SIEMENS POWER SYSTEM SIMULATION FOR ENGINEERS® (PSS/E)

LAB3
AUTO CREATION OF *.CON, *.MON, AND *.SUB FILES

Power Systems Simulations
Colorado State University

Purpose of the lab:
This lab is designed to represent a guide for the user to build the *.con, *.mon and *.sub files automatically according to sample.sav and sample.sld given files for this course. This lab will also explain how the three files are utilized by the AC Contingency Calculation (ACCC) feature of PSS/E to perform a power flow study on a particular zone.

Power Flow (PF) analysis is possibly the single most utilized tool in the power industry. PF analysis allows us to simulate unplanned (or forced) as well as planned outages. A power flow solution is often the starting point for many other types of power system analysis. In addition, power flow analysis is at the heart of contingency analysis and the implementation of real-time monitoring systems. The creation of contingency (*.com), monitor and subsystem files will allow us to perform PF analysis.

Important definition for better comprehension to this lab:
·   ***.sub (subsystem) file:**
The subsystem file informs the power flow analysis to only look at a prescribed section, or zone, of the overall network.
·   ***.mon (monitor) file:**
The monitor file tells the power flow simulator which branches to be supervised during the (N-1) contingencies
·   ***.con (contingency) file:**
The contingency file is programmed to remove equipment, from service; this is referred to as a contingency. When the system is fully operational, it has no outages, therefore it is referred to as system intact or (N-0). When a single line is taken out of service, the case is then referred to as an (N-1). When two elements are taken out of the service, it referred to as (N-2) The easiest way to program how to do this is to see a portion of the code used in the *.con file and understand what everything does.
·   **ACCC:**
The contingency, monitor, and subsystem files are utilized by the AC Contingency Calculation (ACCC) features of PSS/E to perform a power flow study on a prescribed zone. The ACCC produces an analysis of the power system.
·   **DFAX (distribution factors file):**
It is a measure of the impact of injections and network changes on the grid applied over the initial or base case power flow. DFAX represents a measure of the effect of each zone's load on the transmission constraint that requires the mitigating upgrade, as determined by power flow analysis. The source used for the DFAX calculation is the aggregate of all generation external to the study area.
·   **Sample.sav file: (described in lab 1)**
The saved case file (*.sav) is a binary image of the load flow working case. To conserve disk space and minimize the time required for storage and retrieval, saved cases
(*.*sav*) are compressed in the sense that unoccupied parts of the data structure are not stored when the system model is smaller than the capacity limits of the program.
·   **Sample.sld file: (described in lab 2)**
*.sld – Slider file (Single Line Diagram) This file allows for performing network analysis studies on the grid. Sliders are visual displays of the grid. It includes buses, branches, lines, loads, generators, transformers etc... All components should be color coded based on voltage flow. The slider file can also show the operational ratings (power flowing across the component relative to

the capacity) of the listed components. This network can be divided on several zones and areas based on the need of the user.

·   **Areas:**

Graphically, an Area typically represents an entire region, perhaps a state (Colorado) or small country (Bahrain). Areas can be utilized to represent a regional electric market, ie, the majority of load within an area is served with the majority of generation in that same area. Load can be served with generation from another area. This is typically accomplished thru metering and schedules but is outside the scope of this lab. The only reason for a detailed explanation is to present this concept and Bulk Electric System (BES) structural philosophy currently practiced in the real world to familiarize the future power engineer.

·   **Zones:**

Typically, Areas (above) are represented as a collection of Zones. An Area could contain one or more Zones. The reasoning behind this is to allow Areas to have many subsets (Zones) such that detailed analysis and criteria can be applied to a particular Zone. For instance, one town may have a stricter pos-contingent per-unit voltage level. By breaking areas into zones, you will have the flexibility to apply different scenarios to avoid any outages or blackout when overloads occur and could be fixed fast and easy because you know which zones are affected.

If the concept of Areas and Zones sees confusing, review the slider file (sample.sld) from lab two and consider the definition of Areas and Zones described above.

Example:

