
LAB6 – ADDITION OF GENERATION

EE 461 Power Systems

Colorado State University

Lab 6 - Addition of Generation

PURPOSE: The purpose of this lab is to introduce a wind farm into a base case and analyze the effects using PSS/E.

- Introduction to Power Flow Study
- Load Slider File
- Adding New Buses
- Addition of Transformer
- Addition of Wind Generation
- Multi ACCC Report

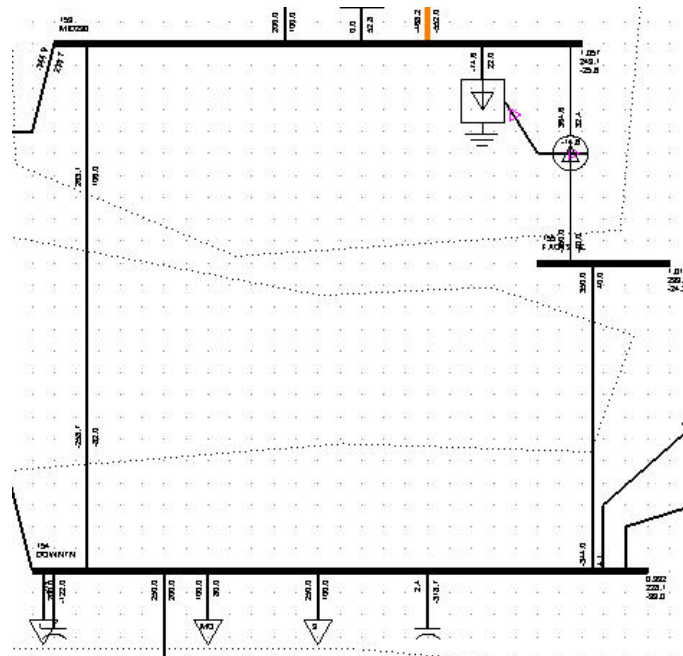
To properly perform this lab, start PSS/E and open the sample.sav file. Refer to Lab 1 on how to do this.

Introduction to Power Flow Study

As in previous labs, the base case used for this power flow study is the sample.sav data file. A portion of this system will be visually represented by a slider file. A model of a wind farm based on characteristics of GE built wind turbine generators rated at 1.5 MW, 60 Hz, can be added to this case. From this a system impact study, or power flow study can be performed.

Load Slider File

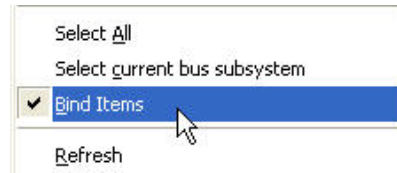
For this lab, load the sample.sld slider file, and use save as to save the sample.sld as sample1.sld. This will prevent the original sample.sld file from being corrupted during the process of this lab. Perform the same process to save the sample.sav data file as sample1.sav. Locate bus 154; this bus represents a central bus with a number of loads at a base 230 kV rating. Spread out the branches and the other buses to better view the diagram and ratings, like in the diagram below:



This will make more space for the addition of the wind generation.

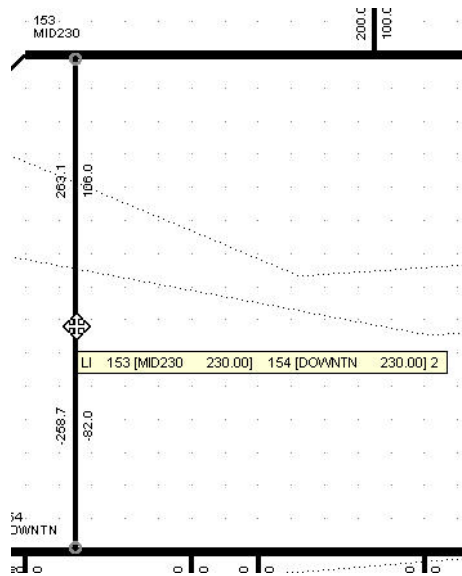
Lab 6 - Addition of Generation

*NOTE: ITEMS ARE BOUND. SO WHEN MAKING A CHANGE TO A SLIDER, THAT CHANGE IS MADE IN THE CASE. IF THIS CHANGE IS UNDESIRE, RIGHT CLICK AND UNCHECK BIND ITEMS.

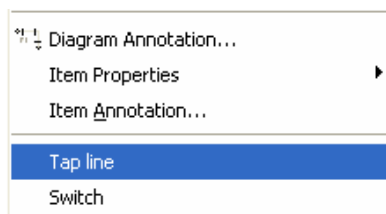


Adding New Buses

A new bus can be added between two existing buses by using the Tap line feature. To do this, select the branch between buses 153 and 154 by left clicking it as shown in the following diagram:

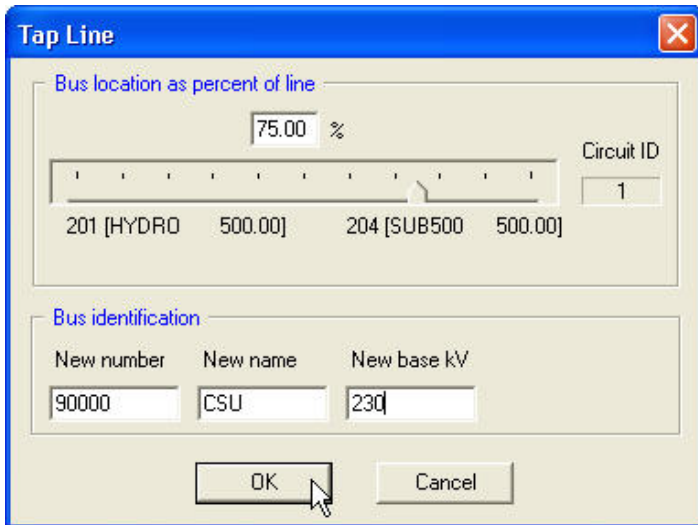


Two circles will appear at either end. Now right click the branch and scroll down and select Tap line.

