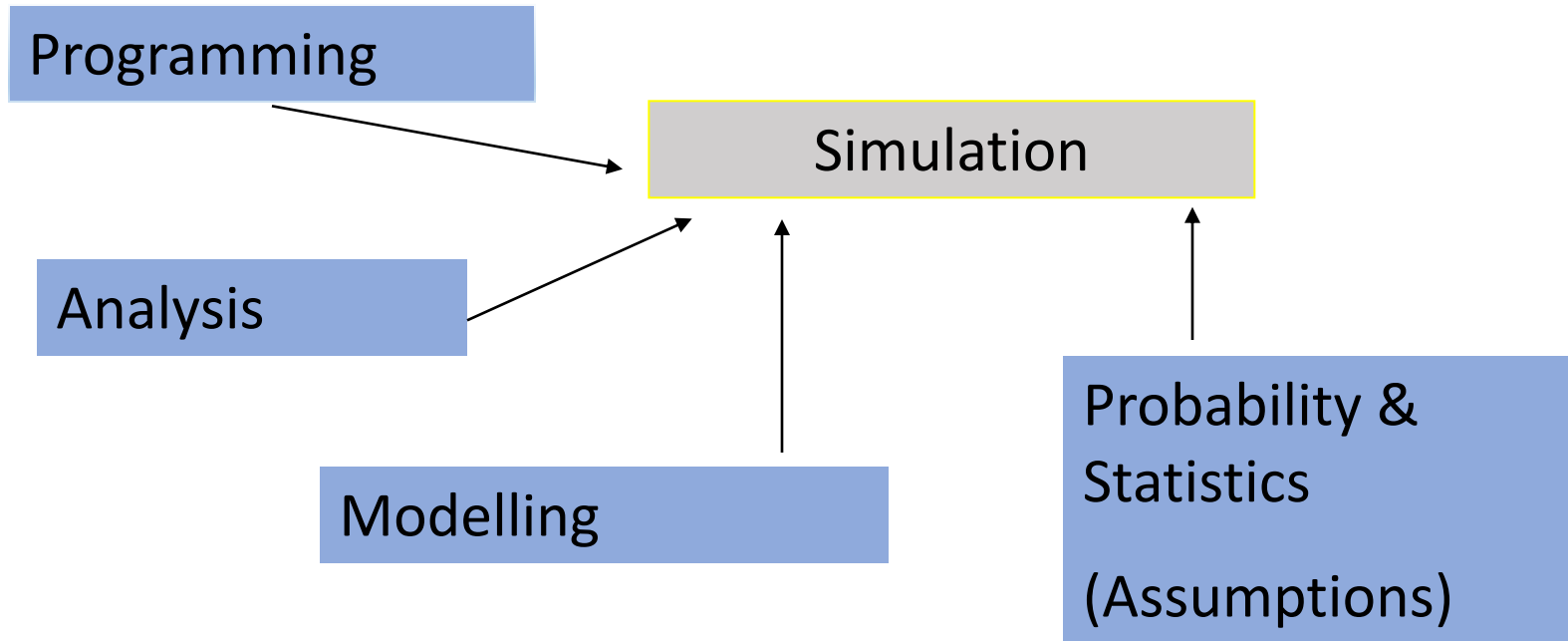
Delivery



Consumption

Introduction to Simulation...(1)

- Simulation => Actual run of a model system to gain insight into its performance.
- Steps in Simulation =>



- Modelling is the Transition of a given Physical problem into it's Mathematical representation

Power System study : Timelines and Categories

- **Steady State**

- Time 't' is invariant => Frequency 'f' is invariant
- Power flow studies

- **Short-circuit**

- Instant of switching ($t=0^+$)

- **Transient Stability (Time-domain)**

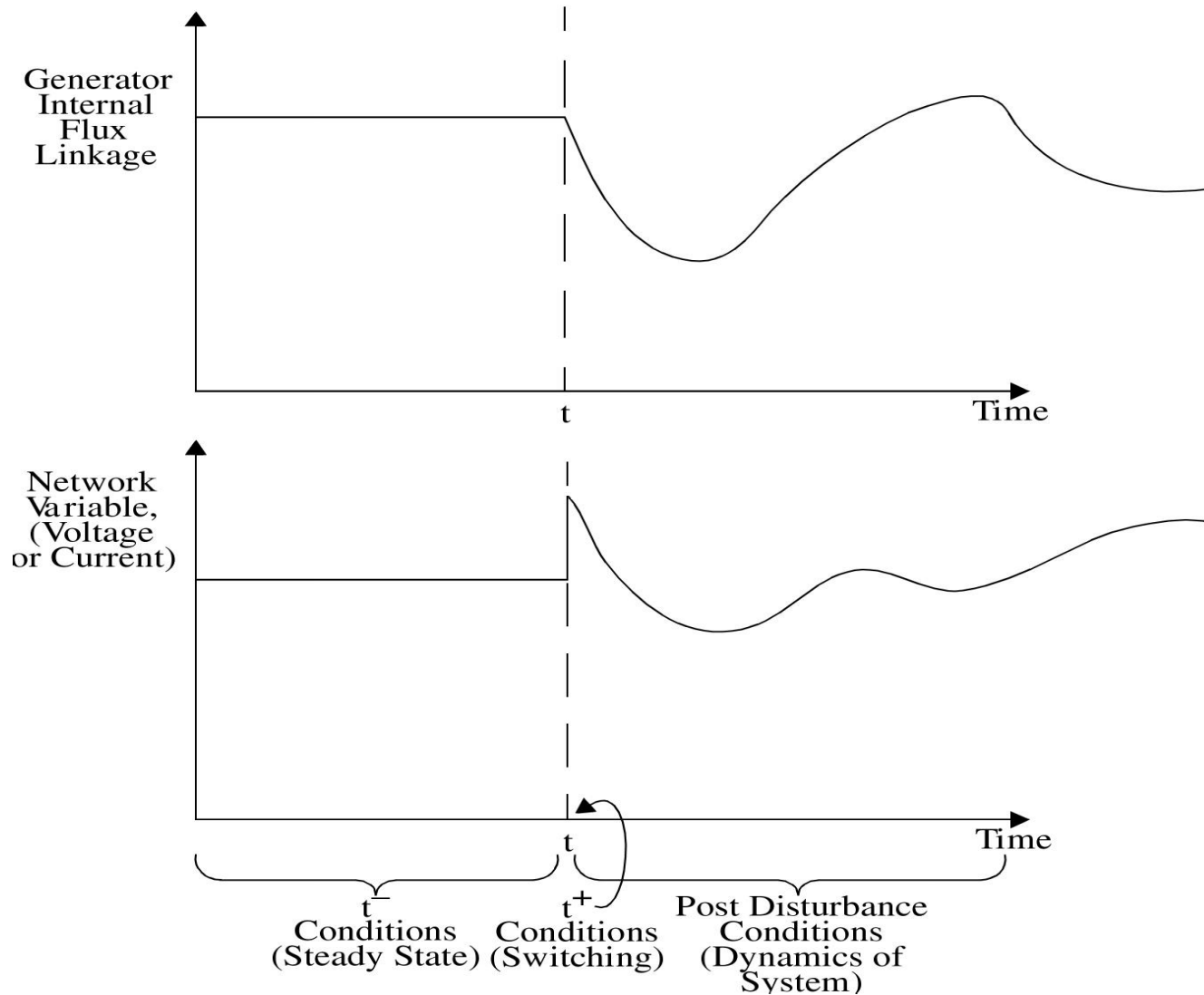
- Time 't' is variant
- $t = 0^+$ to tens of seconds

- **Small-signal stability (Frequency domain)**

- Eigenvalue analysis

- **Electro-magnetic transient analysis (Fast transients)**

Time Regimes in power system simulations



Per Unit (p.u.) System

In p.u. system, power system quantities (such as V, I, R, X, VA, P and Q) are expressed as decimal fractions of chosen base values.

$$\text{p.u. value} = \frac{\text{actual value}}{\text{base value}}$$

p.u. values of circuit parameters are the same on either side a transformer.

Choosing base value:

- Can choose any value as the Base Value
- Choose value to make computation efficient
- In PSSE, usually choose:
 - MVA_{base} = 100.0

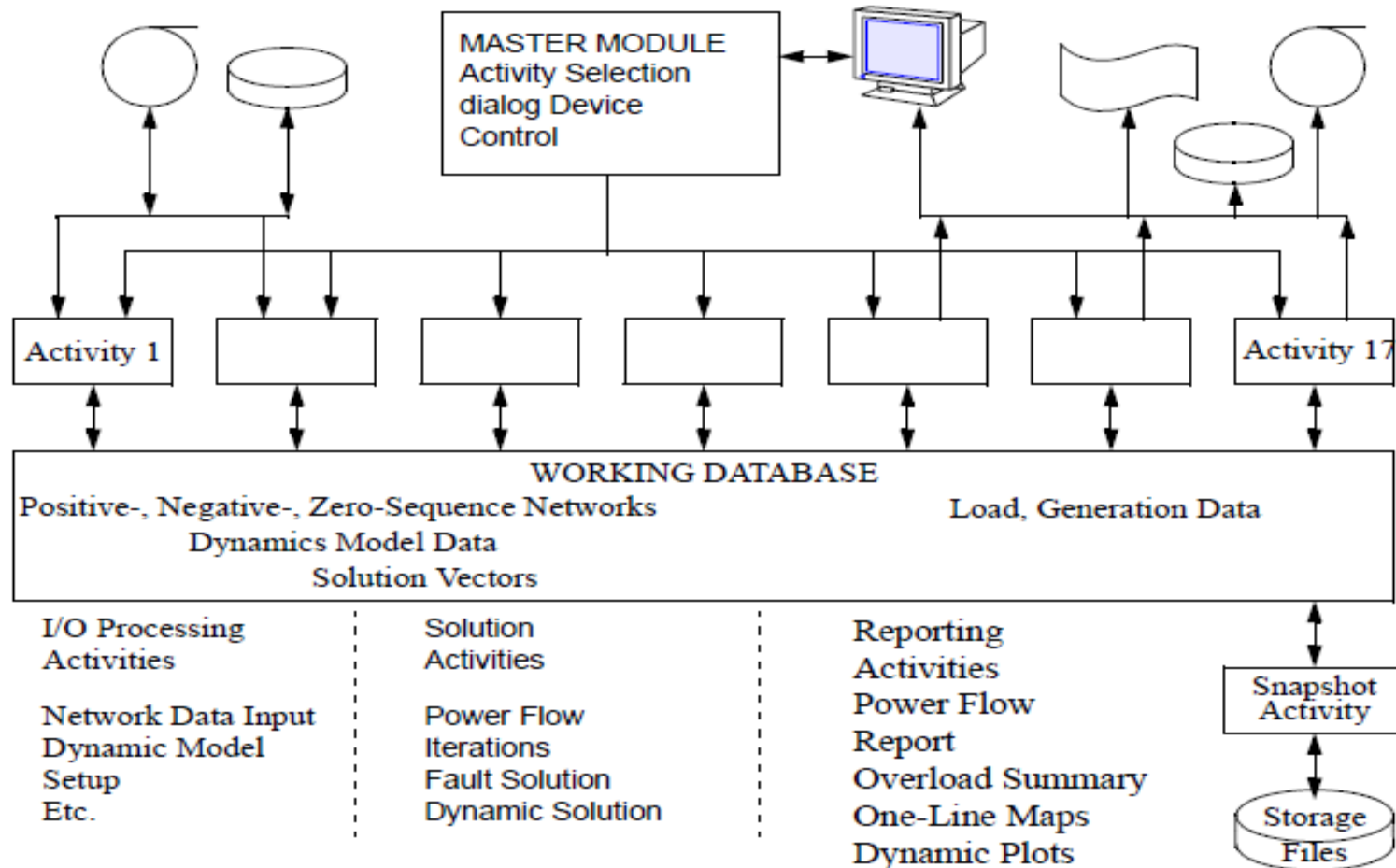
Change of Base:

$$Z_{\text{p.u. (new)}} = Z_{\text{p.u. (old)}} \times \left(\frac{V_{\text{base (old)}}}{V_{\text{base (new)}}} \right)^2 \times \frac{VA_{\text{base (new)}}}{VA_{\text{base (old)}}$$

PSS/E Program overview...(1)

- PSSE Program overview
 - Tool for Linear power system analysis
 - Steady state power flow
 - Short circuit studies
 - Transient simulation (Linear differential equations)
 - Ancillary programs:
 - PSSPLT
 - Vcurve analysis
 - Transmission line parameter estimation tool (Lineprop)
 - Functions like a sophisticated and powerful handheld calculator

Program Overview...(2)



Source : PSSE 34.2 PAG-1

Program overview...(3)

Power Flow Activities	
Buses	200,000
Loads	300,000
Generating Buses	26,840
Generators	33,050
Branches	300,000
Transformers	60,000
dc Transmission Links	50
Interchange Areas	1,200
Zero-Sequence Mutual Couplings	4,000
Zones	2,000
Owners	1,200
Dynamic Simulation Activities	
Buses	200,000
Machines	33,050
Branches	300,000
Transformers	60,000
State Variables	257,900
Constants	515,800
Variables	206,300
Output Channels	66,110
ICONS	257,900

File Classes	Created by	Type	Accessible to	Formats
Working files	PSSE	Binary	PSSE	-
Data input files	User via Text Editor	Text	PSSE and user	*.raw, *.dyr
Output listing files	PSSE	Text	User	-
Channel output files	PSSE	Binary	PSSE	*.out, *.outx
Response files	User via Text Editor	Text	PSSE and user	*.idv
Saved case and Snapshot files	PSSE	Binary	PSSE	*.sav, *.snp

Program overview...(4)

SIEMENS

PSS®E

Program Operation

- > Program Operation Manual (POM)
- > Graphical User Interface (GUI) Users Guide
- > Model Library
- > Application Program Interface (API) Manual
- > Program Application Guide Volume 1
- > Program Application Guide Volume 2
- > PSSPLT Program Manual
- > IPLAN Program Manual
- > Command Line Interface (CLI) Users Guide
- > Cheat Sheets
- > •••• •Guide

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www.usa.siemens.com/energy/pti-education

Utilities

- > PSS®E Applications and Utilities
- > LineProp Manual
- > Transmission Line Characteristics (TMLC) Manual
- > Saved Case
- > WECC Data Conversion Model

Reference

- > Release Notes
- > Compatibility Reference & Release History
- > Installation Guide
- > PSS®E Printing Guide to Printing and Plotting

Program overview...(5)

The screenshot displays the PSS/E 34 software interface. The top menu bar includes File, Edit, View, Data Grid, Power Flow, Short Circuit, OPF, Mode-Breaker, Dynamics, Subsystem, Misc, VO Control, Window, Integrations, and Help. Below the menu is a comprehensive toolbar with icons for file operations, editing, and simulation. The main workspace is divided into several panes:

- Output Bar / Tree View:** Located on the left, it shows a list of operations such as 'Cleaning Diagram' and 'Upgrading Diagram', each with a status like 'Successfully cleaned Diagram' or 'Diagram upgraded'.
- Network data:** A central table listing network components. The table has columns for Bus Number, Section Number, Substation Number, Bus Name, Base kV, Area Num, Area Name, Zone Num, Zone Name, Owner Num, Owner Name, Code, and Voltage (pu).
- Diagram View:** On the right, it shows a detailed single-line diagram of the power system, including buses, lines, and equipment.
- Command Line:** At the bottom left, it contains a 'Command Line Input' field with a dropdown menu set to 'PSS/E Response'.
- Status Bar:** At the bottom right, it displays various system parameters and settings, including 'Met convergence tolerances', 'Powerflow results', 'MW/Mvar flow', 'Layer - 1 (Default)', and 'Bind Items: Next bus - 1'.