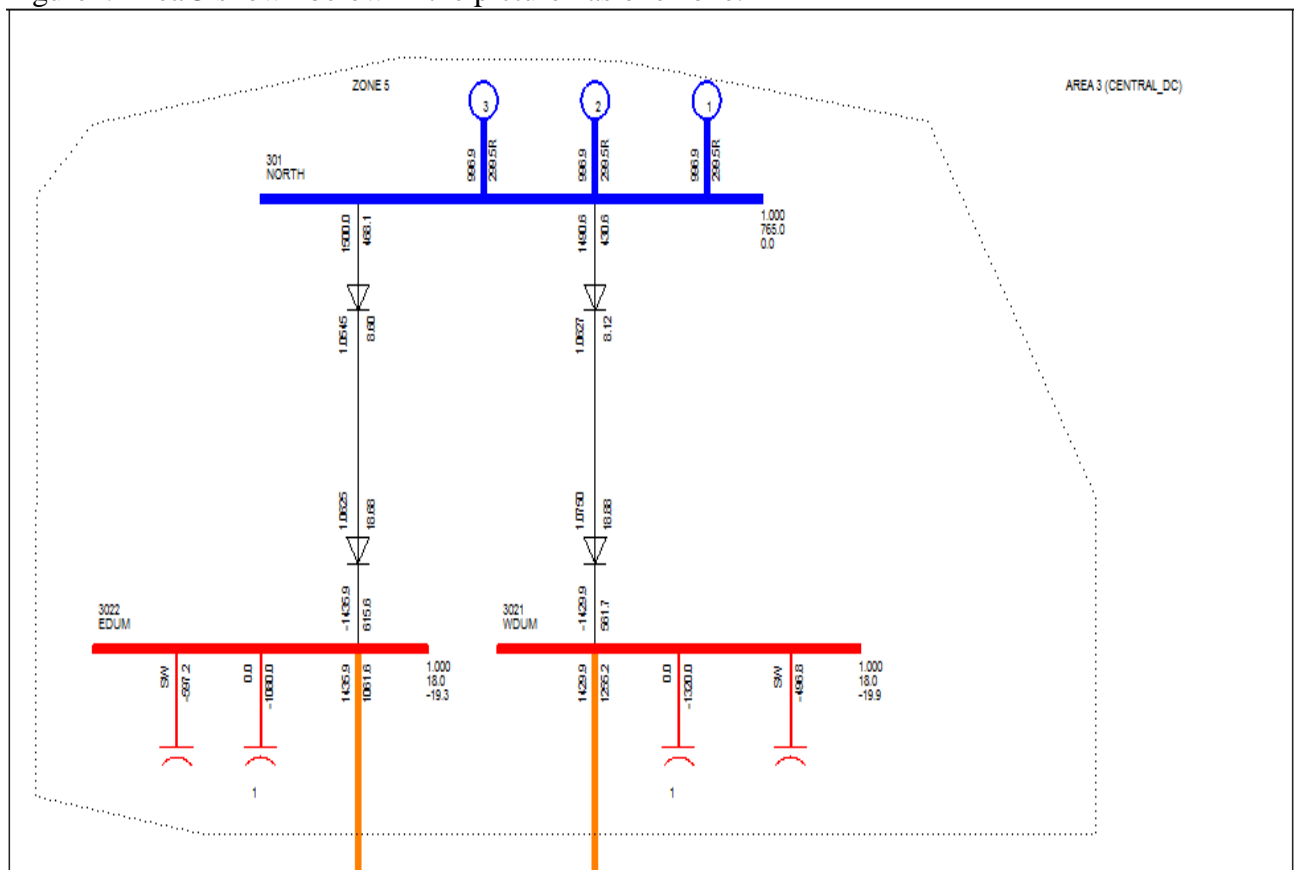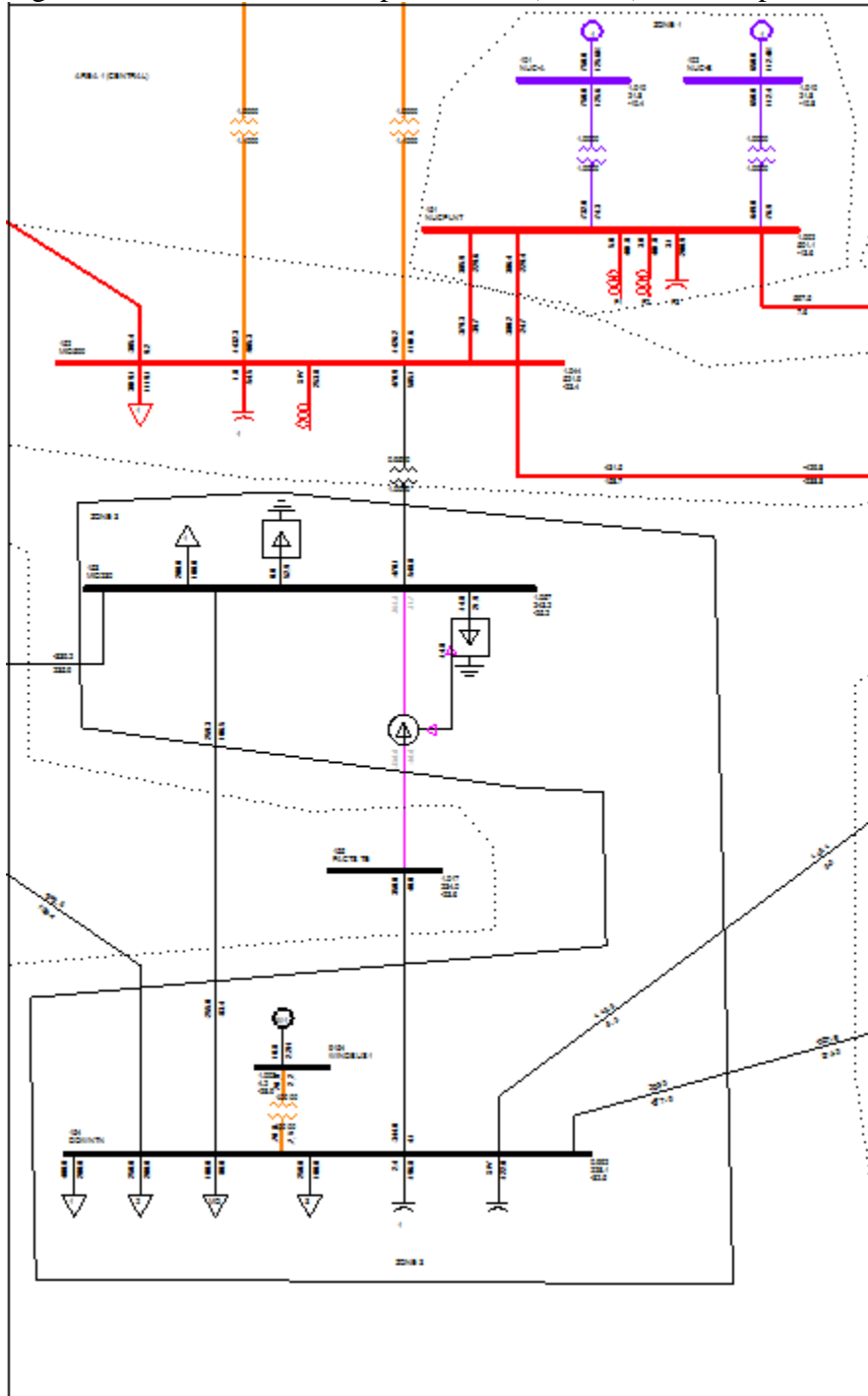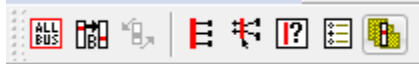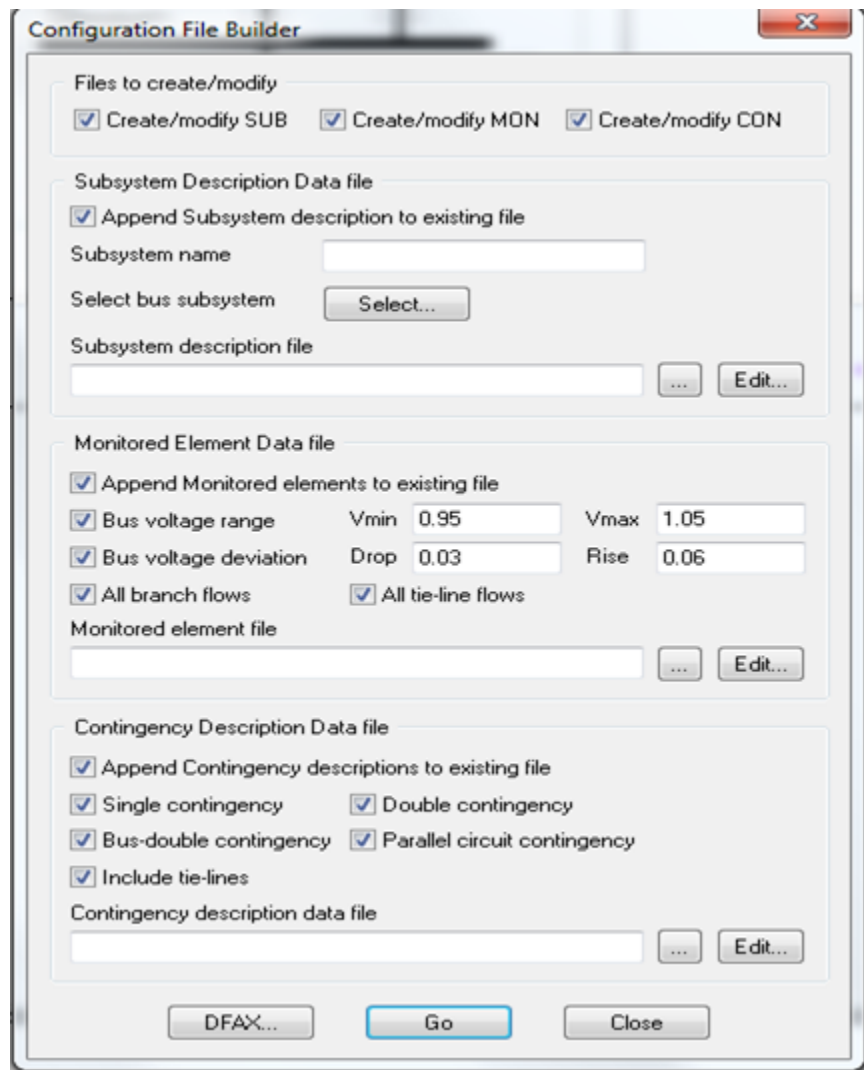Figure1: Area 3 shown below in the picture has one zone.