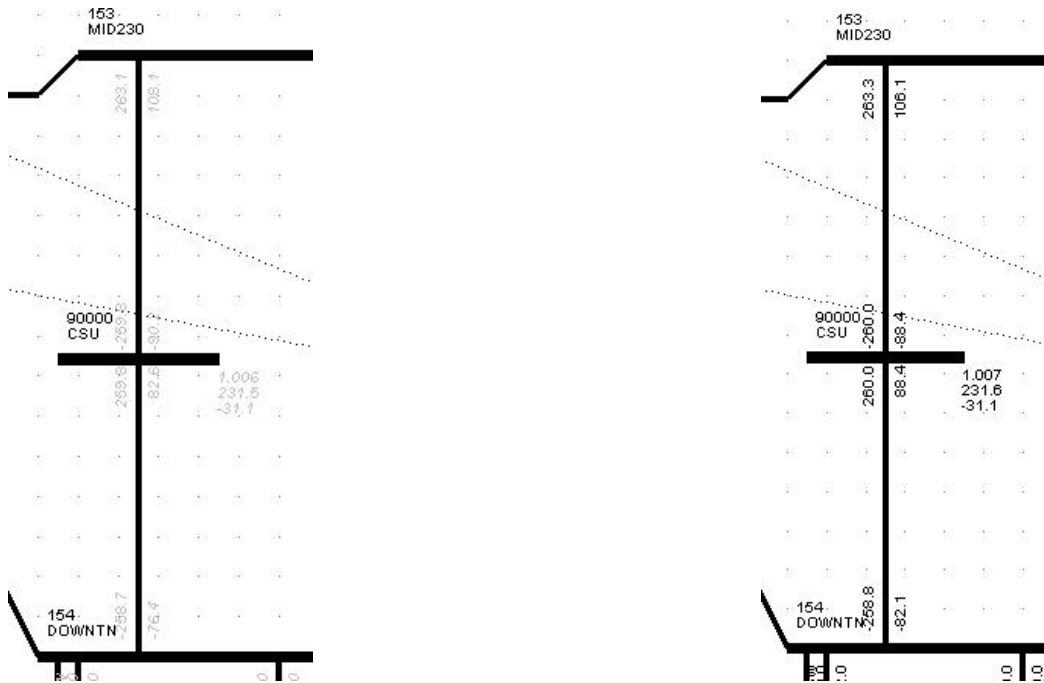



The following window will appear.

Lab 6 - Addition of Generation



Choose 75% for bus location as percent of line. This will tap the line 75% away from Bus 153 and 25% away from Bus 154. Choose a new bus number over 90000. This is done to distinguish between buses added for a study and those with lower bus numbers originally in the case. Name the bus; in this case, it has been named CSU. The base kV should automatically say 230. If not, type in 230, and click OK. The new bus should now appear in the diagram as shown below:



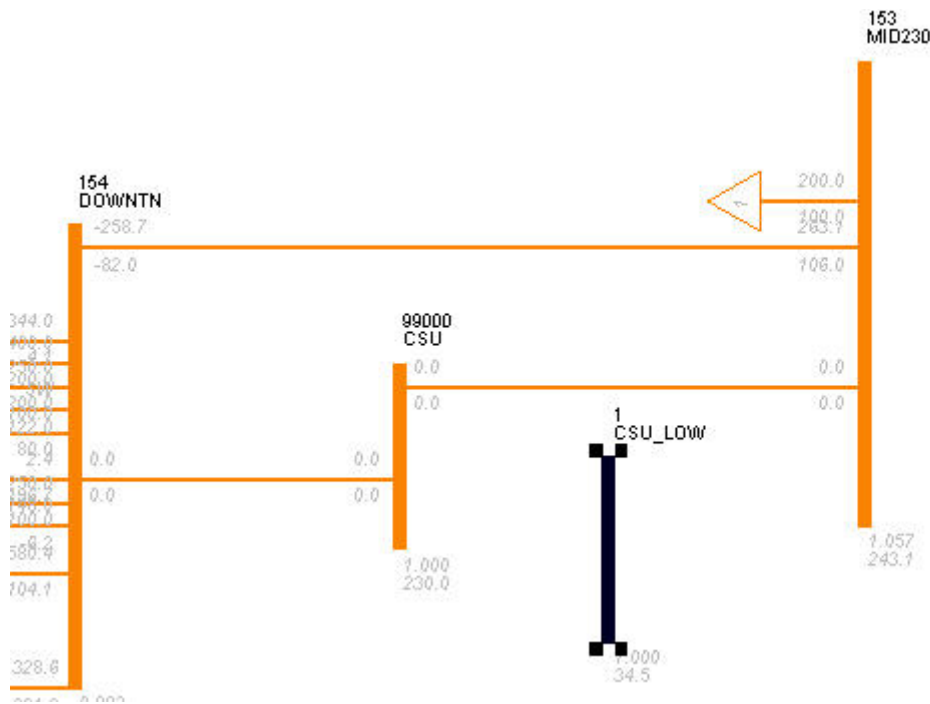
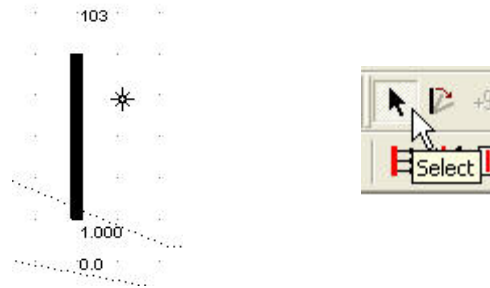
Notice that on the left side all the values are gray. This means that the file needs to be solved. Solve the case.  After solving the case the values will darken as shown on the right in the figure above.

Next, add another bus by clicking the “Sizable Busbar” button in the tools menu.



Lab 6 - Addition of Generation

When the cursor is moved over the diagram, a star will appear as in the picture below. Click an area near buses 153 and 154. A new bus will appear. Then, click Select in toolbar to get rid of the star. If the diagram is maximized, double click the new bus and it will locate the new bus in the sample1.sav data file.



