ECEN 460 Lab 8, Spring 2025
Stability Analysis on Small and Medium Sized Systems

Objective:

Gain experience and insights in the use the transient stability simulation software. In this lab transient stability simulations will be used two small systems and on a 2000 bus systems to determine critical clearing times, and to look at the impact of generator losses on system frequency.

Background on 37 Bus APL System

As was the case with the previous lab, we'll start working with the 37bus system modeling the fictional Aggieland Power and Light (APL) grid; its oneline is shown in Figure 1.

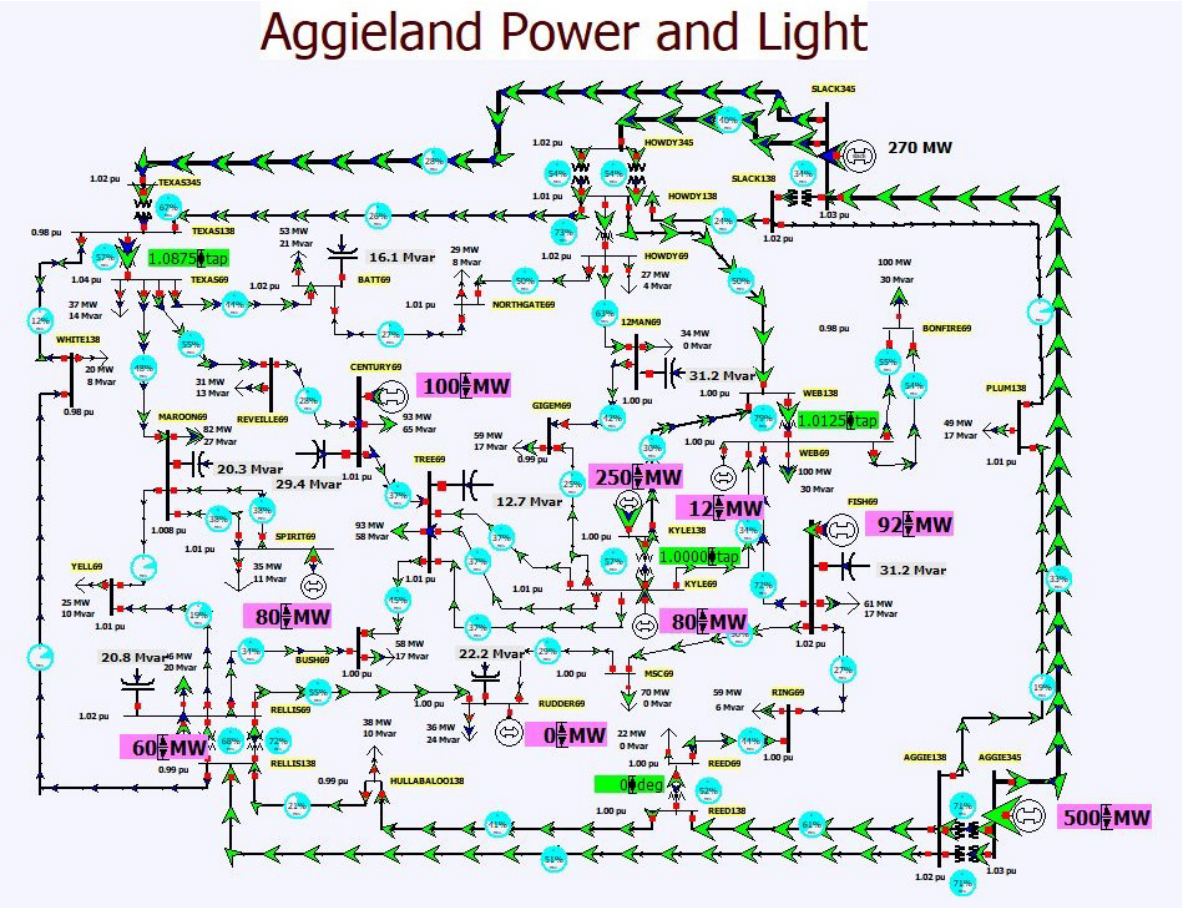

Figure 1: 37 Bus APL System

Procedure for Running Transient Stability on the APL System

1. Start PowerWorld Simulator. Open the **Lab8_AGL_TS** case. The system has been setup to run transient stability with several contingencies predefined for the lab. Select **Add Ons, Transient Stability** to display the Transient Stability form. This will be used throughout the lab to do the transient stability simulations. This is shown in Figure 2.