Toolbar

Spreadsheet View

Diagram View

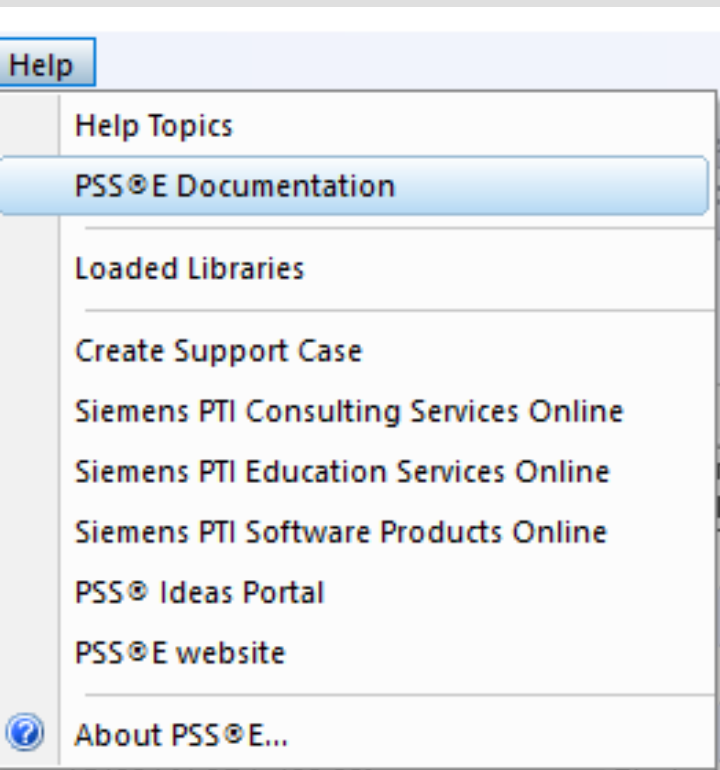
Output Bar / Tree View

Command Line

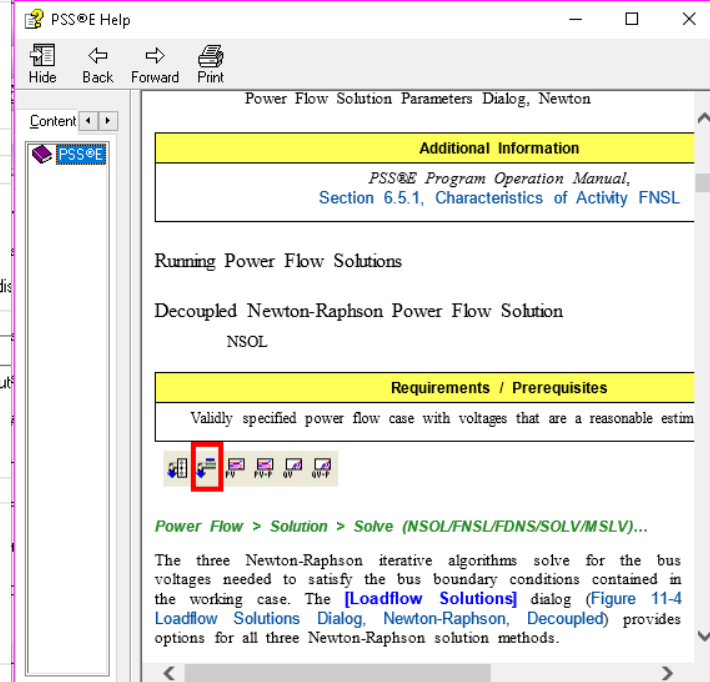
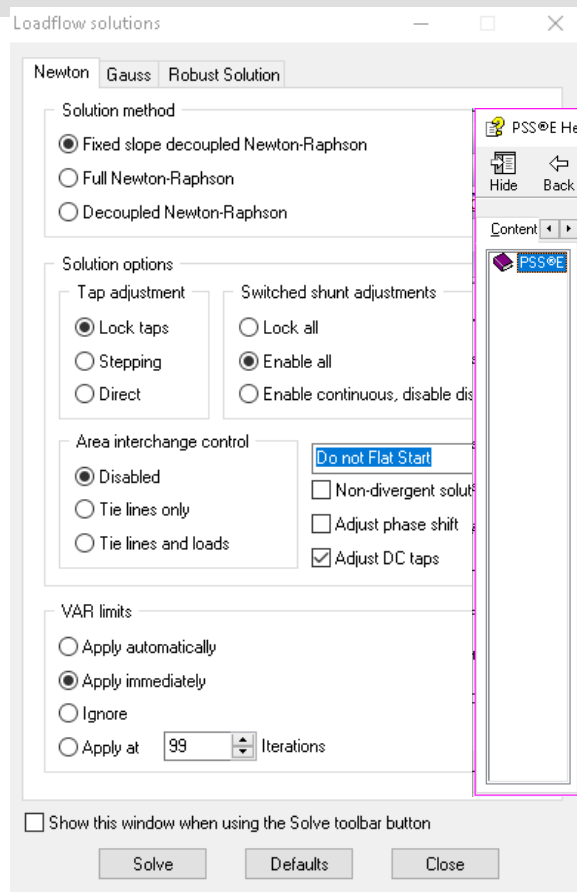
Status Bar

Power flow studies using PSS/E in Bhutan

Program overview...(6)

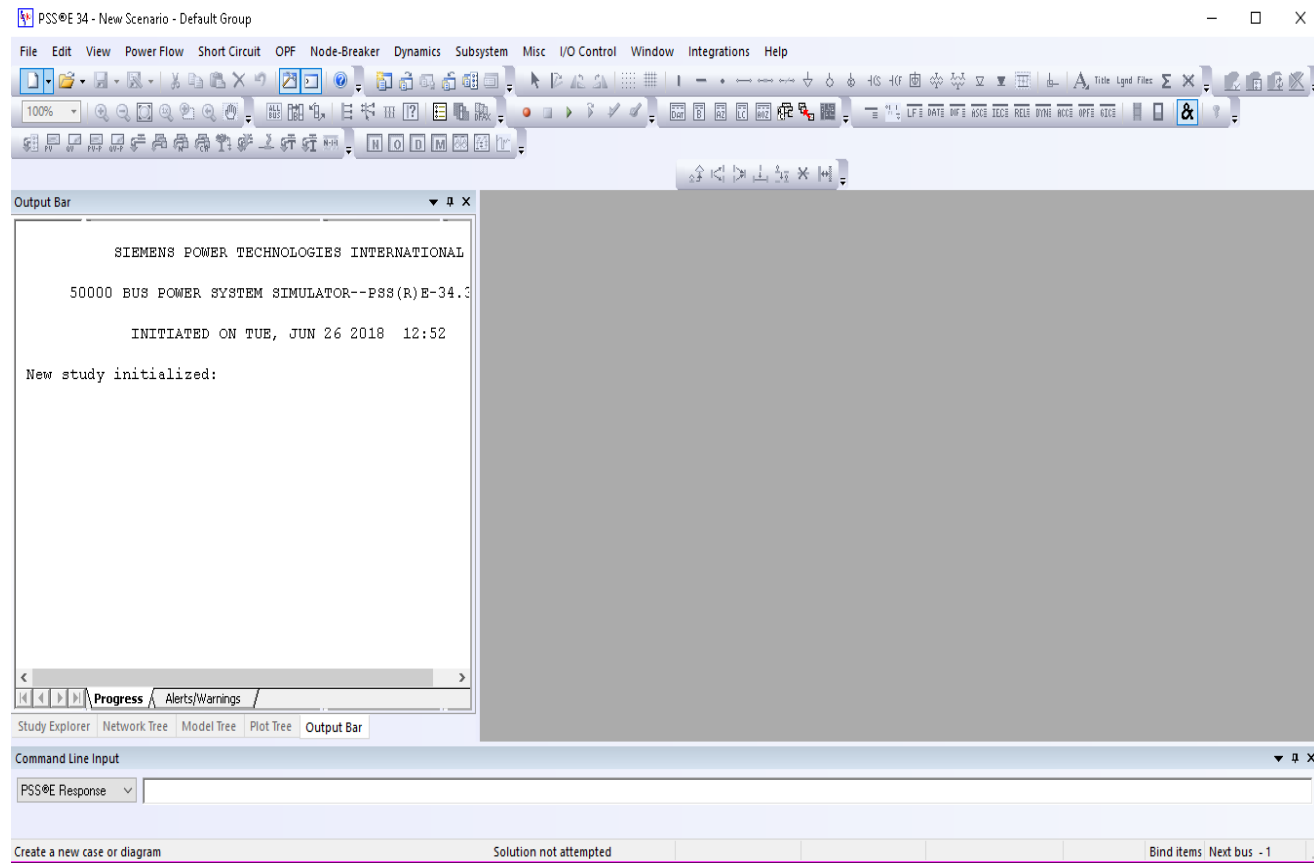
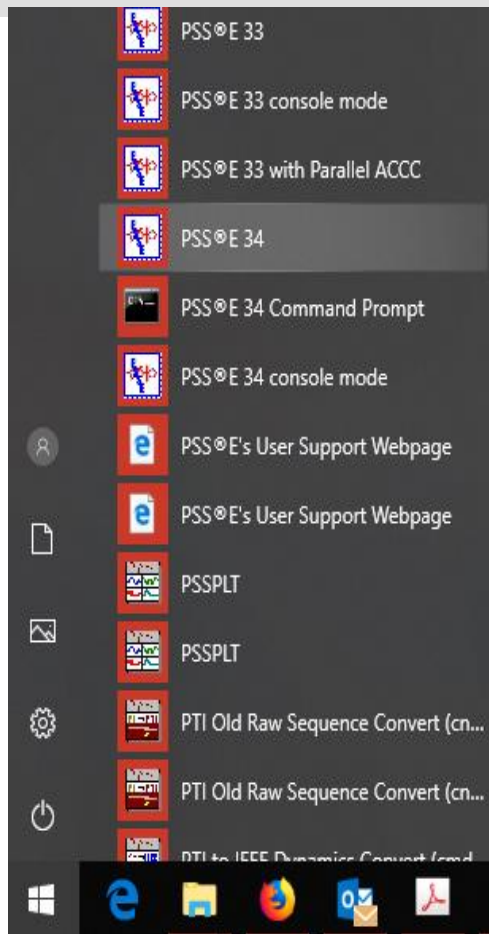


PSSE Help Topics



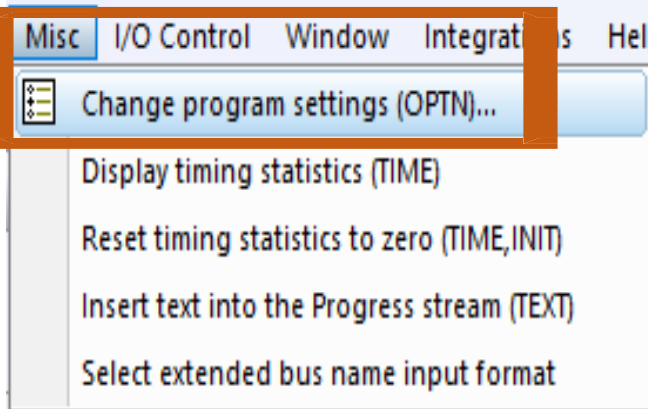
PSSE Topicwise Help : Press F1

PSSE Startup



- Run => Siemens PTI => PSSE 34.x =>
- Starts in EXAMPLE file directory (Default)

Program Options...(1)



Program Settings

General Short Circuit Node-Breaker

Bus input	Number	Startup bus dimension	50000
Bus output	Number	Base frequency	60.00 hz
Power output	MVA	Matrix growth factor	2.00
Voltage output	P.U. (Per Unit)	Contingency processors	1
Voltage input	P.U. (Per Unit)	<input checked="" type="checkbox"/> Check network connectivity before solving	
Transmission line input	P.U. (Per Unit)	<input checked="" type="checkbox"/> Report multi-section lines	
Default rating set	1 (RATING SET 1)	<input type="checkbox"/> Report line shunts	
File overwrite option	Overwrite without asking	<input type="checkbox"/> Print outaged branches	
Transformer percent units	MVA	<input type="checkbox"/> Print "to" buses of 3 winding transformers	
Non transformer percent units	Current expressed as MVA	<input type="checkbox"/> Check for dup contingency names in DFX/CON files	

OK Cancel ☒ Save options to PSSE.OPT file

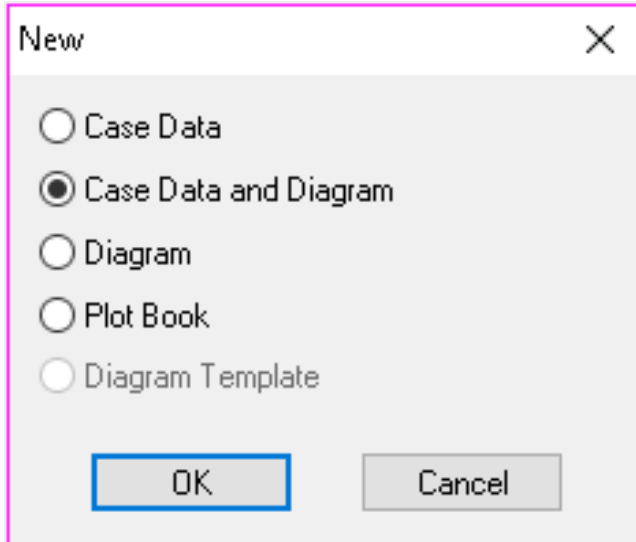
Program Options...(2)

Program Settings

General		Short Circuit		Node-Breaker	
Units - Currents/Voltages	Physical	MOV Maximum iterations	20		
Units - Impedances	Physical	MOV Tolerance	0.010		
Coordinates - Currents/Voltages	Polar	MOV Iteration Alpha	0.300		
Coordinates - Impedances	Polar	<input checked="" type="checkbox"/> Enable fault analysis warnings			
Phase modeling	3-Phase	<input type="checkbox"/> Setup fault network before solving with unba			