Double click the new bus or go to the buses tab in the sample1.sav data file, and a new line will appear with the new buses information. Click in the Bus Name field and, rename it to CSU_LOW. Then click in the Base kV field, and set it to 34.5. This is a typical value for wind generation. After making these changes, make sure to click next to that line to make the updates active. Bus CSU_LOW from the data file can be seen in the figure below:

Bus Number	Bus Name	Base kV	Area Number/Name	Zone Number/Name	Owner Number/Name	Code
1	CSU_LOW	34.5	1 CENTRAL	1 NORTH_A1	1 OWNER 1	1

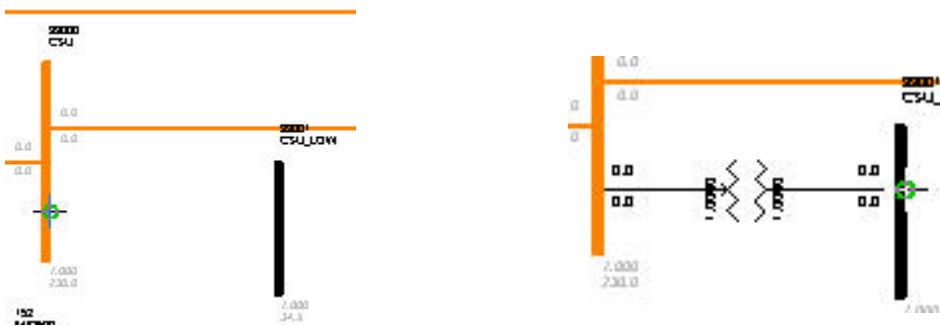
Lab 6 - Addition of Generation

Addition of Transformer

To add a transformer between two buses, Click the 2-Winding Transformer “button”.

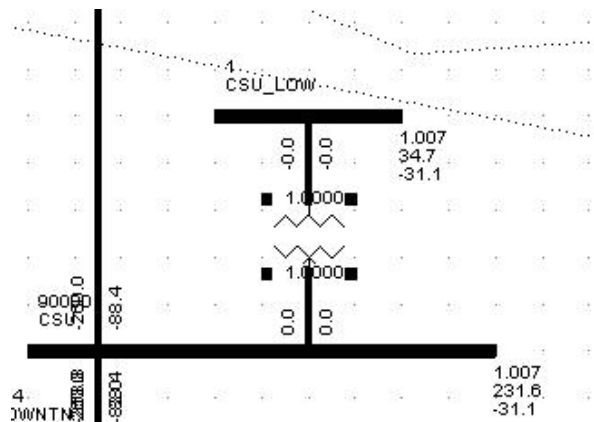


When the cursor is over the diagram, a cross will appear. When moved over a bus, a familiar circle will appear. Click the CSU bus when the circle is present then stretch the cursor over to the CSU_LOW bus and click it. A dotted line will show up while doing this. In this case, a transformer will be added between CSU and CSU_LOW.



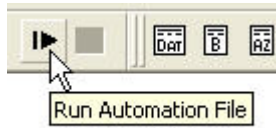
With the new transformer in place on the slider diagram, go to the 2-winding transformer tab in the data file and find the new transformer that was just added. In the Rate A slot, change the rating from 0.0 to 25.0 MVA.

Rate A (MVA)
25.0

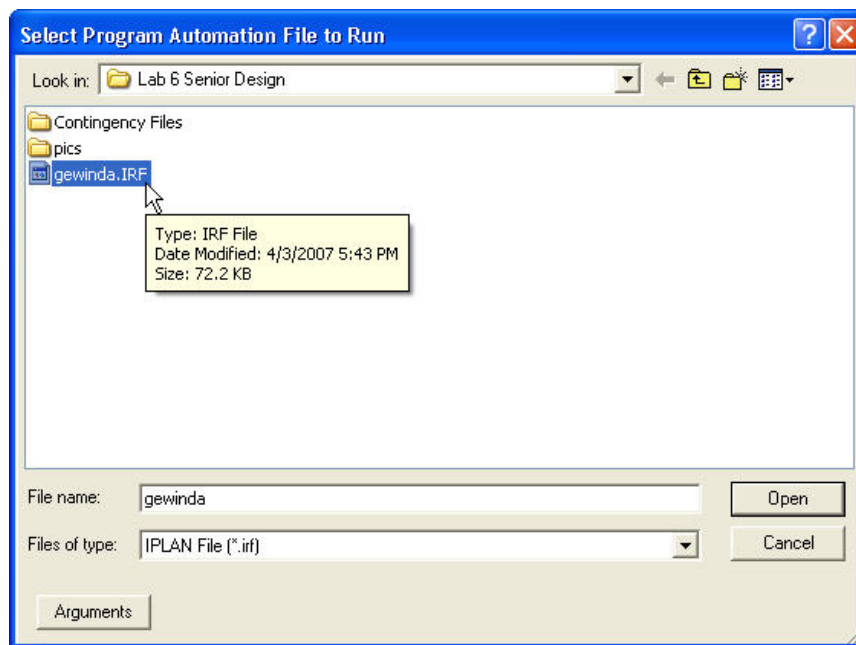


Addition of Wind Generation

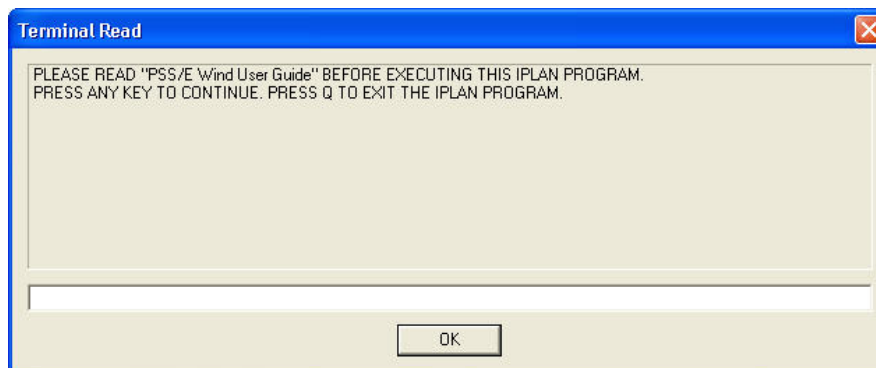
On the toolbar, select Run Automation File. Or, select I/O Control → Run program Automation file.



For file type, select IPLAN File (*.irf). Select the gewinda.IRF file provided and click open.



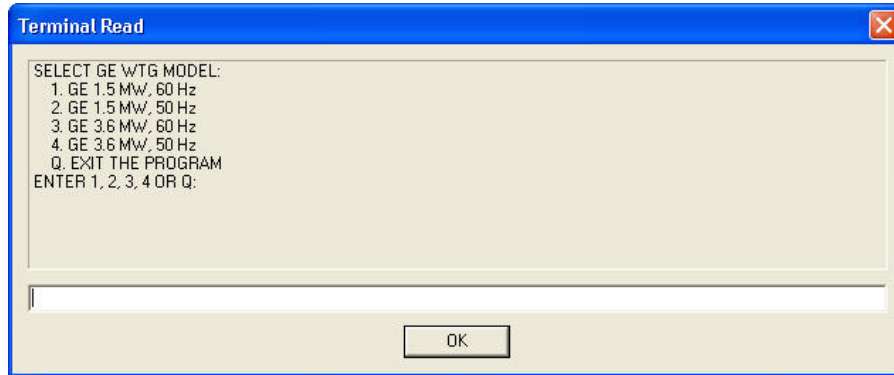
The following window will appear.