Figure 2: Area 1 has two complete zones (1 and 3) and two partial zones (2 and 4) shown below.

1. Start **PSS®E** as it was shown in lab1.
2. Open the sample.sav file from your PSSE Labs folder as it was shown in lab1.
3. Open the sample.sld file from your PSSE Labs folder as it was shown in lab1.
4. Go to toolbar and click on Subsystem-Area. Write down the areas names.

5. Click on the Create/Modify Config Files icon 🏢 . Also, it can be access through Power low-Linear Network- Create/Modify SUB, MON and CON configuration files...

6. The following window will appear.

a) Uncheck the Append subsystem description to the existing file.
b) Enter **Central** as the subsystem name.
c) Click select from the select bus subsystem, a new window will appear as follows

d) Select on central then click on the arrow pointing to the right [>] to have Central switched to be in the Selected areas menu, hit Apply and Ok to close the window.
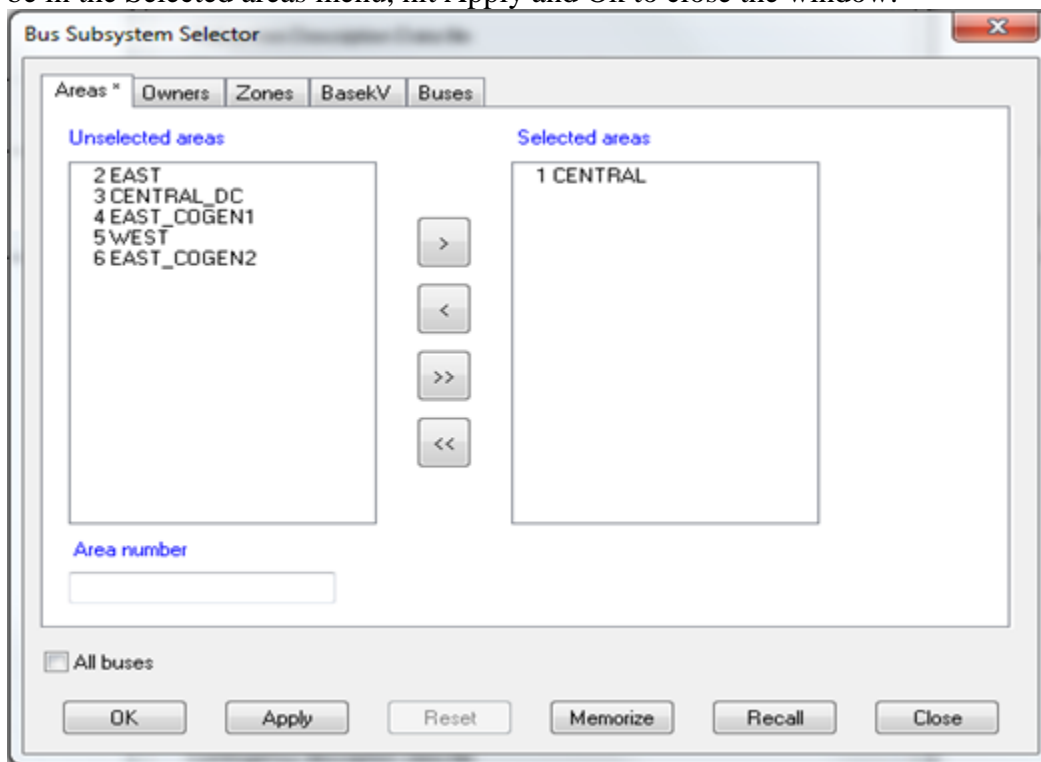
e) Click on [...] (Subsystem description file) and type "area1" in the file name. Then save it.
f) Uncheck the Append Monitored descriptions to existing file option.
g) Verify the Bus voltage range is from 0.95 to 1.05 pu.
h) Click on [...] (Monitored element file) and type "area1" in the file name. Then save it.
i) Uncheck the Append Contingency descriptions to existing file option.
j) Click on [...] and (Contingency description data file) type "area1" in the file name. Then save it.