OK Cancel ☒ Save options to PSSE.OP

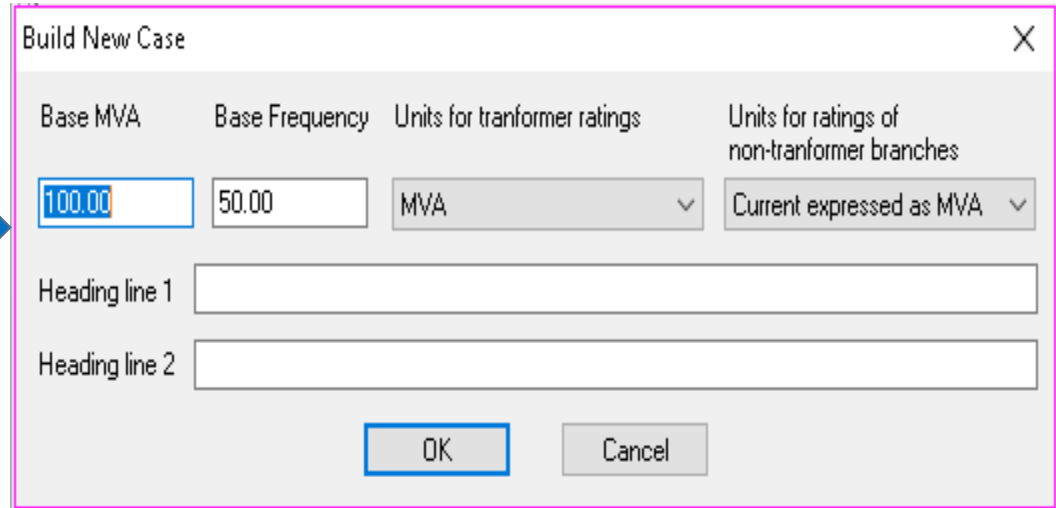
Creating a new case



New

☐ Case Data
☒ Case Data and Diagram
☐ Diagram
☐ Plot Book
☐ Diagram Template

OK Cancel

Build New Case

Base MVA	Base Frequency	Units for tranformer ratings	Units for ratings of non-tranformer branches
100.00	50.00	MVA	Current expressed as MVA

Heading line 1

Heading line 2

OK Cancel

- File => New =>

Power Flow Modeling Data

Case Identification

Bus Data

Load Data

Fixed Bus Shunt Data

Generator Data

Non-Transformer Branch Data

Transformer Data

Area Interchange Data

Two Terminal DC Line Data

Voltage Source Converter DC Line Data

*Transformer Impedance Correction
Data*

Multi-Terminal DC Line Data

Multi-Section Line Grouping Data

Zone Data

Inter-Area Transfer Data

Owner Data

FACTS Device Data

Switched Shunt Data

GNE Device Data

Induction Motor Data

Network Data Tabs...Bus Data...(1)

Network data x

Bus Number	Section Number	Substation Number	Bus Name	Base kV	Area Num	Area Name	Zone Num	Zone Name	Owner Num	Owner Name	Code	Voltage (pu)	Angle (deg)	Normal Vmax (pu)	Normal Vmin (pu)	Em Vr
101			NUC-A	21.6	1	FLAPCO	77	PLANT	11	GEN 1	2	1.0200	16.55	1.1000	0.9000	
102			NUC-B	21.6	1	FLAPCO	77	PLANT	11	GEN 1	2	1.0200	16.55	1.1000	0.9000	
151			NUCPANT	500.0	1	FLAPCO	1	FIRST	1	TRAN 1	1	1.0119	10.89	1.1000	0.9000	
152			MID500	500.0	1	FLAPCO	1	FIRST	1	TRAN 1	1	1.0171	-1.12	1.1000	0.9000	
153			MID230	230.0	1	FLAPCO	1	FIRST	1	TRAN 1	1	0.9930	-3.24	1.1000	0.9000	
154			DOWNTN	230.0	1	FLAPCO	1	FIRST	1	TRAN 1	1	0.9389	-9.89	1.1000	0.9000	
201			HYDRO	500.0	2	LIGHTCO	2	SECOND	22	GEN 2	1	1.0400	6.16	1.1000	0.9000	
202			EAST500	500.0	2	LIGHTCO	2	SECOND	2	TRAN 2	1	1.0088	-1.32	1.1000	0.9000	
203			EAST230	230.0	2	LIGHTCO	2	SECOND	2	TRAN 2	1	0.9665	-6.92	1.1000	0.9000	
204			SUB500	500.0	2	LIGHTCO	2	SECOND	2	TRAN 2	1	0.9787	-3.73	1.1000	0.9000	
205			SUB230	230.0	2	LIGHTCO	2	SECOND	2	TRAN 2	1	0.9490	-9.18	1.1000	0.9000	
206			URBGEN	18.0	2	LIGHTCO	2	SECOND	22	GEN 2	-2	1.0236	-2.97	1.1000	0.9000	
211			HYDRO_G	20.0	2	LIGHTCO	2	SECOND	22	GEN 2	2	1.0404	12.92	1.1000	0.9000	
3001			MINE	230.0	5	WORLD	5	FIFTH	55	GEN 5	1	1.0298	-1.37	1.1000	0.9000	
3002			E. MINE	500.0	5	WORLD	5	FIFTH	5	TRAN 5	1	1.0279	-1.83	1.1000	0.9000	
3003			S. MINE	230.0	5	WORLD	5	FIFTH	5	TRAN 5	1	1.0233	-2.25	1.1000	0.9000	
3004			WEST	500.0	5	WORLD	5	FIFTH	5	TRAN 5	1	1.0165	-3.43	1.1000	0.9000	
3005			WEST	230.0	5	WORLD	5	FIFTH	5	TRAN 5	1	0.9948	-5.18	1.1000	0.9000	
3006			UPTOWN	230.0	5	WORLD	5	FIFTH	5	TRAN 5	1	0.9940	-3.79	1.1000	0.9000	
3007			RURAL	230.0	5	WORLD	5	FIFTH	5	TRAN 5	1	0.9637	-8.54	1.1000	0.9000	
3008			CATDOG	230.0	5	WORLD	5	FIFTH	55	GEN 5	1	0.9586	-9.05	1.1000	0.9000	
3011			MINE_G	13.8	5	WORLD	5	FIFTH	55	GEN 5	3	1.0400	0.00	1.1000	0.9000	

Bus Plan Machine Load Fixed Shunt Switched Shunt Induction Machine NCSFCC /
 Buses and Equipment Branch Node-Breaker Other /

- Buses => Similar to Geographical Nodes in power system
- Mandatory information : Bus number, Bus Name, ID (Type of Bus), Voltage Level (Base KV)

Network Data Tabs...Bus Data...(2)

- Bus Types:

Bus Code	Type	Constant P	Constant Q	Constant V	Constant δ
1	Load Bus	X	X		
2	Generator Bus	X		X	
3	Swing Bus			X	X
4	Isolated Bus				

Network Data Tabs...Load Data

Network data x

	Bus Number	Bus Name	Id	Zone Num	Zone Name	Owner Num	Owner Name	In Service	Scalable	Interruptible	Pload (MW)	Qload (Mvar)	IPload (MW)	IQload (Mvar)	Ypload (MW)	YQload (Mvar)	Distr
	153	MID230 230.00	1	1	FIRST	1	TRAN 1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> Yes	200.0000	100.0000	0.0000	0.0000	0.0000	0.0000	
	154	DOWNTN 230.00	1	1	FIRST	1	TRAN 1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> Yes	600.0000	450.0000	0.0000	0.0000	0.0000	0.0000	
	154	DOWNTN 230.00	2	1	FIRST	100	NO BUSES	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> Yes	400.0000	350.0000	0.0000	0.0000	0.0000	0.0000	
	203	EAST230 230.00	1	2	SECOND	2	TRAN 2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> Yes	300.0000	150.0000	0.0000	0.0000	0.0000	0.0000	
	205	SUB230 230.00	1	2	SECOND	2	TRAN 2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> Yes	1200.0000	700.0000	0.0000	0.0000	0.0000	0.0000	
	3005	WEST 230.00	1	5	FIFTH	5	TRAN 5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> Yes	100.0000	50.0000	0.0000	0.0000	0.0000	0.0000	
	3007	RURAL 230.00	1	5	FIFTH	5	TRAN 5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> Yes	200.0000	75.0000	0.0000	0.0000	0.0000	0.0000	
	3008	CATDOG 230.00	1	5	FIFTH	5	TRAN 5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> Yes	200.0000	75.0000	0.0000	0.0000	0.0000	0.0000	
*								<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> Yes							

< >

 \ Bus \ Plant \ Machine \ **Load** \ Fixed Shunt \ Switched Shunt \ Induction Machine \ NCSFCC /

 \ \ \ \ \ Buses and Equipment \ Branch \ Node-Breaker \ Other /

- Mandatory information : Bus number, ID, Pload & Qload (or other types)
- Types : Constant P, Constant I, Constant Z
- Scalable / Non-scalable, Interruptible / Non-interruptible

Network Data Tabs...Machine Data

Bus Number	Bus Name	Id	In Service	PGen (MW)	PMax (MW)	Mbase (MVA)	PMin (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)	VSched (pu)	Gentap (pu)	R Source (pu)	X Source (pu)	RTran (pu)	XTran (pu)	Terr M
101	COAL-A 138.00	1	<input type="checkbox"/>	10.0000	20.0000	40.00	0.0000	0.0000	10.0000	0.0000	1.0491	1.00000	0.000000	0.200000	0.000000	0.000000	
101	COAL-A 138.00	2	<input type="checkbox"/>	10.0000	20.0000	40.00	0.0000	0.0000	10.0000	0.0000	1.0491	1.00000	0.000000	0.200000	0.000000	0.000000	
101	COAL-A 138.00	3	<input checked="" type="checkbox"/>	76.0000	80.0000	100.00	0.0000	18.2560	30.0000	-25.0000	1.0491	1.00000	0.000000	0.181000	0.000000	0.000000	
101	COAL-A 138.00	4	<input checked="" type="checkbox"/>	76.0000	80.0000	100.00	0.0000	18.2560	30.0000	-25.0000	1.0491	1.00000	0.000000	0.181000	0.000000	0.000000	
101	COAL-A 138.00	5	<input checked="" type="checkbox"/>	76.0000	80.0000	100.00	0.0000	18.2560	30.0000	-25.0000	1.0491	1.00000	0.000000	0.181000	0.000000	0.000000	
102	COAL-B 138.00	1	<input type="checkbox"/>	10.0000	20.0000	40.00	0.0000	0.0000	10.0000	0.0000	1.0494	1.00000	0.000000	0.200000	0.000000	0.000000	
102	COAL-B 138.00	2	<input type="checkbox"/>	10.0000	20.0000	40.00	0.0000	0.0000	10.0000	0.0000	1.0494	1.00000	0.000000	0.200000	0.000000	0.000000	
102	COAL-B 138.00	3	<input checked="" type="checkbox"/>	76.0000	80.0000	100.00	0.0000	13.0100	30.0000	-25.0000	1.0494	1.00000	0.000000	0.181000	0.000000	0.000000	
102	COAL-B 138.00	4	<input checked="" type="checkbox"/>	76.0000	80.0000	100.00	0.0000	13.0100	30.0000	-25.0000	1.0494	1.00000	0.000000	0.181000	0.000000	0.000000	
102	COAL-B 138.00	5	<input checked="" type="checkbox"/>	76.0000	80.0000	100.00	0.0000	13.0100	30.0000	-25.0000	1.0494	1.00000	0.000000	0.181000	0.000000	0.000000	
107	MINI 138.00	1	<input checked="" type="checkbox"/>	80.0000	100.0000	120.00	0.0000	35.2630	60.0000	0.0000	1.0444	1.00000	0.000000	0.170000	0.000000	0.000000	

- Mandatory information : MVA_{base} , P_{max} , P_{min} , Q_{max} , Q_{min} , P_{gen} , $V_{scheduled}$, X_{source} , X_{tran}
- All Machines attached to a Plant (viz. a collective of machines)
- For multiple machines => Use IDs to identify units
- Importance of individual parameters
- Generator transformer modelling => Implicit / explicit

Network Data Tabs...Plant Data

Bus Number	Bus Name	Area Num	Area Name	Code	PGen (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)	VSched (pu)	Remote Bus	Remote Bus Name	Voltage (pu)	RMPCT
101	COAL-A	138.00	1	SOUTH	2	228.0	39.0	90.0	-5.0	1.0491	0	1.0491	100.00
102	COAL-B	138.00	1	SOUTH	2	228.0	39.0	90.0	-5.0	1.0494	0	1.0494	100.00
107	MIDOIL	138.00	5	RADIAL	2	240.0	105.8	180.0	0.0	1.0444	0	1.0444	100.00
213	BIGOIL	230.00	3	MIDAREA	3	346.7	297.3	320.0	0.0	1.0156	0	1.0156	100.00
214	CONDENS	230.00	3	MIDAREA	2	0.0	100.0	100.0	-40.0	1.0044	0	0.9958	100.00
215	MIDCOALP	230.00	4	NORTH	2	155.0	80.0	80.0	-20.0	1.0245	0	1.0176	100.00
216	MIDCOAL	230.00	4	NORTH	2	155.0	80.0	80.0	-20.0	1.0265	0	1.0258	100.00
218	NUKE-A	230.00	4	NORTH	2	400.0	150.8	200.0	-20.0	1.0499	0	1.0499	100.00
221	NUKE-B	230.00	4	NORTH	2	400.0	121.5	200.0	-20.0	1.0499	0	1.0499	100.00
222	HYDRO	230.00	4	NORTH	2	500.0	-27.6	160.0	-100.0	1.0497	0	1.0497	100.00
223	BIGCOAL	230.00	3	MIDAREA	2	1010.0	190.5	460.0	-100.0	1.0499	0	1.0499	100.00
*													

Non-editable

Editable

Network Data Tabs...Shunt Data

Fixed Shunt

Network data x															
	Bus Number	Bus Name	Id	In Service	G-Shunt (MW)	B-Shunt (Mvar)	Term Node Num	Term Node Name	Area Num	Area Name	Zone Num	Zone Name	Code	G-Zero (MW)	B-Zero (Mvar)
	106	REACTOR 138.00	1	<input checked="" type="checkbox"/>	0.00	-40.00			2	SOUTHGEN	2	SOUTHEST	1		
*				<input checked="" type="checkbox"/>											