Click OK.

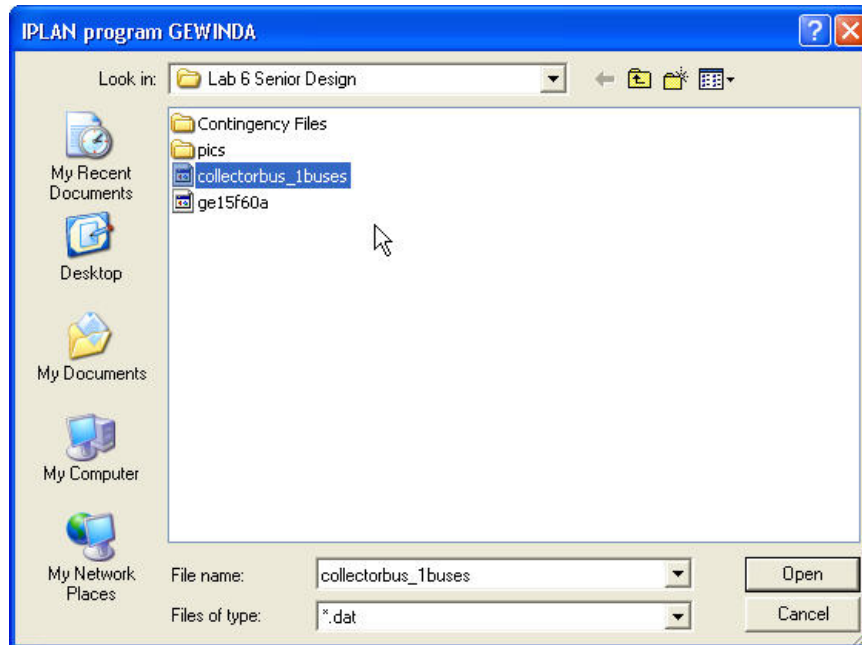
Lab 6 - Addition of Generation

The next window will ask to select the model of turbines to use. Select 1. GE1.5 MW, 60 Hz.

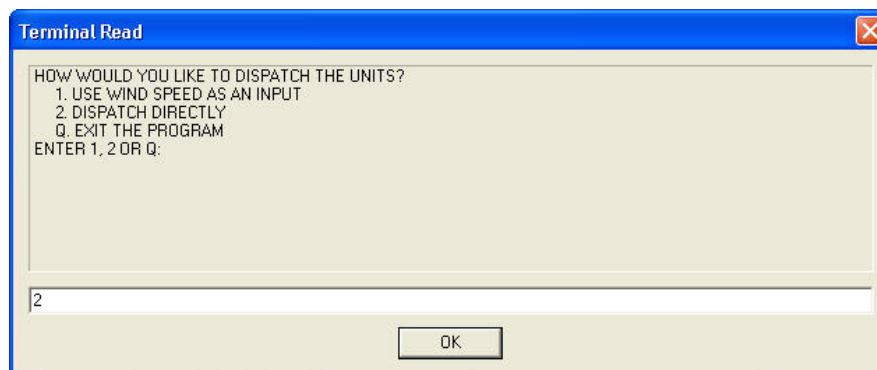


Click OK.

The next window will ask for a *.dat file. Select collector_1buses.dat and click open.

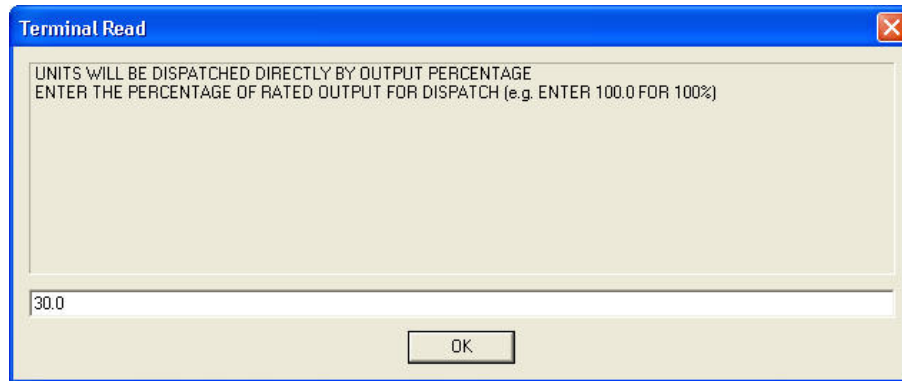


The next window will ask how would you like to dispatch the units? Type 2 into the command line and click OK.

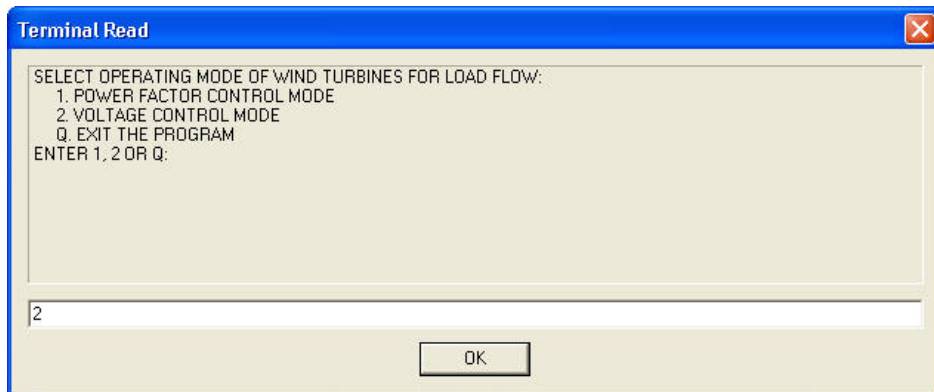


Lab 6 - Addition of Generation

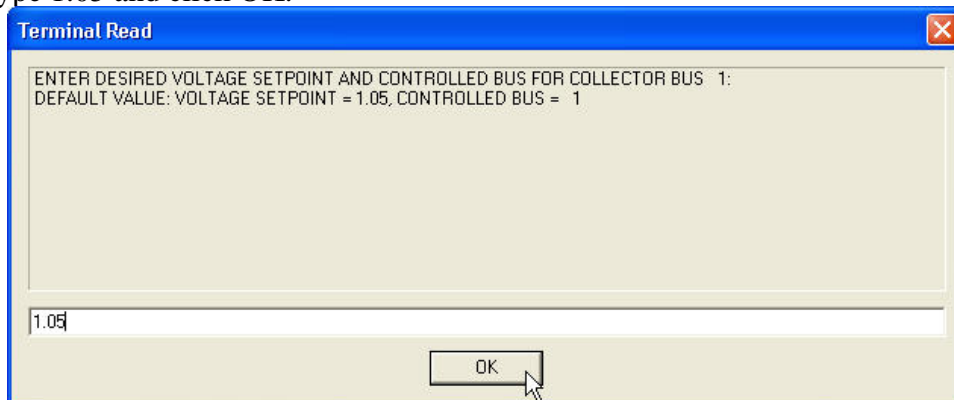
For the next window, type 30.0 for 30%, click OK. This is a typical output for wind generation.