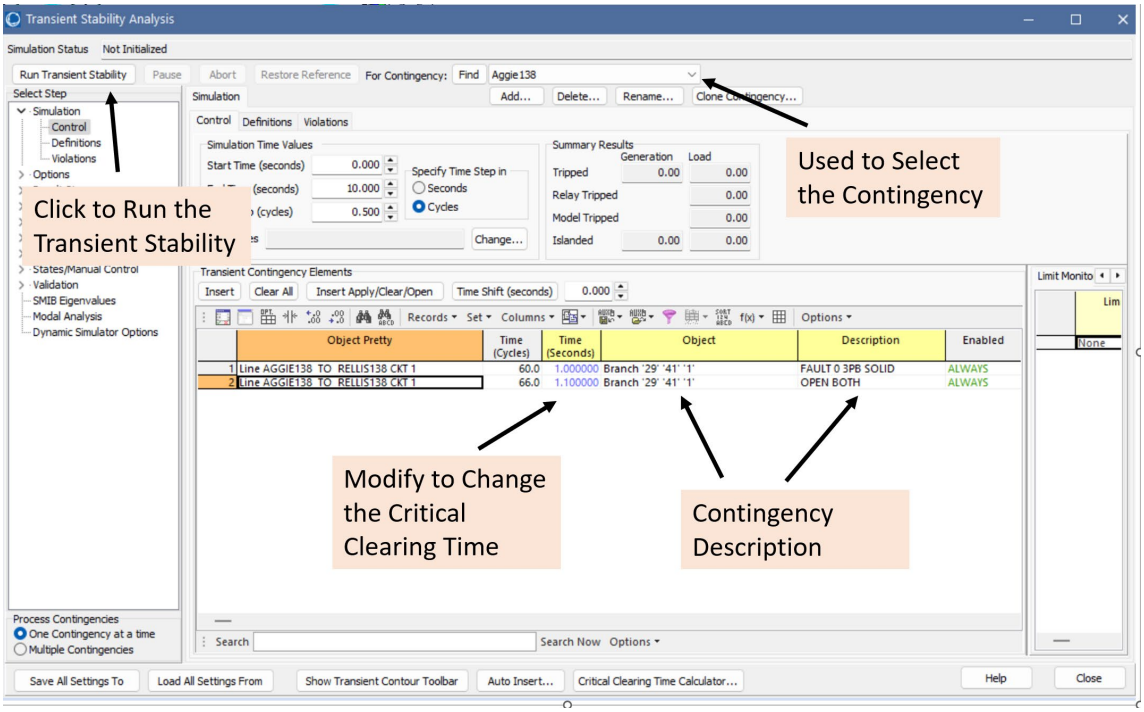

Figure 2: Transient Stability Form

2. For the first transient stability contingency, select the Aggie138 contingency. This contingency applies a balanced three-phase fault at time equals 1.0 seconds right at the terminal of one of the 138 kV transmission lines going out of the Aggie substation. After 0.1 seconds the fault is cleared by opening the transmission line. To do the transient stability run, click on the **Run Transient Stability** button. At the end of the simulation a graph will appear showing the time-varying generator rotor angles. Save a copy of this graph for your report.

3 Iteratively change the time the transmission line is opened to determine the critical clearing time for this fault (to a precision of 0.01 seconds – critical time is defined as the longest time the fault can be applied without one of the generators losing synchronism). The critical clearing time is the time difference between when the fault is applied (i.e., time = 1.0 seconds) and that largest clearing time. Save a copy of the rotor angle graph for the critical clearing time for your report, and record the critical clearing time.