Switched Shunt

Network data

Network data x

	Bus Number	Bus Name	Term Node Num	In Service	Control Mode	Adjustment method	Vhi (pu)	Vlo (pu)	Blk 1 Steps	Blk 1 Bstep (Mvar)	Blk 2 Steps	Blk 2 Bstep (Mvar)	Blk 3 Steps	Blk 3 Bstep (Mvar)
	106	REACTOR 138.00		<input checked="" type="checkbox"/>	Continuous, cntrl voltage (2)	Sequential input order (0)	1.0381	1.0381	5	-20.00	0	0.00	0	0.00
*				<input checked="" type="checkbox"/>	Locked (0)	Sequential input order (0)								

Network Data Tabs...AC Lines

Network data Network data x

	From Bus Number	From Bus Name	To Bus Number	To Bus Name	Id	Line R (pu)	Line X (pu)	Charging B (pu)	In Service	Metered	RATE1 (l as MVA)	RATE2 (l as MVA)	RATE3 (l as MVA)	Length	Line G From (pu)	Line B From (pu)	Line G To (pu)
	101	COAL-A 138.00	102	COAL-B 138.00	1	0.002600	0.013900	0.461100	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	175.0	193.0	200.0	0.000	0.00000	0.00000	0.0000
	101	COAL-A 138.00	103	WESTIE-1 138.00	1	0.054600	0.211200	0.057200	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	175.0	208.0	220.0	0.000	0.00000	0.00000	0.0000
	101	COAL-A 138.00	105	ANNELOAD 138.00	1	0.021800	0.084500	0.022900	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	175.0	208.0	220.0	0.000	0.00000	0.00000	0.0000
	102	COAL-B 138.00	104	MARYLOAD 138.00	1	0.032800	0.126700	0.034300	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	175.0	208.0	220.0	0.000	0.00000	0.00000	0.0000
	102	COAL-B 138.00	106	REACTOR 138.00	1	0.049700	0.192000	0.052000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	175.0	208.0	220.0	0.000	0.00000	0.00000	0.0000
	103	WESTIE-1 138.00	109	MIDTIE-1 138.00	1	0.030800	0.119000	0.032200	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	175.0	208.0	220.0	0.000	0.00000	0.00000	0.0000
	104	MARYLOAD 138.00	109	MIDTIE-1 138.00	1	0.026800	0.103700	0.028100	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	175.0	208.0	220.0	0.000	0.00000	0.00000	0.0000
	105	ANNELOAD 138.00	110	EASTIE-1 138.00	1	0.022800	0.088300	0.023900	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	175.0	208.0	220.0	0.000	0.00000	0.00000	0.0000
	106	REACTOR 138.00	110	EASTIE-1 138.00	1	0.013900	0.060500	2.459000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	999.0	999.0	999.0	0.000	0.00000	0.00000	0.0000
	107	MIDCOIL 138.00	108	ERIKLOAD 138.00	1	0.015900	0.061400	0.016600	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	175.0	208.0	220.0	0.000	0.00000	0.00000	0.0000
	108	ERIKLOAD 138.00	109	MIDTIE-1 138.00	1	0.042700	0.165100	0.044700	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	175.0	208.0	220.0	0.000	0.00000	0.00000	0.0000
	108	ERIKLOAD 138.00	110	EASTIE-1 138.00	1	0.042700	0.165100	0.044700	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	175.0	208.0	220.0	0.000	0.00000	0.00000	0.0000
	211	MIDTIE-2 230.00	213	BIGCOIL 230.00	1	0.006100	0.047600	0.099900	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	500.0	600.0	625.0	0.000	0.00000	0.00000	0.0000
	211	MIDTIE-2 230.00	214	CONDENS 230.00	1	0.005400	0.041800	0.087900	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	500.0	600.0	625.0	0.000	0.00000	0.00000	0.0000
	212	EASTIE-2 230.00	213	BIGCOIL 230.00	1	0.006100	0.047600	0.099900	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	500.0	600.0	625.0	0.000	0.00000	0.00000	0.0000
	212	EASTIE-2 230.00	223	BIGCOAL 230.00	1	0.012400	0.096600	0.203000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	500.0	600.0	625.0	0.000	0.00000	0.00000	0.0000
	213	BIGCOIL 230.00	223	BIGCOAL 230.00	1	0.011100	0.086500	0.181800	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	500.0	600.0	625.0	0.000	0.00000	0.00000	0.0000
	215	MIDCOALP 230.00	216	MIDCOAL 230.00	1	0.002200	0.017300	0.036400	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	500.0	600.0	625.0	0.000	0.00000	0.00000	0.0000
	215	MIDCOALP 230.00	221	NUKE-B 230.00	1	0.006300	0.049000	0.103000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	500.0	600.0	625.0	0.000	0.00000	0.00000	0.0000
	215	MIDCOALP 230.00	221	NUKE-B 230.00	2	0.006300	0.049000	0.103000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	500.0	600.0	625.0	0.000	0.00000	0.00000	0.0000
	215	MIDCOALP 230.00	224	WESTIE-2 230.00	1	0.006700	0.051900	0.109100	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	500.0	600.0	625.0	0.000	0.00000	0.00000	0.0000
	216	MIDCOAL 230.00	217	NOLOAD 230.00	1	0.003300	0.025900	0.054500	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	500.0	600.0	625.0	0.000	0.00000	0.00000	0.0000

AC Line	2 Winding	3 Winding	Mutual	System Switching Device	Multi-section line	2-Term DC	VSC DC	Multi-Term DC	FACTS	GNE
	Buses and Equipment	Branch	Node-Breaker	Other						

- Mandatory information : From Bus, To Bus, Branch-ID, R, X, B (in p.u.), Ratings, Length, Line Shunts (From end / To end)

Network Data Tabs...2-winding transformer

Network data

Network data x

	From Bus	From Bus Name	To Bus Number	To Bus Name	Id	In Service	Metered	Specified R (pu or watts)	Specified X (pu)	RATE1 (MVA)	RATE2 (MVA)	RATE3 (MVA)	Controlled Bus	Controlled Bus Side	Tap Positions	Control Mode
	103	WESTIE-1 138.0	224	WESTIE-2 230.00	1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	0.002300	0.020000	400.0	510.0	600.0	215	<input type="checkbox"/> Tapped	17	Voltage
	109	MIDTIE-1 138.00	211	MIDTIE-2 230.00	1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	0.002300	0.020000	400.0	510.0	600.0	213	<input type="checkbox"/> Tapped	17	Voltage
	109	MIDTIE-1 138.00	212	EASTIE-2 230.00	1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	0.002300	0.020000	450.0	510.0	600.0	213	<input type="checkbox"/> Tapped	17	Voltage
	110	EASTIE-1 138.00	211	MIDTIE-2 230.00	1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From	0.002300	0.020000	400.0	510.0	600.0	110	<input checked="" type="checkbox"/> Tapped	17	Voltage
	110	EASTIE-1 138.00	212	EASTIE-2 230.00	1	<input checked="" type="checkbox"/>	<input type="checkbox"/> From	0.002300	0.020000	400.0	510.0	600.0	110	<input checked="" type="checkbox"/> Tapped	9999	MV symmetrical P
	214	CONDENS 230.0	225	ADDON 230.00	1	<input checked="" type="checkbox"/>	<input type="checkbox"/> From	0.001000	0.020000	500.0	600.0	625.0	0	<input type="checkbox"/> Tapped	9999	MV symmetrical P
*						<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> From							<input type="checkbox"/> Tapped		

Network data		Network data x														
	From Bus	From Bus Name	To Bus Number	To Bus Name	Id	Auto Adjust	Winding MVA Base	Wnd 1 Ratio (pu or kV)	Wnd 1 Nominal kV	Wnd 1 Angle	Wnd 2 Ratio (pu or kV)	Wnd 2 Nominal kV	Rmax (pu, kV, deg)	Rmin (pu, kV, deg)	Vmax (pu, Mvar, MW)	Vmin (pu, Mvar, MW)
	103	WESTIE-1 138.0	224	WESTIE-2 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0375	0.0000	0.00	1.0000	0.0000	1.05000	0.95000	1.10000	
	109	MIDTIE-1 138.00	211	MIDTIE-2 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0469	0.0000	0.00	1.0000	0.0000	1.05000	0.95000	1.10000	
	109	MIDTIE-1 138.00	212	EASTIE-2 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0391	0.0000	0.00	1.0000	0.0000	1.05000	0.95000	1.10000	
	110	EASTIE-1 138.00	211	MIDTIE-2 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0500	0.0000	0.00	1.0000	0.0000	1.05000	0.95000	1.10000	
	110	EASTIE-1 138.00	212	EASTIE-2 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0372	0.0000	-24.23	1.0000	0.0000	45.05000	-45.00000	250.00000	
	214	CONDENS 230.0	225	ADDON 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0000	0.0000	22.55	1.0000	0.0000	45.00000	-45.00000	330.00000	
*						<input type="checkbox"/> Yes										

- Mandatory information : From Bus, To Bus, R, X, Ratings, Tap Settings

Network Data Tabs...Area/ Owner / Zone

Owners

Zones

Areas

	Area Num	Area swing bus	Desired Interchang	Tolerance (MW)	Area Name
	1	101	250.00	10.00	FLAPCO
	2	206	-100.00	10.00	LIGHTCO
	5	3011	-150.00	10.00	WORLD
*					

Ratings	Area	Owner	Zone	Inter-area Transfer
◀◀	▶▶	Buses and Equipment	Branch	Node-Breaker
				Other

	Owner Num	Owner Name
	1	TRAN 1
	2	TRAN 2
	5	TRAN 5
	11	GEN 1
	22	GEN 2
	55	GEN 5
	100	NO BUSES
*		

	Zone Num	Zone Name
	1	FIRST
	2	SECOND
	5	FIFTH
	77	PLANT
*		

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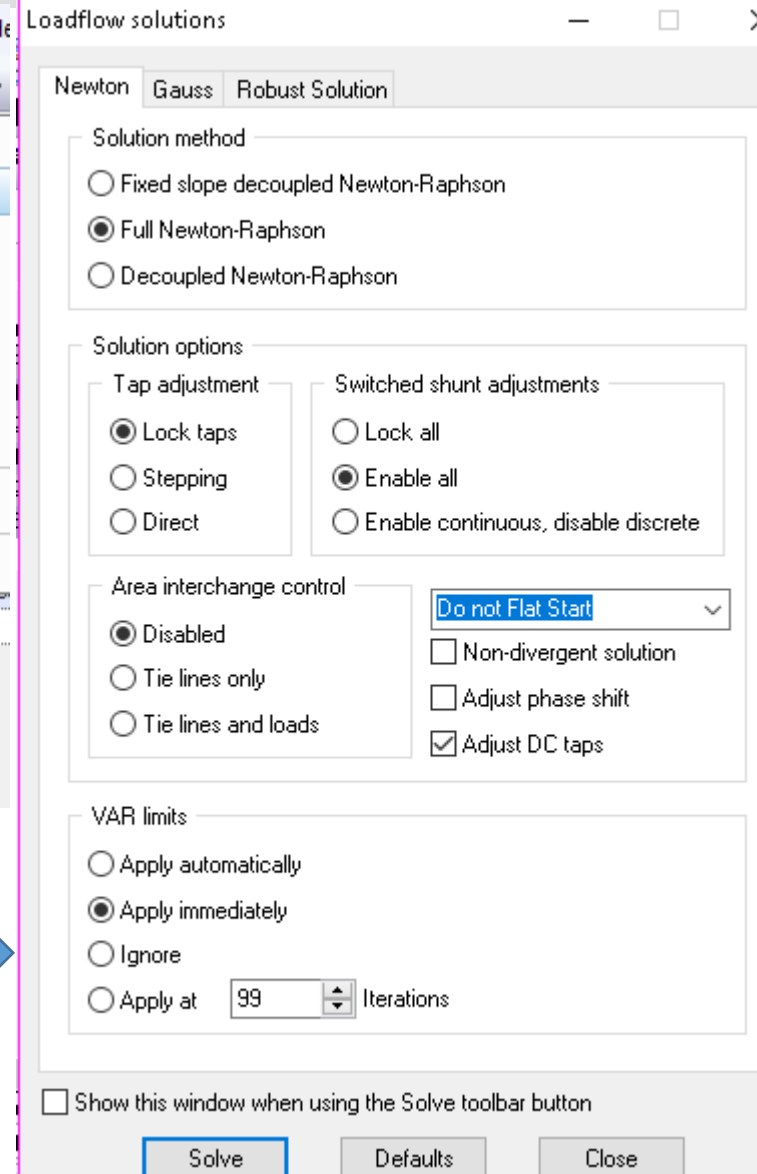
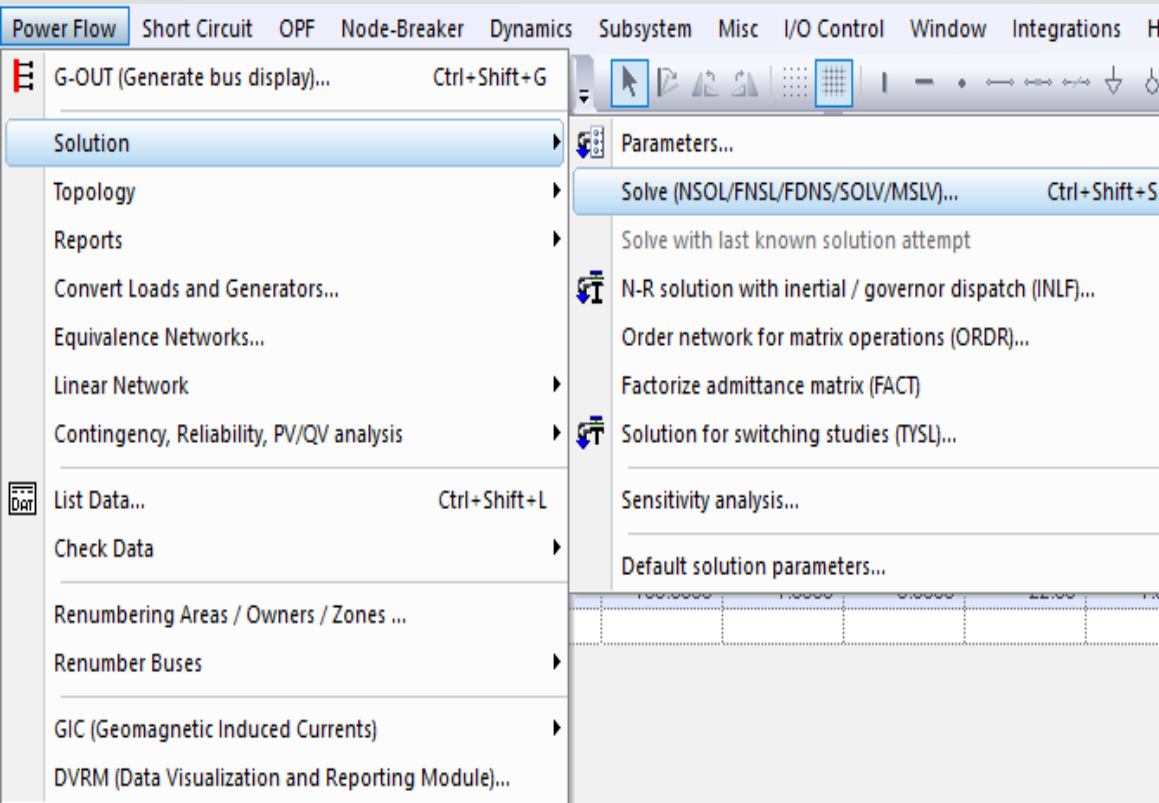
SAARC Workshop on Load/Power Flow Studies using PSS/E for Efficient National & Cross Border Interconnected Power Systems in South Asia

Session II : Getting started with power flow in PSS/E

Day-1

**Thimphu, Bhutan
18th to 20th July 2018**

Power flow solution options



Robust method : Newton-Raphson

Power flow solution

PSS®E 34 - New Scenario - Default Group - C:\Users\02470\Documents\PTI\PSSE34\EXAMPLE\ieee_25bus.sav

File Edit View Data Grid Power Flow Short Circuit OPF Node-Breaker Dynamics Subsystem Misc I/O Control Window Integrations Help

100%

Output Bar

The Saved Case in file C:\Users\02470\Documents\PTI\PSSE34\EXAMPLE\ieee_25bus.sav

Ordering network...