In the next window, type 2 for voltage control mode and click OK.

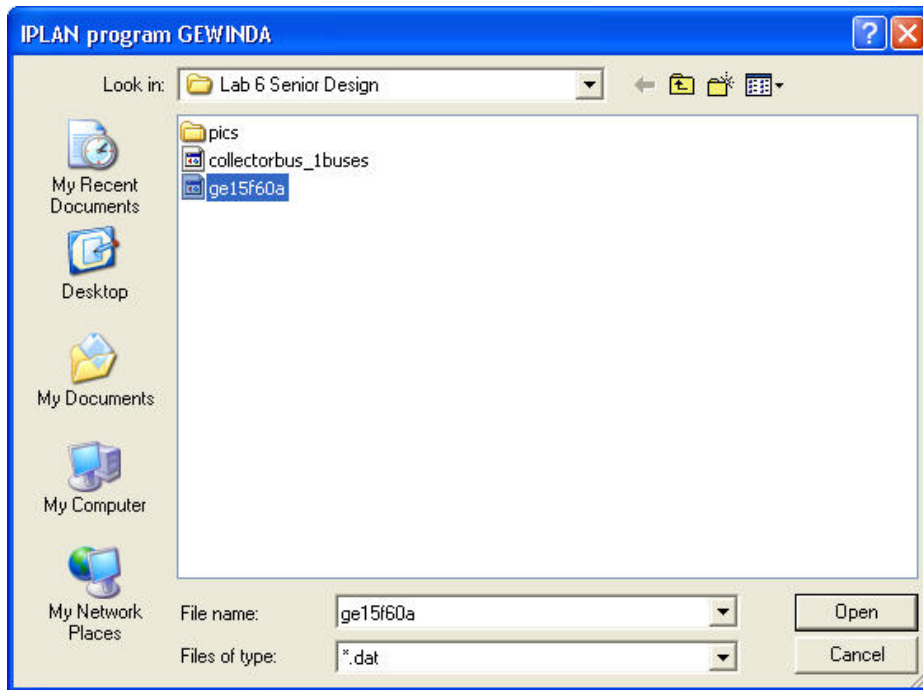


Next, type 1.05 and click OK.

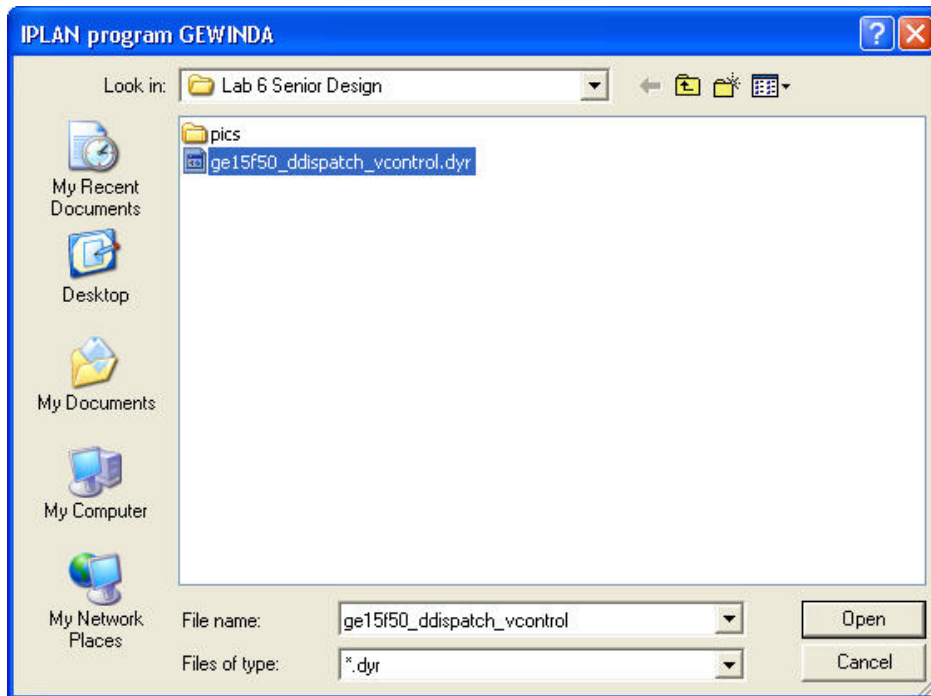


Lab 6 - Addition of Generation

Another window will open asking for a *.dat file. Select the ge15f60a file provided and click open.



Next, select the ge15f50_ddispatch_vcontrol.dyr file provided and click open.



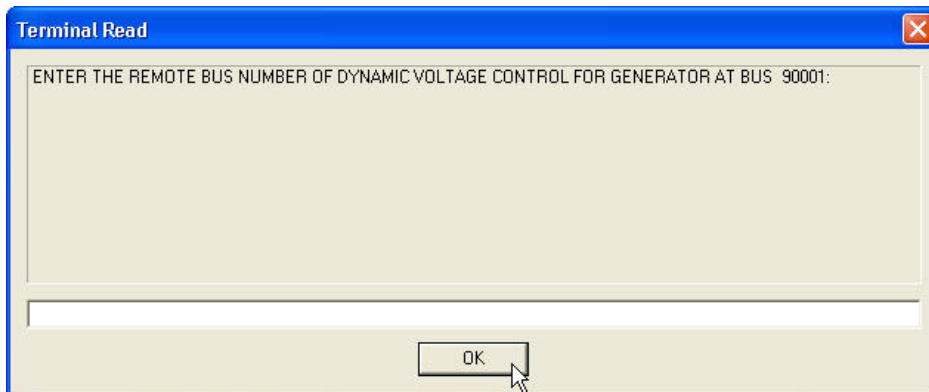
Lab 6 - Addition of Generation

After the ge15f50_ddispatch_vcontrol.dyr file is opened, the case should have the addition of the wind farm. It's possible that a few windows will appear asking for more parameters of the wind farm to be entered.