The Configuration File Builder should look exactly like the given window below:
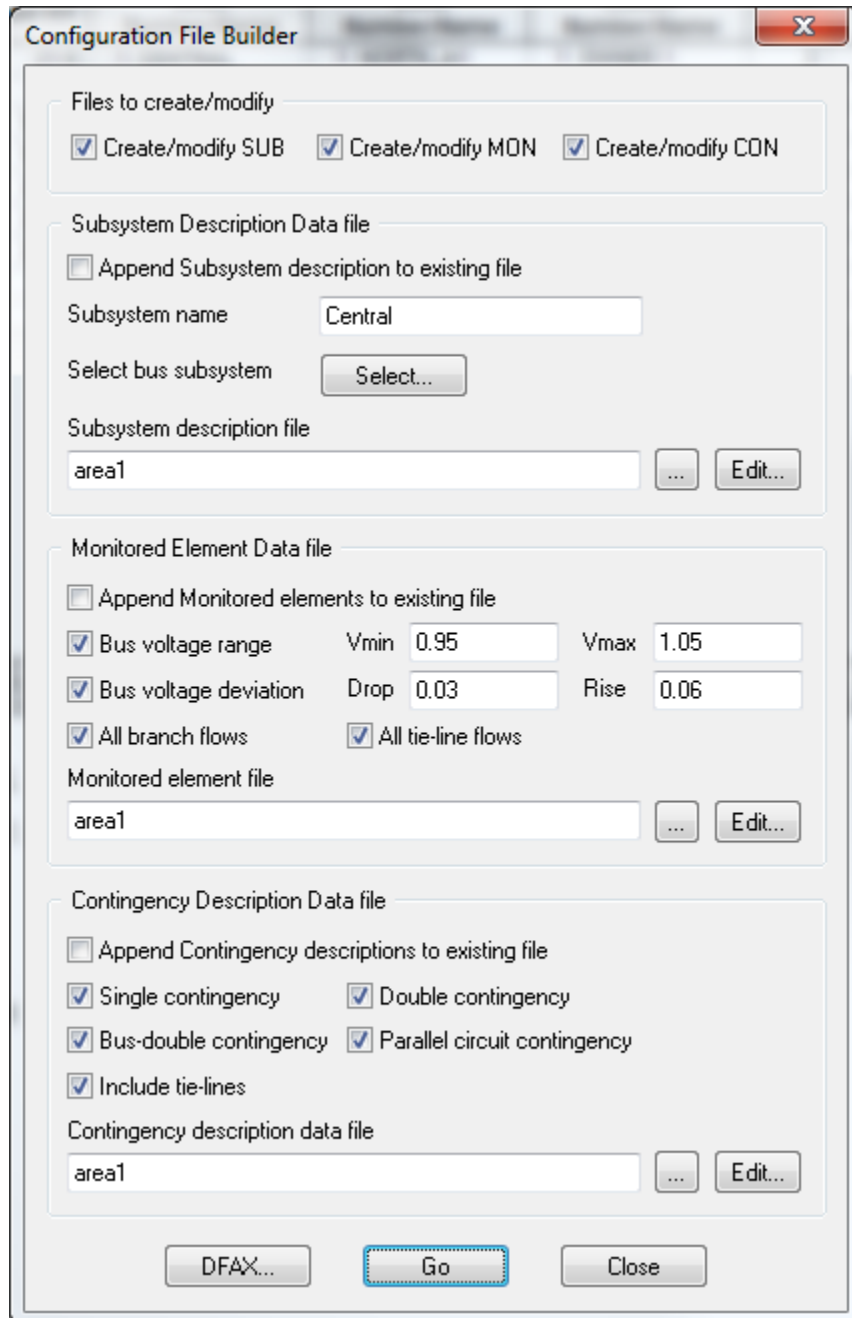
j) Click on Go, then click DFAX and navigate to your folder location created in lab1 and type area1" in the File name box.
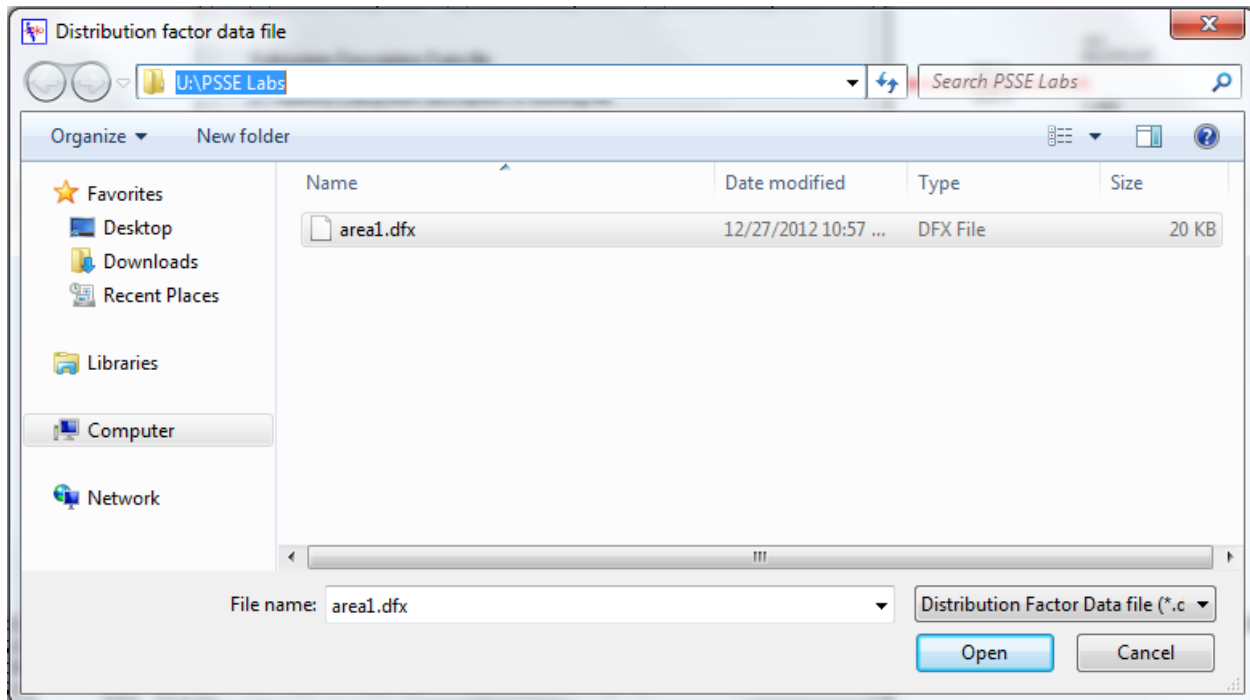
Click open and a new window will appear:
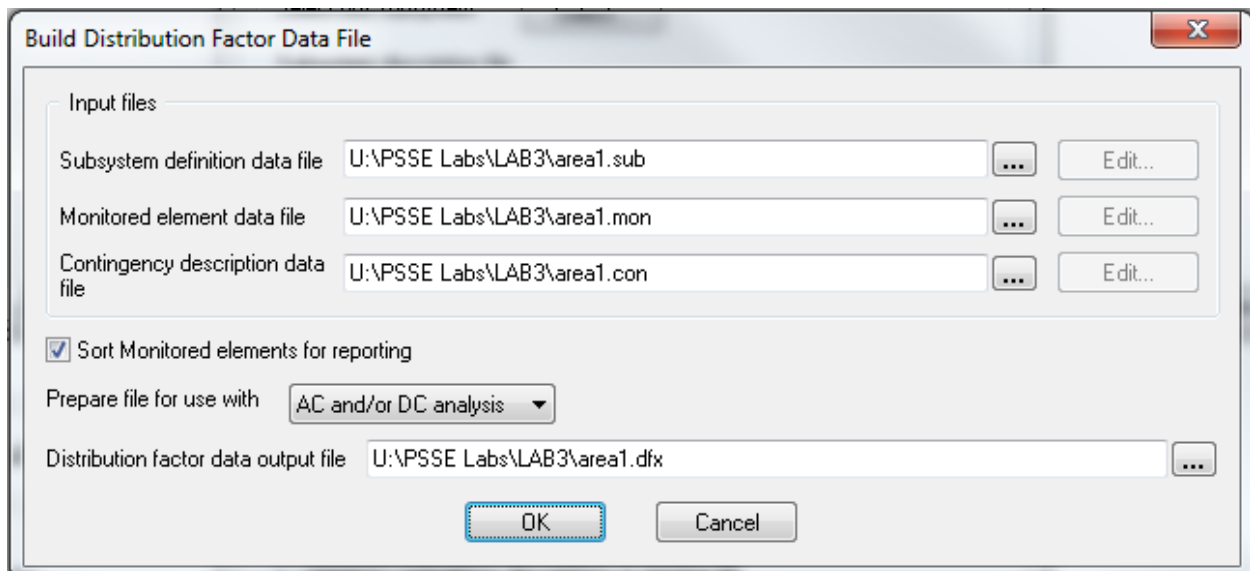
Click OK.