Diagonals = 24 Off-diagonals = 49 Maximum size = 64

ITER	DELTAP	BUS	DELTAQ	BUS	DELTA/V	BUS
0	0.0002	110	0.0009	110		
1	0.0000	214	0.0000	110		103

Reached tolerance in 1 iterations

Largest mismatch: 0.00 MW 0.00 Mvar 0.00 MVA at bus 106 [REACTIVE POWER]

System total absolute mismatch: 0.00 MVA

SWING BUS SUMMARY:

BUS#-SCT	X-- NAME	--X BASKV	PGEN	PMAX	PMIN	QGEN	QMAX
213	BIGOIL	230.00	346.7	800.0	0.0	297.3	320.0

Network data

From Bus	From Bus Name	To Bus Number	To Bus Name	Id	Auto Adjust	Winding MVA Base	Wnd 1 Ratio (pu or kV)	No.
103	WESTIE-1 138.0	224	WESTIE-2 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0375	
109	MIDTIE-1 138.00	211	MIDTIE-2 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0469	
109	MIDTIE-1 138.00	212	EASTIE-2 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0391	
110	EASTIE-1 138.00	211	MIDTIE-2 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0500	
110	EASTIE-1 138.00	212	EASTIE-2 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0372	
214	CONDENS 230.0	225	ADDON 230.00	1	<input checked="" type="checkbox"/> Yes	100.0000	1.0000	
*					<input type="checkbox"/> Yes			

Progress Alerts/Warnings

Study Explorer Network Tree Model Tree Plot Tree Output Bar

Command Line Input

PSS®E Response

Workshop on Power flow studies using PSSE at Thimphu, Bhutan

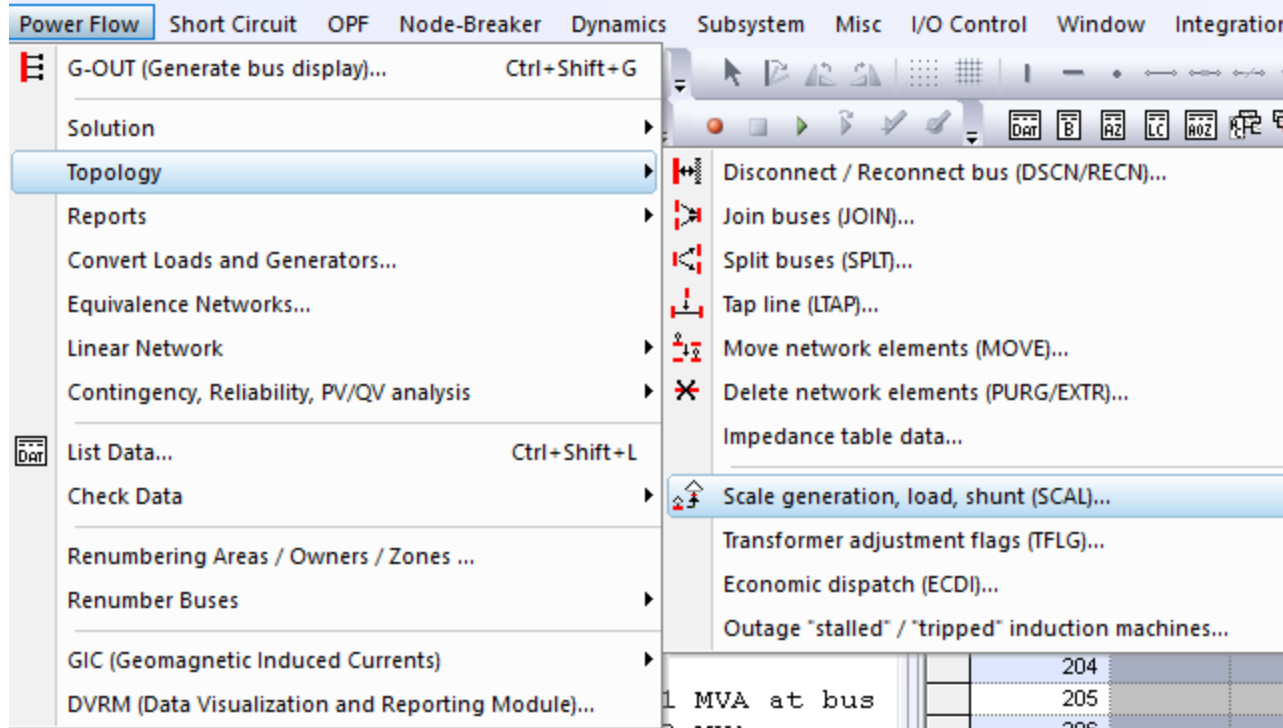
Select an object on which to get Help

Met convergence tolerances

-2.08, 2.25 Bind items Next bus - 1

36

Modifying power flow data...(1)



Topology Toolbar

- Power flow data modification options:
 - Change topology (Split buses, Join buses, Move network elements, etc.)
 - Scale Load / Generation (Bus wise / Subsystem wise)

Modifying power flow data...Scale...(2)

Scale Powerflow Data

Scale only non-interruptible scalable loads

Select

☐ All buses

☒ Selected bus subsystem

☐ The following buses

Bus Subsystem Selector

Area Owner Zone Base kV Bus

Unselected areas

1 FLAPCO
2 LIGHTCO
5 WORLD

Selected areas

Area number

☐ All buses

Modifying power flow data...Scale...(3)

Scale Powerflow Data

	Original	New total	% Change	Incremental change
Load -MW	200.000	200.0000 10 MW	0.0000 1 %	0.0000 10 MW
Generation	1500.000	1500.0000 10 MW	0.0000 1 %	0.0000 10 MW
Shunt-MW	0.000	0.0000	0.0000	0.0000
Reactors	600.000	600.0000 10 Mvar	0.0000 1 %	0.0000 10 Mvar
Capacitors	300.000	300.0000 10 Mvar	0.0000 1 %	0.0000 10 Mvar
Motor Load	-0.000	-0.0000	0.0000	0.0000

Reactive Power Component

☐ Load-Mvar 100.000 100.0000 10 Mvar 0.0000 1 % 0.0000 10 Mvar
☐ Constant Load P/Q Ratio
☒ Load Power Factor 0.9500 0.01

Limits	P min	P max
Total generator	0.000	1620.000
Total motor load	-0.000	-0.000

☐ Enforce machine power limits

Responses recorded as

☒ New Totals
☐ Percent changes
☐ Incremental changes

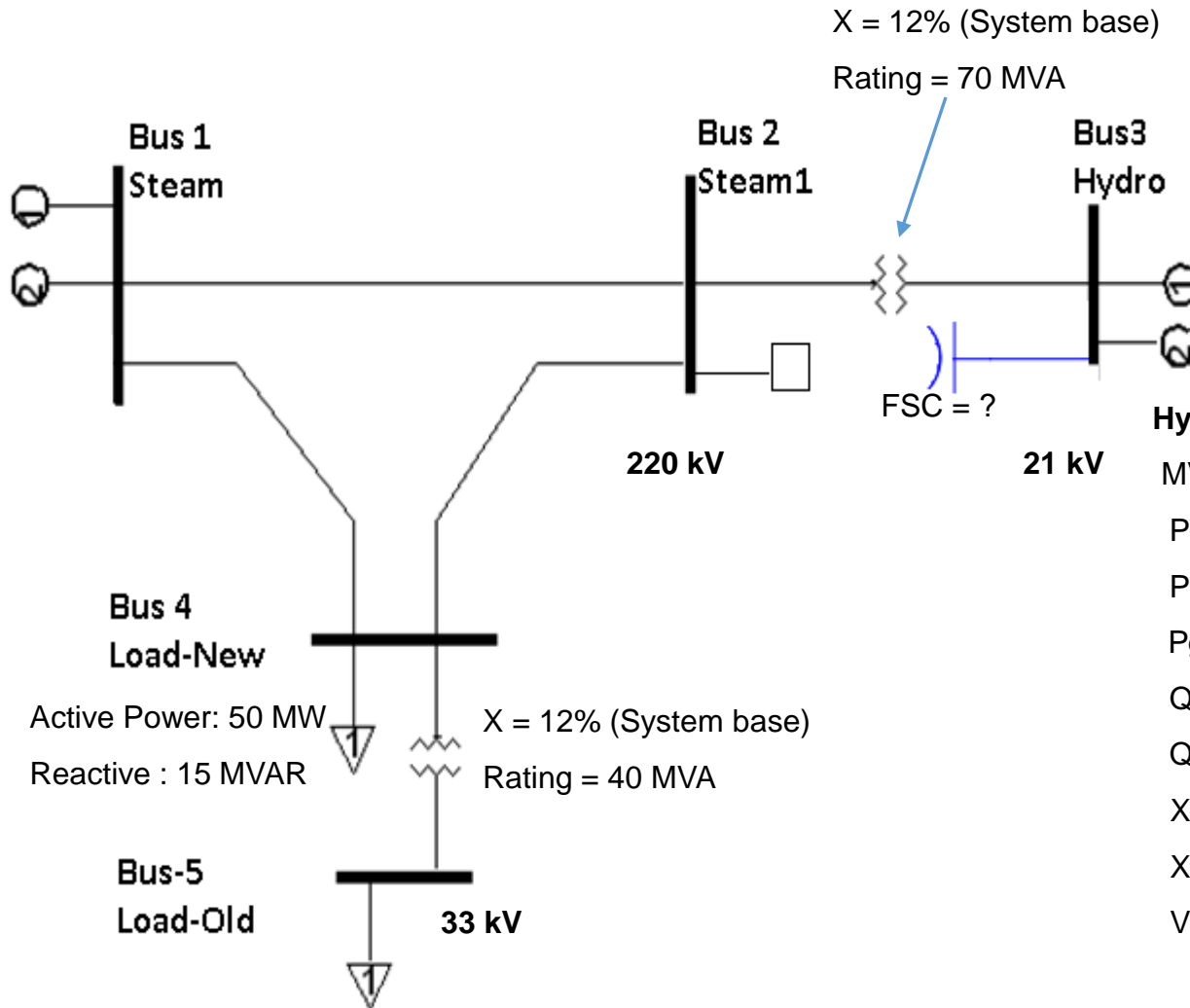
OK Close

- Scale Load / Generation / Fixed Shunts
- Scale Active / Reactive power components
- Utility :
 - Change subsystem wise data

Exercise : Power flow modelling...(1)

Steam :

MVA_b = 58 MVA
 P_{max} = 50 MW
 P_{min} = 20 MW
 P_{gen} = 40 MW
 Q_{max} = 20 MVar
 Q_{min} = -10 Mvar
 X_{source} = 13%
 X_{tran} = 14.5%
 V_{sched} = 220



Hydro:

MVA_b = 28 MVA
 P_{max} = 23 MW
 P_{min} = 0 MW
 P_{gen} = 20 MW
 Q_{max} = 10 MVar
 Q_{min} = 0 Mvar
 X_{source} = 20%
 X_{tran} = 12%
 V_{sched} = 21.21

System Base : 50 Hz, 100 MVA

Swing bus (Type-3) : Bus3

Exercise : Power flow modelling...(2)

<u>Line Data</u>	<u>Impedances (PU on System Base)</u>			<u>(MVA)</u>		
	<u>R</u>	<u>X</u>	<u>B</u>	<u>Rate A</u>	<u>Rate B</u>	<u>Rate C</u>
Bus1 – Bus2	0.0003	0.0124	0.5435	132	200	220
Bus1 – Bus4	0.0002	0.0020	0.0068	132	200	220
Bus2 – Bus4	0.0001	0.0015	0.0049	132	200	220

Problem statement:

- Model the standard 5 bus system above using data given
- Use appropriate bus types (Refer previous slides on Bus-type)
- Save as 'Case-1.1.sav'
- Solve power flow
- Find the highest loaded line (in percentage terms)