If these windows appear, choose the default values.
Type Y (yes), for a remote bus for windvar emulator.

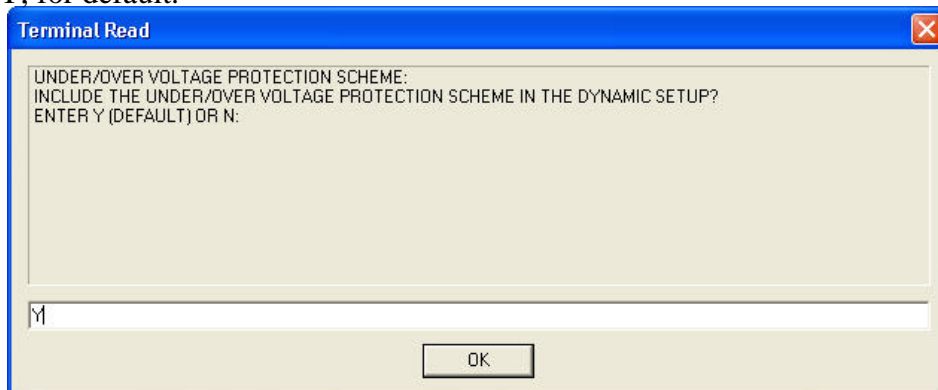


Click OK.



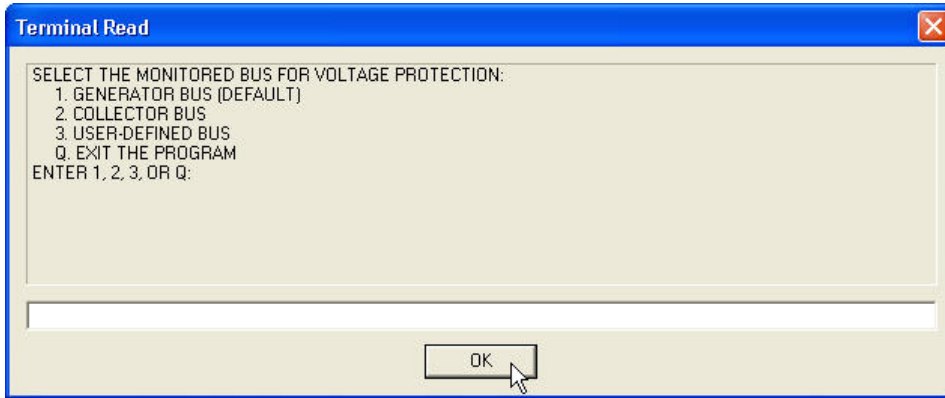
Click OK.

Type Y, for default.



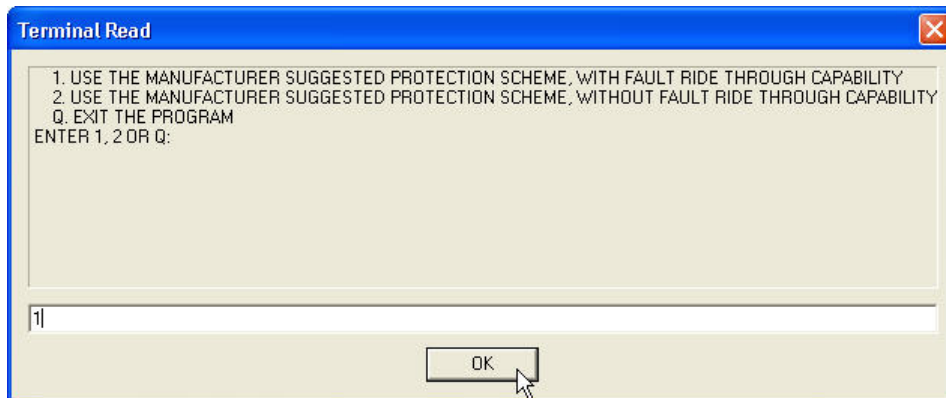
Click OK.

Lab 6 - Addition of Generation

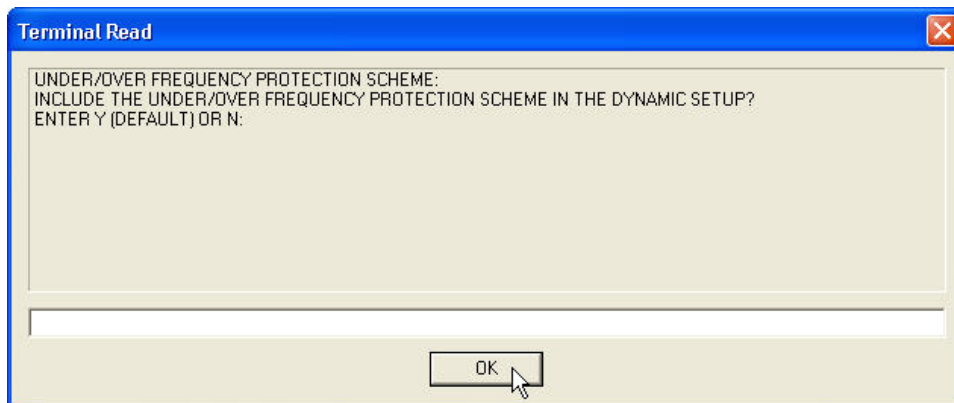


Click OK.

Type 1 for the manufacturer suggested protection scheme with fault ride through capability.