NOW: the *.con, *.mon, and *.sub files have created and can be opened using WordPad or Notepad as shown in the picture below.

```
area1.sub - Notepad
File  Edit  Format  View  Help

COM
COM SUBSYSTEM description file entry created by PSS®E Config File Builder
COM
SUBSYSTEM 'CENTRAL'
    AREA 1
END
END
```

```
area1.mon - Notepad
File  Edit  Format  View  Help

/PSS/E32.00
COM
COM MONITORED element file entry created by PSS®E Config File Builder
COM
MONITOR VOLTAGE RANGE SUBSYSTEM 'CENTRAL' 0.9500 1.050
MONITOR VOLTAGE DEVIATION SUBSYSTEM 'CENTRAL' 0.030 0.060
MONITOR BRANCHES IN SUBSYSTEM 'CENTRAL'
MONITOR TIES FROM SUBSYSTEM 'CENTRAL'
END
```

```
area1.con - Notepad
File  Edit  Format  View  Help

/PSS/E32.00
COM
COM CONTINGENCY description file entry created by PSS®E Config File Builder
COM
SINGLE BRANCH IN SUBSYSTEM 'CENTRAL'
DOUBLE BRANCH IN SUBSYSTEM 'CENTRAL'
BUSDOUBLE BRANCH IN SUBSYSTEM 'CENTRAL'
PARALLEL BRANCH IN SUBSYSTEM 'CENTRAL'
SINGLE TIE FROM SUBSYSTEM 'CENTRAL'
DOUBLE TIE FROM SUBSYSTEM 'CENTRAL'
PARALLEL TIE FROM SUBSYSTEM 'CENTRAL'
END
```