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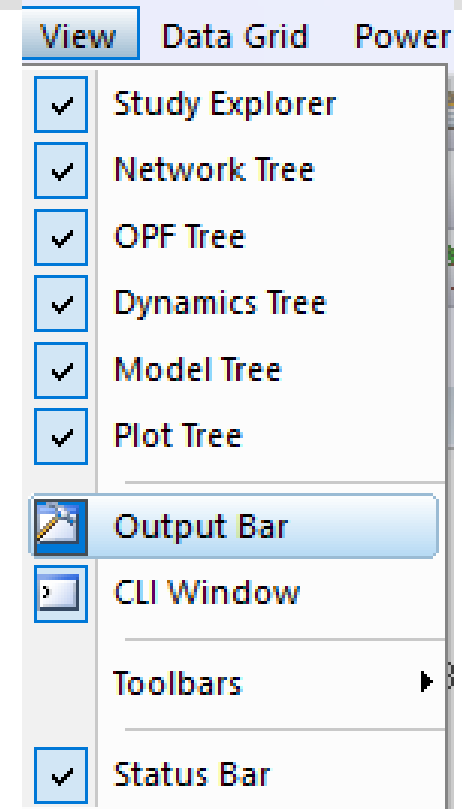
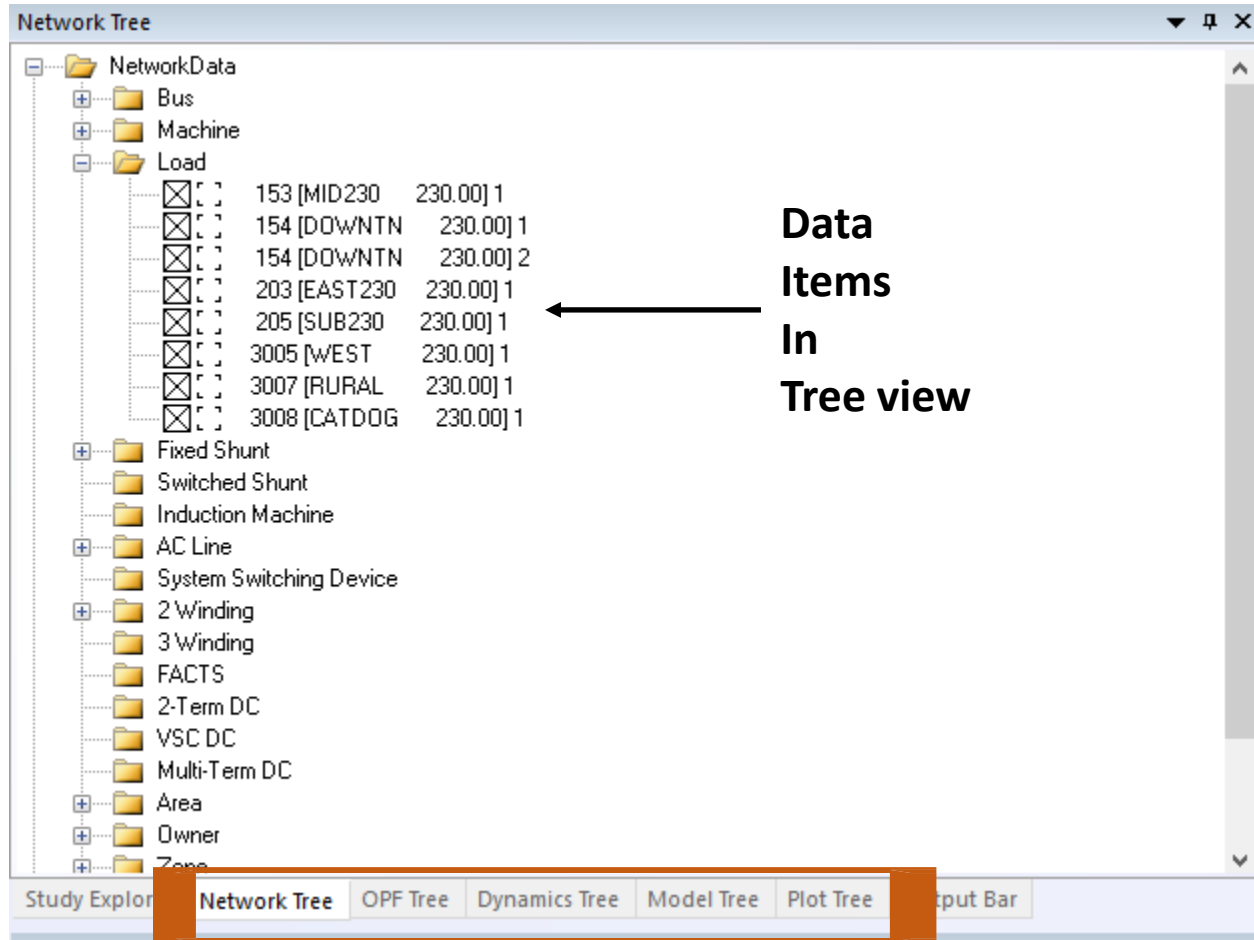
SAARC Workshop on Load/Power Flow Studies using PSS/E for Efficient National & Cross Border Interconnected Power Systems in South Asia

Session III : Diagrams in PSS/E

Day-1

**Thimphu, Bhutan
18th to 20th July 2018**

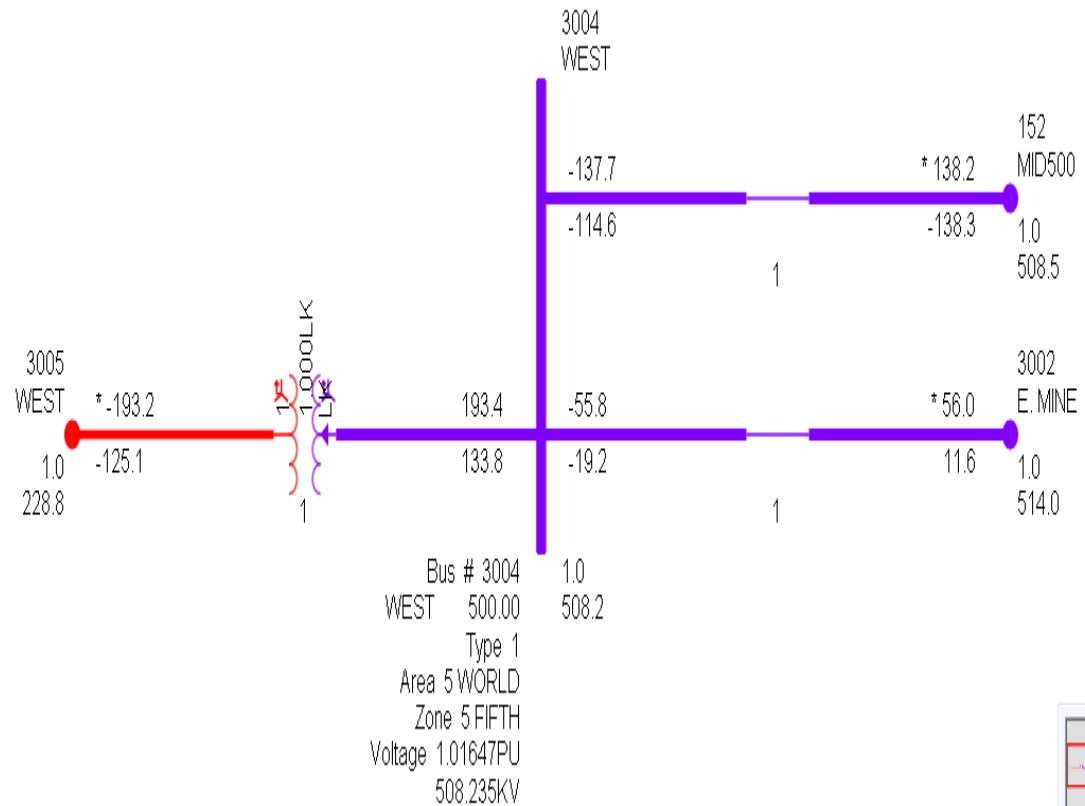
Tree Views in PSSE



- Tree views in PSSE present useful information at a glance
- To enable tree views for a particular category => View > Tick/Untick
- Useful for creating diagrams, plotting transient simulation results, viewing model data, etc.

Diagram View in PSSE

- For ease of visualisation
- SLD (Single Line Diagram) form
- Add/modify network elements
- Perform power flow solution
- View results



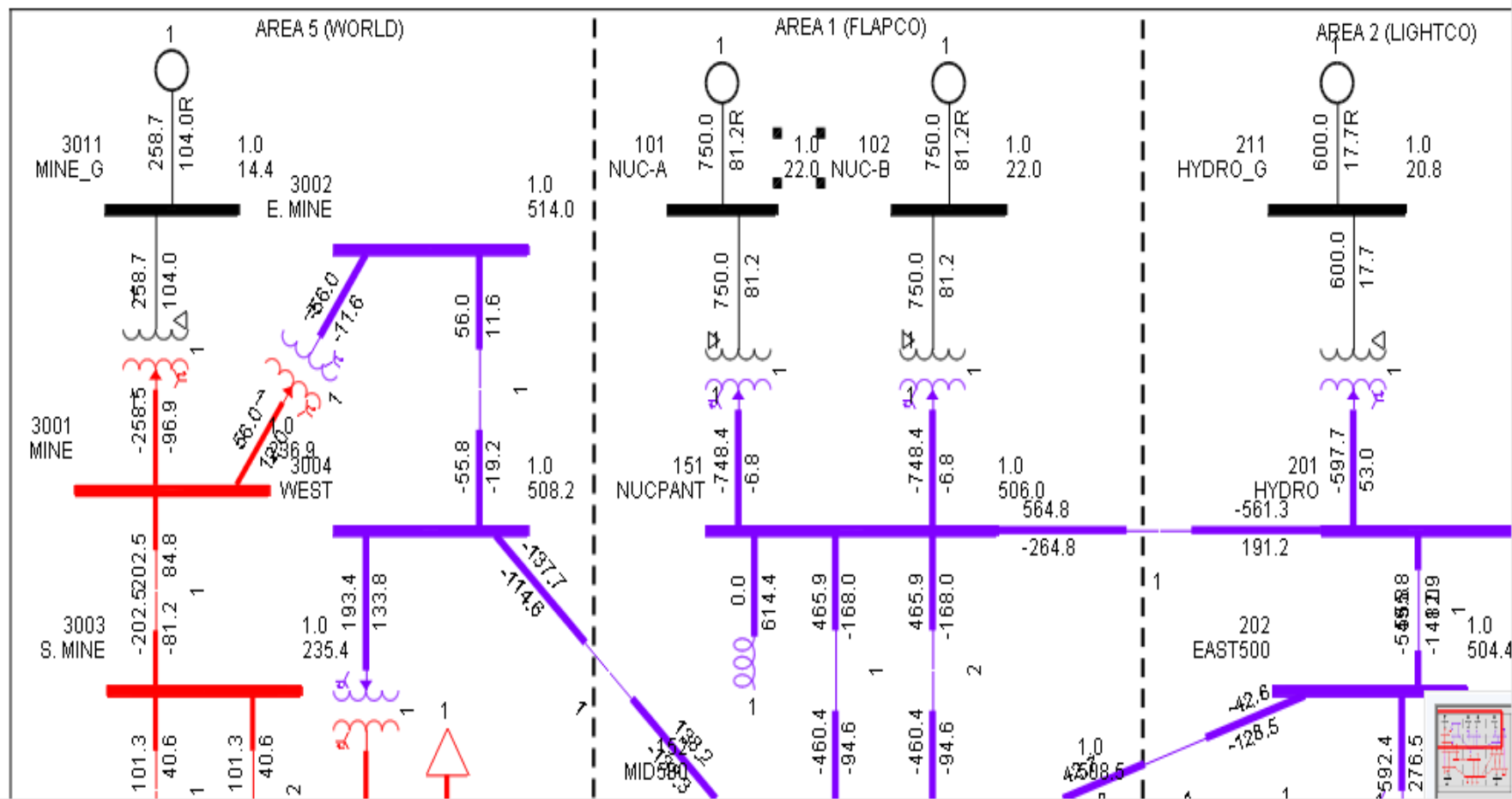
New

☐ Case Data
☐ Case Data and Diagram
☒ Diagram
☐ Plot Book
☐ Diagram Template

OK Cancel

Single Line Diagram View (*.sld file)

Dynamics data Network data savnw.sld x



To Create a New Diagram

The screenshot shows the PSS@E 33 software interface. The 'New' dialog box is open, and the 'Diagram' option is selected. The 'Network data' table is visible in the background.

Bus Number	Bus Name	Base kV	Area Num	Area Name	Zone Num	Zone Name	Owner Num	Owner Name	Code	Voltage (pu)
101	NUC-A	21.6	1	FLAPCO	77	PLANT	11	GEN 1	2	1.0200
102	NUC-B	21.6	1	FLAPCO	77	PLANT	11	GEN 1	2	1.0200
151	NUCPANT	500.0	1	FLAPCO	1	FIRST	1	TRAN 1	1	1.0119
152	MID500	500.0	1	FLAPCO	1	FIRST	1	TRAN 1	1	1.0171
153	MID230	230.0	1	FLAPCO	1	FIRST	1	TRAN 1	1	0.9930

The 'New' dialog box options are:

- ☐ Network case
- ☐ Network case and Diagram
- ☒ Diagram
- ☐ Plot Book
- ☐ Diagram Template

The 'Diagram1' window is also visible, showing the 'Diagram' option selected in the 'New' dialog box.