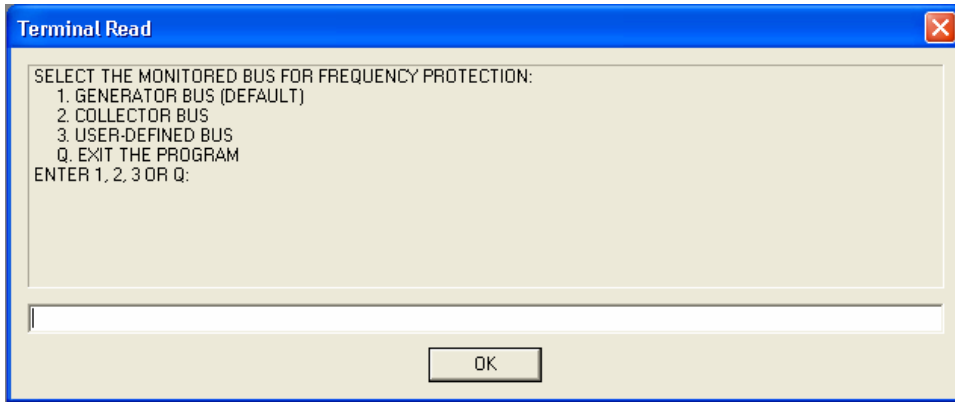


Click OK.



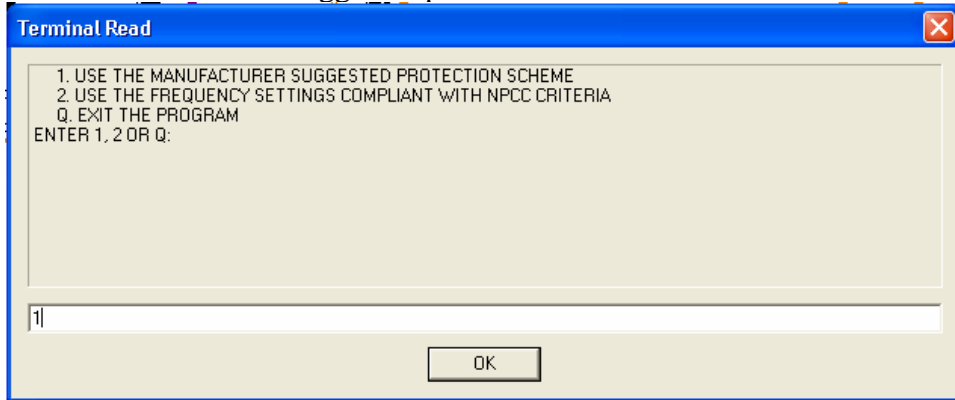
Click OK.

Lab 6 - Addition of Generation



Click OK.

Type 1 for the manufacturer suggested protection scheme.



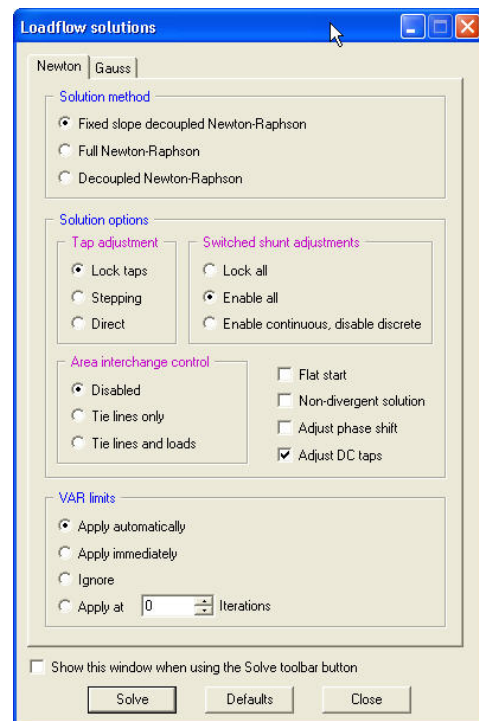
Click OK.

Now, solve the system. Right click the CSU_LOW bus and grow. The new transformer, bus, and wind generator are now present on the slider diagram as well as in the sample1.sav data file. The *.IRF file that was just used added all the values and parameters for the wind generation. If the system does not solve, try selecting Lock all for Switched shunt adjustments, and apply immediately for VAR limits.

The Loadflow solutions window shown on the right can be access by selecting Power Flow → Solution → Solve.

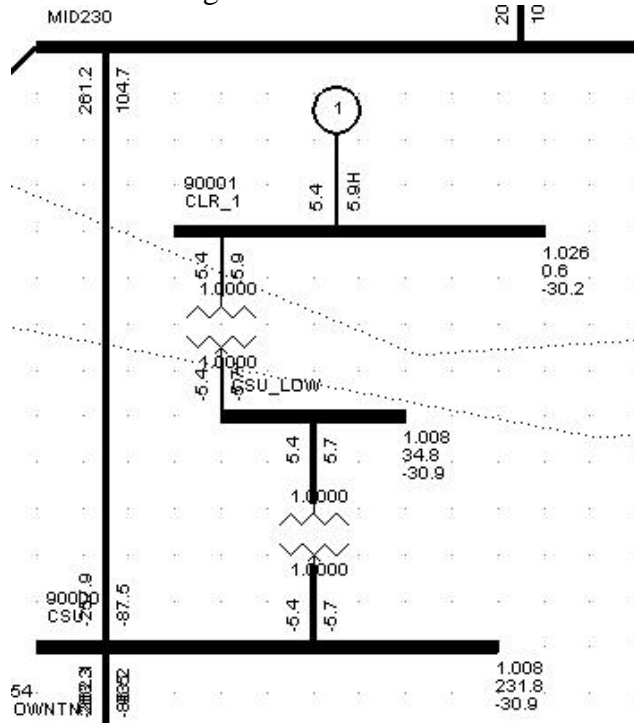
Note:

This window will not appear by clicking the solve button in the toolbar after the initial solve has been performed.



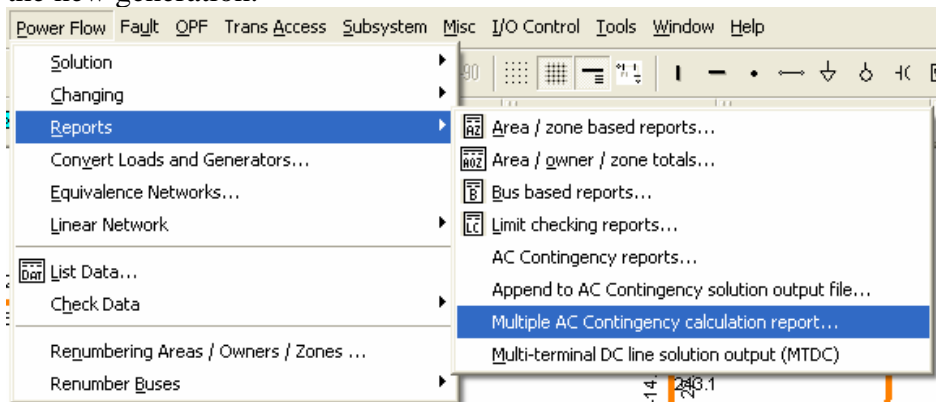
Lab 6 - Addition of Generation

The new wind generation is shown in the one-line diagram below:



Multi ACCC Report

As explained in Lab 5, create new *.acc files and run the multiple AC contingency report with the new generation.