Items of note:
"COM" denotes a comment line and all text following has no program implications. As in all programming, commenting is good practice and should be implemented here. "END" statements will be required for *.sub. *.mon and *.con files. The "area1.sub" file contains two "END" statements. Both, and sometimes more (and in future labs) are required. This to be explained in lab 4??.

area1.sub file:

The "area1.sub' file has subsystem we called out (specified) as "central" and it contains all buses in 'area1' as defined in the sample.sav database.

area1.mon file:

The "area1.mon' utilizes the subsystem we indicated as "central". As such, we are now able to implement a wide variety of monitoring functions on this subsystem. The first line sets a per unit voltage range for the subsystem. Next, the line gives a +/- deviation from the prescribed values in first line. Then, the line comments inform which branches to monitor in the subsystem named "central". Finally, the line tells that the monitor file is tied to "central" subsystem.

area1.con file:

The "area1.con" is another file that is dependent on the subsystem. This file is utilized to simulate contingencies in power flow analysis for system-in-tact-minus-1 simulations, also known as N-1 simulations. The contingency operation will work in all of the elements in the specified area or zone. For instance, it plans to remove any single branch between two buses, double branches between two buses, or any single/double branch from one area/zone to another.

AC Contingency Calculation (ACCC):

The three files area1.sub, area1.mon, and area1.con are utilized to by the AC Contingency Calculation (ACCC) feature of PSS®E to perform a PF study on a particular area or zone. After creating "area1" files, now it's time to solve the system. Follow the steps below:

1- ACCC icon located on the Fourth Toolbar
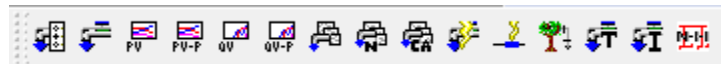
Or there is always another long way to run the ACCC contingency solution:

1- Go to Toolbar and click on Power Flow menu
2- Scroll down to Solution.
3- Under Solution click on AC contingency solution (ACCC)
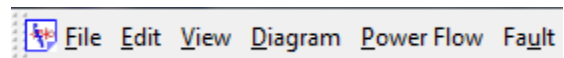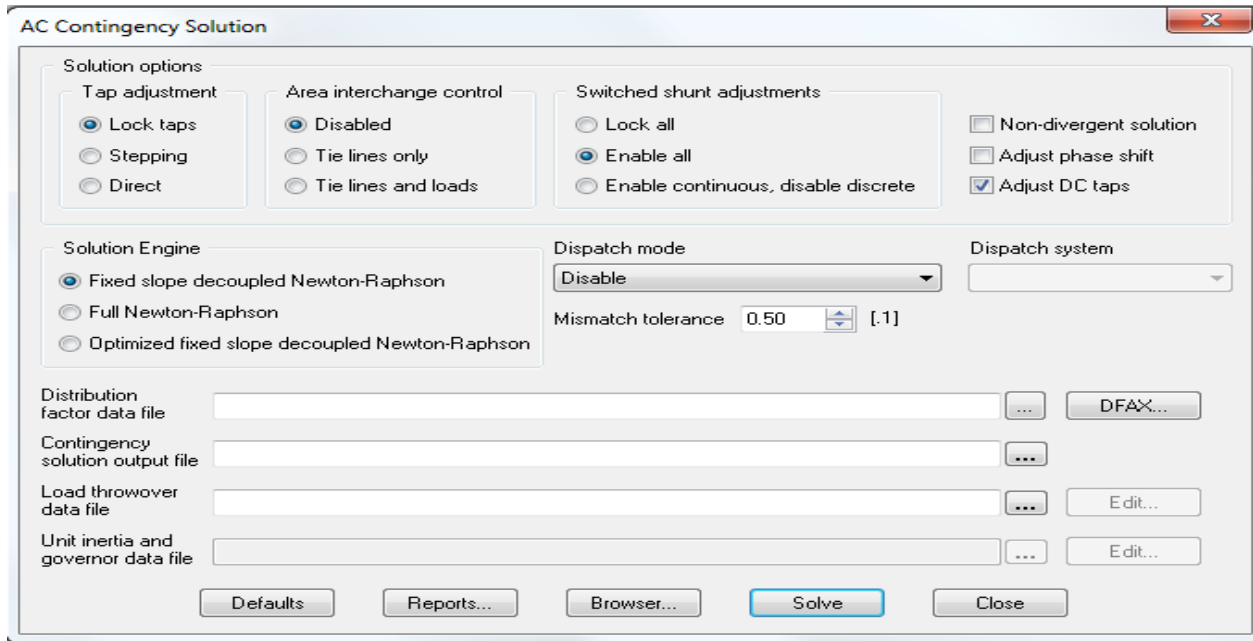
The widow of the ACCC will displayed as above place the files created earlier in the lab:

Distribution factor data file [...]: **area1.dfx**

Contingency solution output file [...]: type in the file name **"area1"**
Leave Load throwover data file empty.
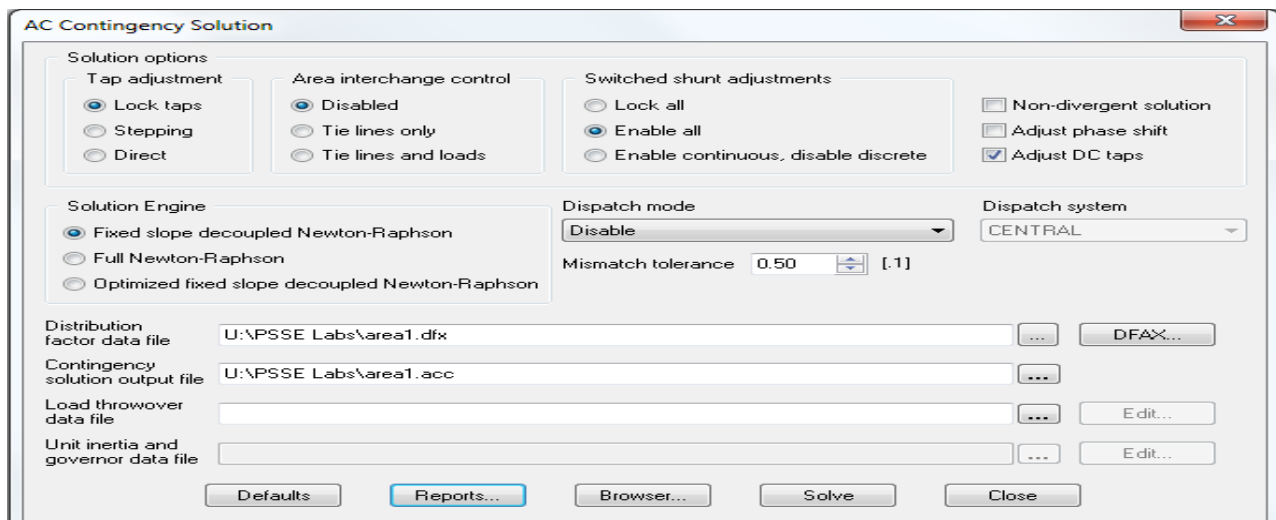
Click on Solve. Don't close the Window yet!
Click on reports the window below will open and make sure you have the correct file name for
*.acc file you created above.

AC Contingency Reports

Report format	Spreadsheet overload report
Base case rating	Rate A
Contingency case rating	Rate A

☐ Exclude interfaces from reports

☑ Perform voltage limit check

☐ Exclude elements with base case loading violations from contingency reports

☐ Exclude elements with base case voltage range violations from contingency reports

☐ Exclude cases with no overloads from non-spreadsheet overload report

☐ Report post-tripping simulation solutions

|	
0	Number of low voltage range violations
0	Number of high voltage range violations
0	Number of voltage deviation violations
0	Number of buses in largest disconnected island
6000	Maximum elements in available capacity table
100.00	Percent of flow rating
0.000	Minimum contingency case flow change for overload reports
0.00	Minimum contingency case voltage change for range violations
0.00	Minimum contingency case % loading increase for overload reports
99999.00	Cutoff threshold for available capacity table
0.50	Bus mismatch tolerance (MVA)
5.00	System mismatch tolerance (MVA)

Contingency solution output file: `U:\PSSE Labs\area1.acc`

[Browser...] [Go] [Close]

Then hit GO to run the report for "area1" your report will appear in the 'report' tab.

Go over the reports and check all the files you created from AC Contingency are shown in the reports as the picture below.

```
ACCC OVERLOAD REPORT: MONITORED BRANCHES AND INTERFACES LOADED ABOVE 100.0 % OF RATING SET A
                     % LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES
INCLUDES VOLTAGE REPORT

AC CONTINGENCY RESULTS FILE:   U:\PSSE Labs\area1.acc
DISTRIBUTION FACTOR FILE:      U:\PSSE Labs\area1.dfx
SUBSYSTEM DESCRIPTION FILE:    U:\PSSE Labs\area1.sub
MONITORED ELEMENT FILE:        U:\PSSE Labs\area1.mon
CONTINGENCY DESCRIPTION FILE:  U:\PSSE Labs\area1.con

**PERCENT LOADING UNITS**
%MVA FOR TRANSFORMERS
% I  FOR NON-TRANSFORMER BRANCHES
```

 NOW after you have the appropriate files for this operation. the report contains three majors Section described below.

1- Monitored Branch

* It shows all the branched double or single with its number and base voltage in kV that has been monitored by the contingency assigned to it. It also shows the machine identifier "ID".

* Under the contingency, the name of this contingency "BASE CASE"

* Next column states the rating for the first power rating; entered in MVA

* Under Flow indicates the amount of the power flow through this branch.

* % shows the loads percentage which above 100% loads called overload.

```
<--------------- MULTI-SECTION LINE --------------> <---------------- MONITORED BRANCH ----------------> CONTINGENCY   RATING   FLOW    %
                                                    152 MID500   500.00  3021*WDUM    18.000 T4 BASE CASE   1500.0   1902.6  126.8
                                                    152 MID500   500.00  3022*EDUM    18.000 T5 BASE CASE   1510.0   1785.7  118.3
```

2- Monitored voltage report

 This section will sort the buses according to the subsystem name in this case "CENTRAL"

```
MONITORED VOLTAGE REPORT:
SYSTEM                          CONTINGENCY  <-------- B U S -------->   V-CONT   V-INIT   V-MAX    V-MIN
'CENTRAL     '        DEVIATION SINGLE 5         153 MID230     230.00  0.94224  1.05721  0.06000  0.03000
'CENTRAL     '        DEVIATION DOUBLE 4         153 MID230     230.00  0.86455  1.05721  0.06000  0.03000
```

- V-CONT: is the post contingency voltage. It indicates the voltage element under the specified network label. Ex: Single 5
- V-INIT: it shows the initial voltage for this bus in deviation.
- V-MAX: indicates the maximum voltage deviation in the CENTRAL subsystem. (above V-initial)
- V-MIN: indicates the minimum voltage deviation in the CENTRAL subsystem. (below V-initial)