Diagram Menu Options

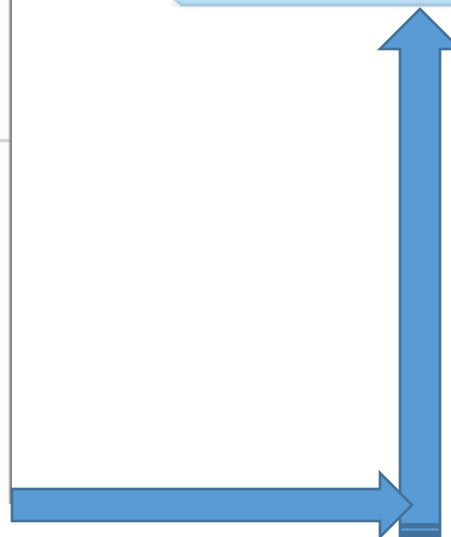
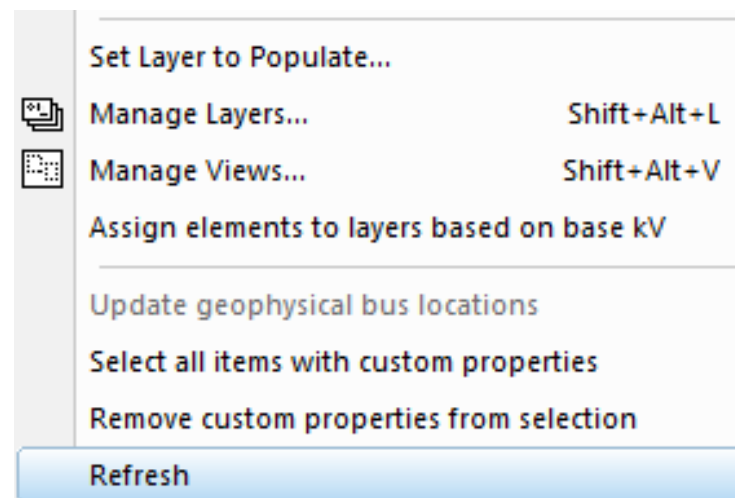
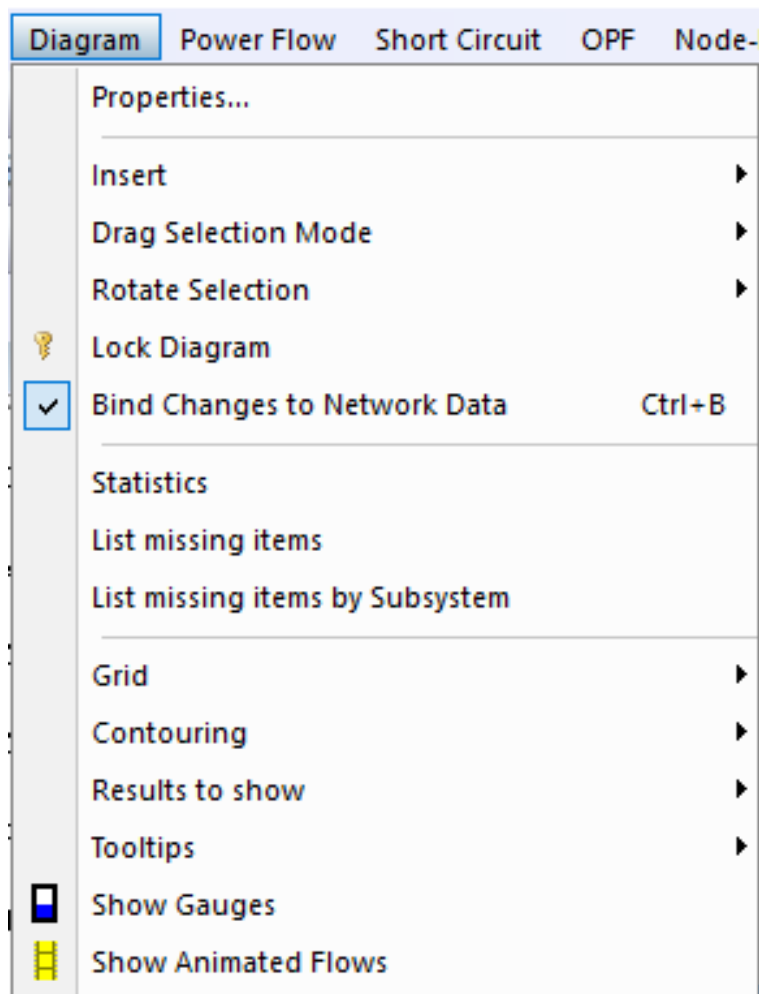
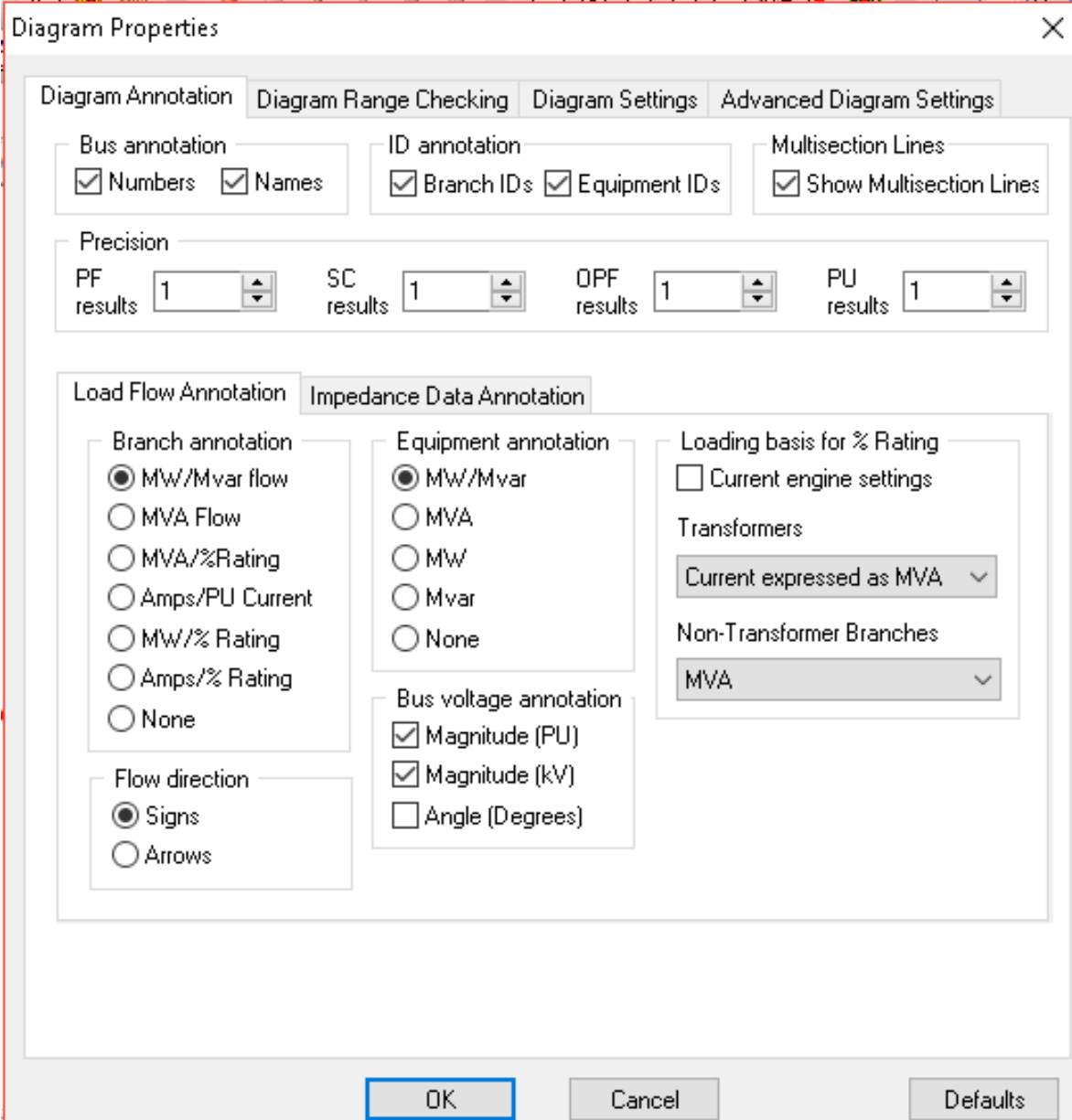


Diagram Properties...(1)

- **Menu Bar -> Diagram -> Properties**
- Diagram Annotation
- Diagram Range Checking
- Diagram Settings
- Used to modify visualisation experience on SLD files



The screenshot shows the 'Diagram Properties' dialog box with the following settings:

- Diagram Annotation** (selected tab):
 - Bus annotation: ☒ Numbers, ☒ Names
 - ID annotation: ☒ Branch IDs, ☒ Equipment IDs
 - Multisection Lines: ☒ Show Multisection Lines
- Precision**:
 - PF results: 1
 - SC results: 1
 - OPF results: 1
 - PU results: 1
- Load Flow Annotation** (selected sub-tab):
 - Branch annotation:
 - ☒ MW/Mvar flow
 - ☐ MVA Flow
 - ☐ MVA/%Rating
 - ☐ Amps/PU Current
 - ☐ MW/% Rating
 - ☐ Amps/% Rating
 - ☐ None
 - Flow direction:
 - ☒ Signs
 - ☐ Arrows
- Impedance Data Annotation** (sub-tab):
 - Equipment annotation:
 - ☒ MW/Mvar
 - ☐ MVA
 - ☐ MW
 - ☐ Mvar
 - ☐ None
 - Bus voltage annotation:
 - ☒ Magnitude (PU)
 - ☒ Magnitude (kV)
 - ☐ Angle (Degrees)
- Advanced Diagram Settings** (sub-tab):
 - Loading basis for % Rating: ☐ Current engine settings
 - Transformers: Current expressed as MVA (dropdown)
 - Non-Transformer Branches: MVA (dropdown)

Buttons at the bottom: OK, Cancel, Defaults.

Diagram Properties...(2)

Diagram Properties

Diagram Annotation | **Diagram Range Checking** | Diagram Settings | Advanced Diagram Settings

☒ Use voltage level thresholds ☒ Assign items to layers based on base kV

33 66 132 220 400 765 1200

☒ Out-of-service equipment Faulted bus appearance

☒ Use line ratings % Loading: 100 5%

☐ Use bus voltage limits Vmax: 1.05 0.01 pu Vmin: 0.95 0.01 pu

Network items colors: Bound item (black), Unbound item (magenta), Hide Unbound Items

Breaker/Switch colors: Open item (green), Closed item (red)

Line rating set: 1 (RATING SET 1)

☐ Use loading percentages Loading percentages for bar charts: 95, 100, 105, 110

For 2 winding transformers, display loading charts on: High current loading side

OK Cancel Defaults

Diagram Range Checking

Diagram Properties

Diagram Annotation | Diagram Range Checking | **Diagram Settings** | Advanced Diagram Settings

Diagram Title: WEST

Labels: Color (black), Alignment (Center), Hide Labels

Flow Arrows: ☒ Scale Flow Arrows ("P" flow arrow), ☐ Animate Flows ("Q" flow arrow)

Busbar Layout: Default Orientation (Horizontal, Vertical), Perpendicular branch connections, Overwrite default spacing (0), Display filled busbars

Label Orientation: ☒ No upside-down text, Vertical Direction (Up, Down)

Geophysical Scaling and Centering: One screen inch (96 DIPs) at 100% zoom equals 1 in, Longitude at Center (0), Latitude at Center (0)

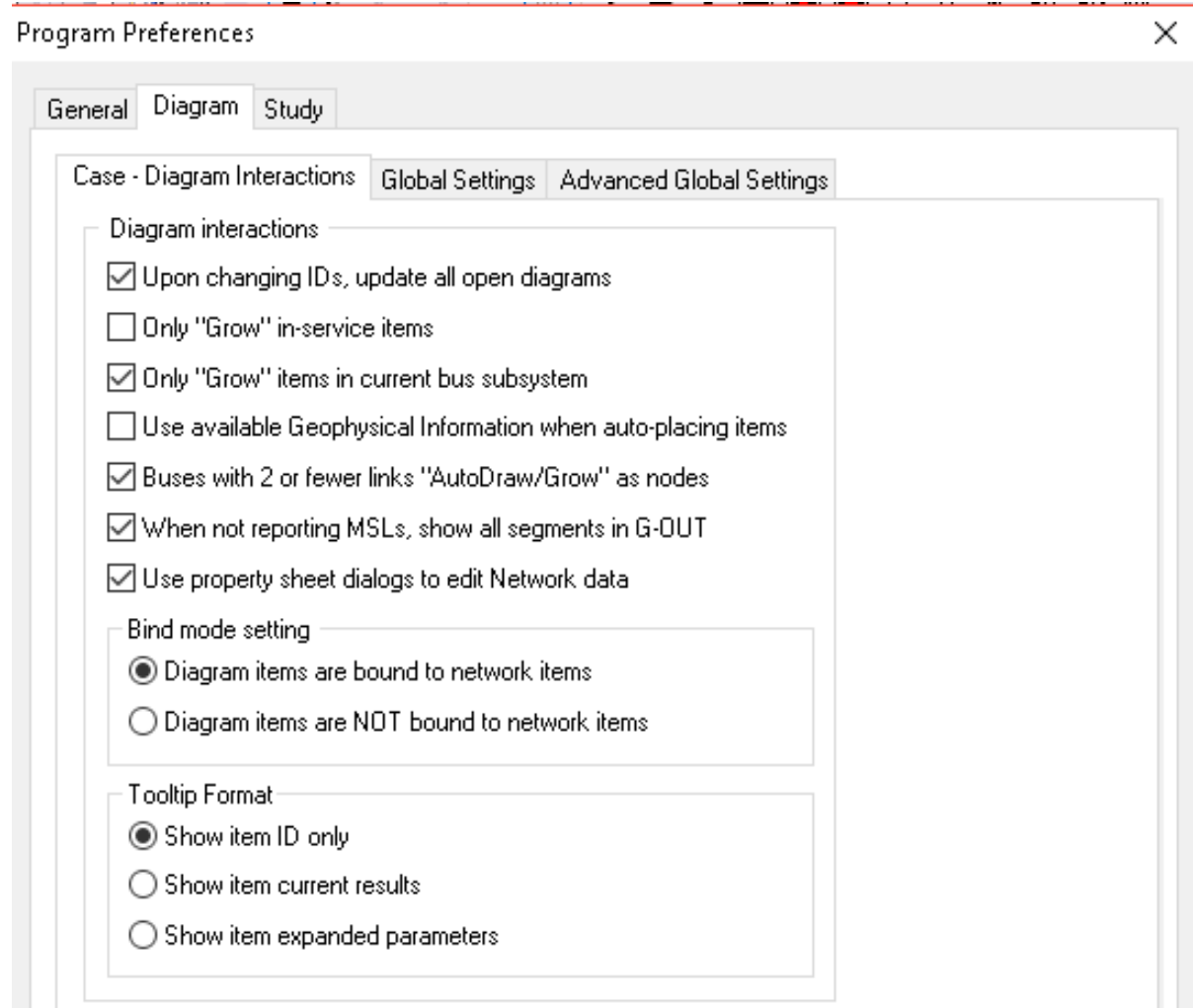
Spacing: 0.2, Snap: 0.1

OK Cancel

Additional Diagram settings

Diagram Preferences

- **Menu bar -> Edit -> Preferences**
- For 'Grow' activity
- For control on bind/unbind mode



Program Preferences

General Diagram Study

Case - Diagram Interactions Global Settings Advanced Global Settings

Diagram interactions

- ☒ Upon changing IDs, update all open diagrams
- ☐ Only "Grow" in-service items
- ☒ Only "Grow" items in current bus subsystem
- ☐ Use available Geophysical Information when auto-placing items
- ☒ Buses with 2 or fewer links "AutoDraw/Grow" as nodes
- ☒ When not reporting MSLs, show all segments in G-OUT
- ☒ Use property sheet dialogs to edit Network data