Lab 6 - Addition of Generation

Select all the *.acc files for each zone and click Go to run the report.

The screenshot shows the 'AC Multiple Contingency Run Report' dialog box. It is divided into three main sections: 'Select reports', 'Report options', and 'AC Contingency output files'.

- Select reports:** Contains several checked options: 'Monitored elements summary', 'Missing contingencies', 'Missing monitored elements', 'Non-converged contingencies', and 'Missing monitored voltage buses'. It also includes three dropdown menus for 'Contingency legend' (set to 'Both master legend report and legend with each table'), 'Loading violations' (set to 'Base case and worst case contingency violations only'), and 'Voltage violations' (set to 'Base case and worst case contingency violations only').
- Report options:** Includes a 'Column headings' dropdown set to 'AC Contingency report filenames'. It has two dropdowns for 'Base case rating set' and 'Contingency case rating set', both set to 'Rate A'. There are three unchecked checkboxes: 'Include interface loading violations', 'Exclude elements with base case loading violations from contingency reports', and 'Exclude elements with base case voltage range violations from contingency reports'. Below these are seven numeric input fields with up/down arrows, representing various reporting thresholds like 'Percent of flow rating for reporting' (100.00) and 'Bus mismatch "converged" tolerance (MVA)' (0.50).
- AC Contingency output files:** A list box containing file paths for zones 1 through 9, such as 'C:\Documents and Settings\Jen Carden\Desktop\home work\Lab 6 Senior Design\Contingency Files\zone1_wind.acc'. A text box below the list shows the selected file path: 'C:\Documents and Settings\Jen Carden\Desktop\home work\Lab 6 Senior Design\Contingency Files\zone9_wind.acc'. There are 'Go' and 'Close' buttons at the bottom.

Lab 6 - Addition of Generation

Questions

The “sample.sav” data file as well as the “sample.sld” slider file must be open to perform this section of the lab.

NOTICE:

Before continuing, make sure the “sample.sav” data file has been saved as “sample1.sav” and the “sample.sld” slider file as “sample1.sld”. It is very important not to overwrite the existing files in the process of completing this lab.

Add an 18MW (5.4MW @ 30%) wind farm to the system as described above.

- Tap the branch between Bus #153 (MID230) and Bus #154 (DOWNTN) and add a new 230kV bus. Give this new bus number 90000 and name it CSU. Bus #90000 (CSU) will be in Area #1 and Zone #3.
- Add a new 34.5kV bus. This bus will be number 1 and name it CSU_LOW. Bus #1 (CSU_LOW) will be in Area #1 and Zone #1.
- Add a branch between Bus #1 and Bus #90000 with a 25MVA, 34.5kV/230kV transformer.
- Add a 18MW, 60Hz wind farm that is connected to Bus #1 (CSU_LOW).

Create a new Multi-ACCC report with the wind farm added to the system.

- Use the “*.con”, “*.mon” and “*.sub” files that were saved from Lab 5.
- Revise the “Zone1.sub” file to include Bus #1 and Bus #90001. The contingency and monitor files for this zone do not need to be revised because no branches without transformers have been added to this zone.
- Revise the “Zone3.con” file. Remove the contingency “MD2-DNTN” which is the branch between Bus #153 and Bus #154 (since it no longer exists). Add the contingency “MD2-CSU” which is the branch between Bus #153 and Bus #90000. Add the contingency “DNTN-CSU” which is the branch between Bus #154 and Bus #90000.
- Revise the “Zone3.mon” file. Remove the requirement to monitor the branch between Bus #153 and Bus #154 (again, since it no longer exists). Add the requirements to monitor the branches between Bus #153 and Bus #90000 and between Bus #154 and Bus #90000.
- Revise the “Zone3.sub” file to include Bus #90000.
- Create a new ACCC and a new DFAX file for Zone 1 through Zone 9. To reduce the possibility of confusion, name the ACCC files “Zone#_wind.acc” and the DFAX files “Zone#_wind.dfx” for each zone. There will be a total of 18 files created. Refer to Lab 4 if needed.

Lab 6 - Addition of Generation

- Create a Multi-ACCC report by loading all nine “*.acc” file that were created. This process is laid out in detail in Lab 5. Print out this report and include it in the lab write-up. As in Lab 5, all the information that this lab will focus on will be on pages 8 and 9.

Use the printed report to answer the following questions. Review the tables that were created on page 8 and on page 9 and compare these tables with the tables obtained in Lab 5. Just as a reminder, the table on page 8 shows all of the overloads that occur in the “Base Case” contingency while the table on page 9 shows all of the overloads that occur, or greater overloads than that occurred in the “Base Case” condition, in each of the contingencies.

- 1) Which zone contains the most overloads during the “Base Case” contingency? _____
Which zone contains the most overloads during the other contingencies? _____
Has this changed from the results obtained in Lab 5? _____
- 2) Which branch suffered from the largest overload (compared to the “Base Case”) and what is the overload? _____
During what contingency did this occur (which branch was taken out)? _____
Has this changed from the results obtained in Lab 5? _____
- 3) Compare the contingency “EMN-WMN” from Lab 5 and what was obtained for this lab. Each had two overloads. How do they differ? _____
- 4) Compare the “Zone 8” columns from page 9 of the Multi-ACCC report generated in this lab and from Lab 5. How do they differ? _____
- 5) If the addition of a wind farm (or any other source of generation) creates more overloads in the system during contingencies then without it, it is said to “hurt” the system. If it creates fewer overloads, it is said to “help” the system. Based on the Multi-ACCC reports generated in this lab and in Lab 5, how does the addition of the 150MW wind farm affect this system? Does it hurt, help or make no discernable difference? _____
- 6) If you were the engineer in charge of this region of the power grid you would be responsible for the stability of the grid if anything were to be added to the grid (like a 150MW wind farm). Inspect the one-line diagram with the current loading percentages displayed. Based on what you see and the information you have obtain from compiling this Multi-ACCC report compared to the data from Lab 5, would you recommend this wind farm addition for approval and why or why not? _____

Answer these questions and include the printed Multi-ACCC report with the lab write-up.