3- *Contingency Legends*

Sorts all the contingencies according to the network label and shows the action/event of this contingency. It runs contingency in every branch in all possible network choice and evaluates the overloads with each event.

```
CONTINGENCY LEGEND:
LABEL           EVENTS
SINGLE 1    : OPEN LINE FROM BUS 101 [NUC-A      21.600] TO BUS 151 [NUCPLNT     500.00] CKT T1
SINGLE 2    : OPEN LINE FROM BUS 102 [NUC-B      21.600] TO BUS 151 [NUCPLNT     500.00] CKT T2
```

These label networks can be explored in the "sample.sld" file by double-click on the bus number as shown below:

```
SINGLE 4    : OPEN LINE FROM BUS 151 [NUCPLNT     500.00] TO BUS 152 [MID500      500.00] CKT 2
```
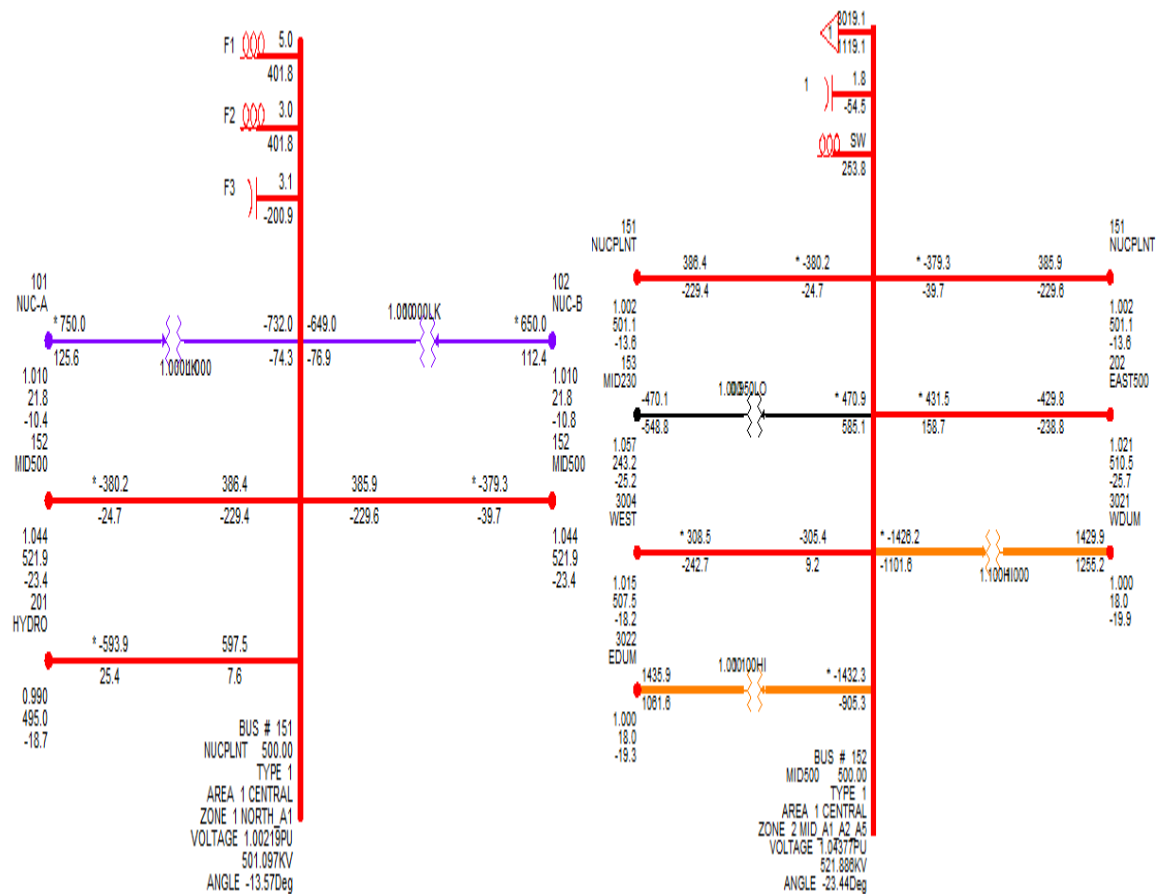
PSSE Lab # 3 Questions:

The "sample.sav" data file must be open to perform this section of the lab.

Using the "area1" contingency file, the "area1" monitor file and the "area1" subsystem file that have been provided, create an "area1.dfx" DFAX and an "area1.acc" AC contingency file. Solve the system with the loaded AREA1 files and run the ACCC report as shown above. View the report generated by PSS®E and print out the report, this print out will need to be included in the lab report. It will also be helpful in answering the following questions.

1) Which branches suffer from overloads during the "BASE CASE" contingency and what is their percentage of overload?

BRANCH	Percentage overload

2) Looking at the "SINGLE 9" contingency, which branches suffer from overloads that did not suffer from overloads during the "BASE CASE", and what is their percentage of overload?

BRANCH	Percentage overload

3) Of the branches suffering from overloads during the "BASE CASE", which one(s) got worse during this contingency (SINGLE 9), and by how much?

BRANCH	Percentage overload increase

4) Did any of these branches actually see a reduction in overload, if so, which ones and by how much were they reduced? _____

5) Which of the contingencies created the highest number of overloaded branches? _____

6) Find the "SINGLE 7" contingency.
   a) What is the rating of the branch between bus #153 and #154 (in MW) and what is the actual power flow (in MW) on this branch? _____
   b) What is the rating of the branch between bus #152 and #3021 (in MW) and what is the actual power flow (in MW) on this branch? _____

7) Using the lab manual, run the ACCC for "**area2**" and named the subsystem "EAST ". Printout the report and submit it with Lab #3 Questions.