Bind mode setting

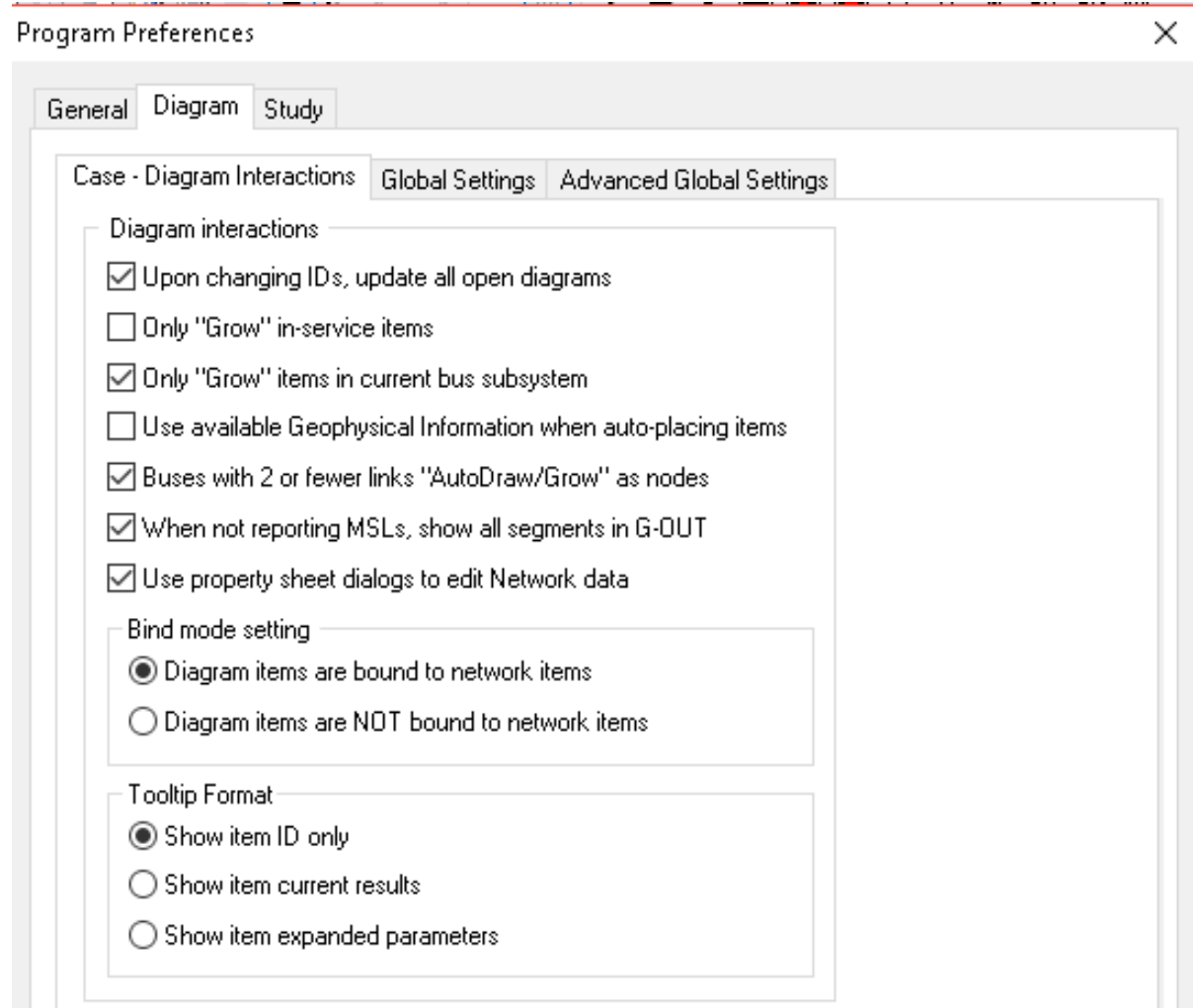
- ☒ Diagram items are bound to network items
- ☐ Diagram items are NOT bound to network items

Tooltip Format

- ☒ Show item ID only
- ☐ Show item current results
- ☐ Show item expanded parameters

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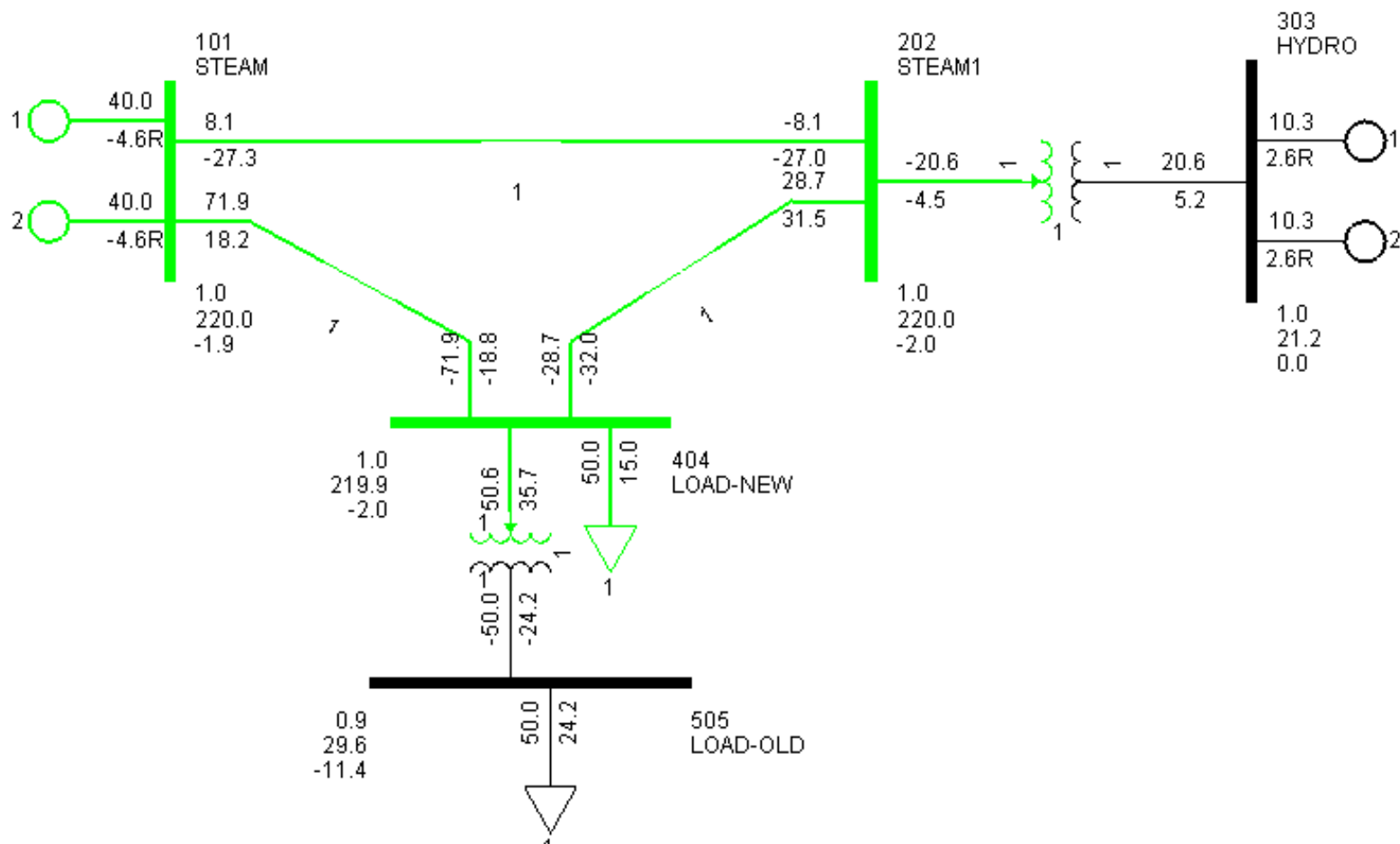
Tooltip Format

- ☒ Show item ID only
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- ☐ Show item expanded parameters

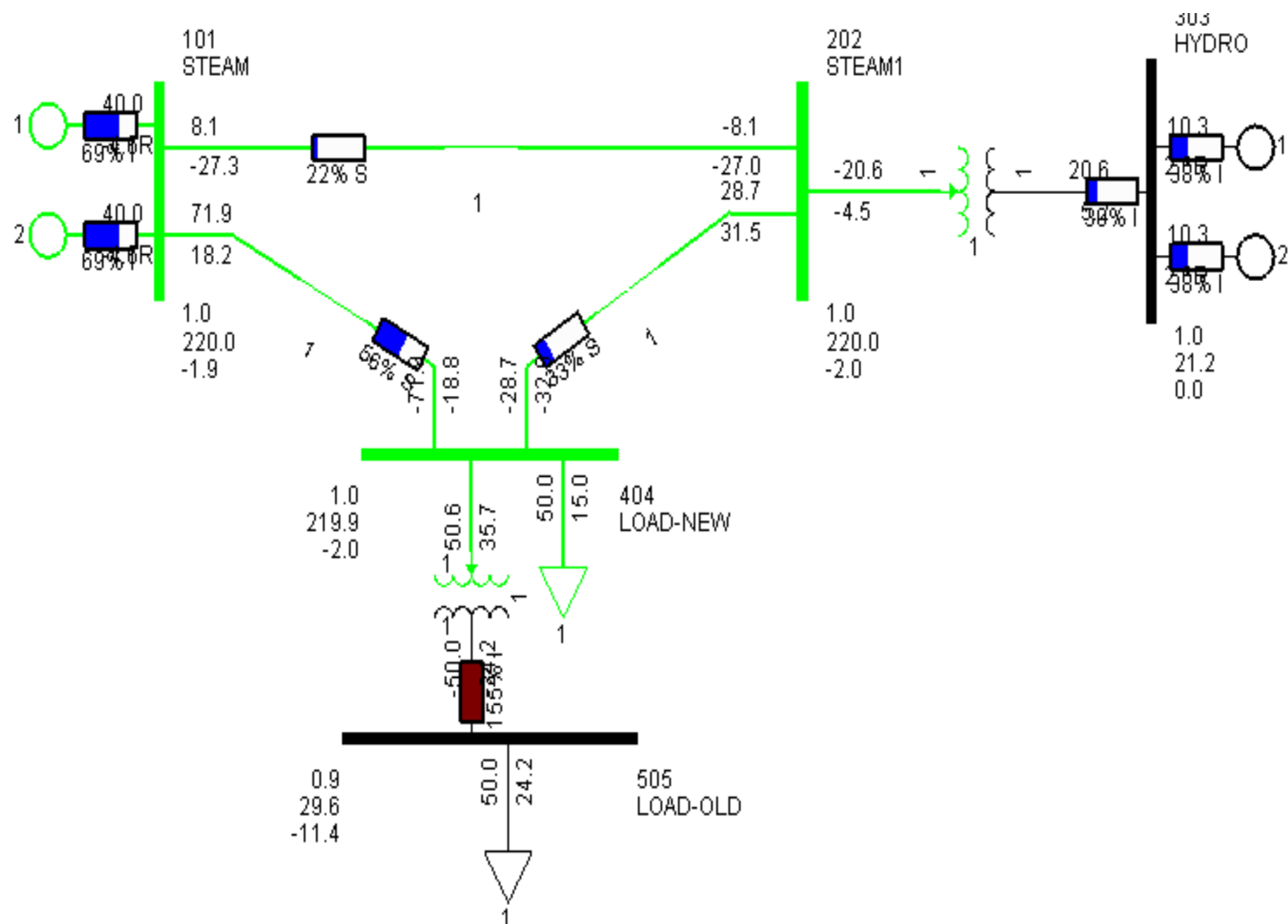
Exercise

- A. Open Case 1_1.sav- Solve the system using Full Newton-Raphson Solution Method (under Powerflow > Solutions) with Defaults Options.
- B. Create a one-line diagram of the Case 1_1.sav system. Refer to the attached one-line diagram to check your progress.
- C. Use auto-draw to add the system components. When you are finished, save the diagram information to a file called Case 1-1.SLD
- D. Automate power flows
- E. Check branch loadings as percentage of RATE-B
- F. Tap Branch between Bus-1 and Bus-2 (at Bus#606) with 40:60 ratio of impedances between Bus-1 to Bus-6 and Bus-6 to Bus-2. Add Load-SEC with $P=5$ MW, p.f. 0.9.
- G. Save Modified case as Case 1_2.sav
- H. Find Pair of buses with maximum angular difference

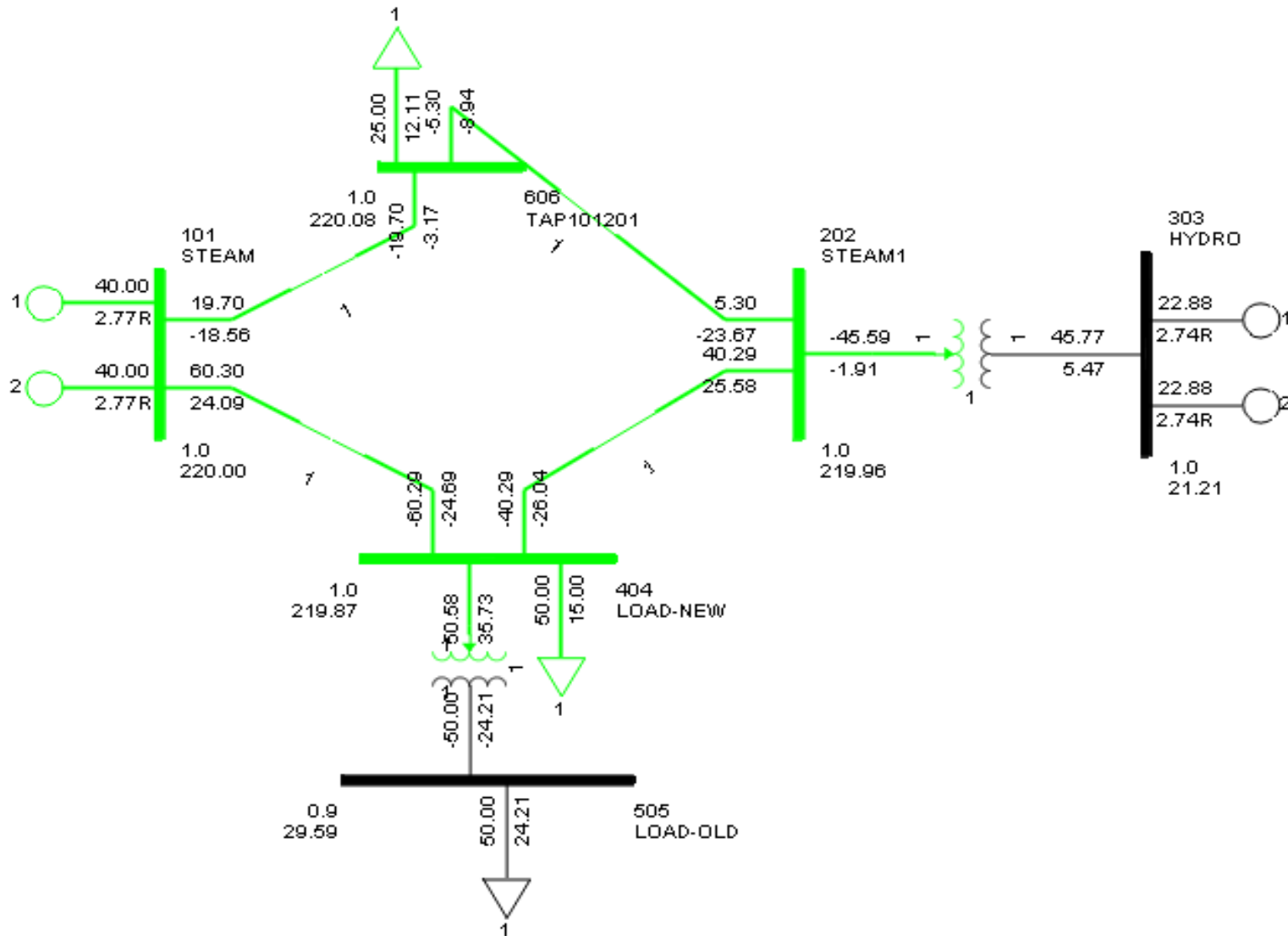
Case 1_1.sld



Case 1_1.sld => Branch Overload Checking



Case 1_2tapped.sld => Network after tapping



Thank You !!