4. Decrease the output of the Aggie345 generator from 500 to 450 MW, and repeat step 3. In your report comment on why such a change result in a different critical clearing time.

5. Re-open the **Lab9_AGL_TS** case and the Transient Stability Form. Change the contingency to Kyle138/69, which simulates a fault on the 138/69 kV transformer at the Kyle substation, which is also cleared by opening the device. Again, calculate the critical clearing time for this fault, saving a copy of the graph for your report.

6. Next, change the assumed H value for the Kyle138 generator. There are several ways to do this. One is to right click on the generator on the oneline and select **Generator Information Dialog**. On the **Stability, Machine Models** page change the **H** value from 3.0 to 6.0. Select **OK** to save your change and close the dialog.

Again calculate the critical clearing time for the Kyle138 contingency. Did the change in the critical clearing time match your expectations?

Background on the 2000 Bus TSGC System

This is the same Texas Synthetic Grid Company (TSGC) 2000 bus system you used in in previous labs though again the operating conditions are different; its online is shown in Figure 3. In this portion of the lab you'll be considering some of the dynamic aspects of the system.

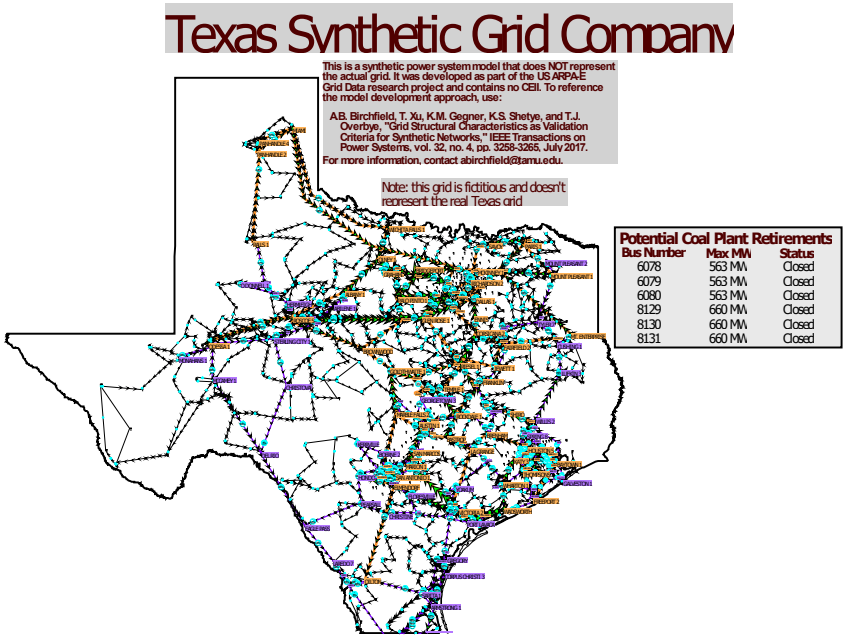

Figure 3: TSGC Lab 10 System

Procedure for TSGC Transient Stability

1. Open up the Lab8_TSGC_GenDrop case, open the Transient Stability Form, and run the "Gen Drop 1200 MW" contingency. This contingency simulates the loss of the largest generator in the system, a close to 1200 MW nuclear power plant. This contingency does a 20 second simulation (because it is a larger case it does take a little bit of time to run the simulation). During the simulation you'll see a graph showing the time-varying frequency at ten high voltage buses. At the end of the simulation you'll see three additional graphs. One shows the time-varying frequency at all 2000 buses in the system, the second shows the per unit voltage magnitudes at ten high voltage buses, and the last shows the per unit voltage magnitude at all the buses in the system. Make a note of the lowest bus frequency and the lowest per unit bus voltage magnitude. Save a copy of the graph showing the frequency at all the system buses for inclusion in your report.
2. Next, change the contingency to "Gen Drop 2700 MW Together." This contingency simulates the loss of the two largest generators in the system, consisting of two 1200 MW nuclear power plants located at the same substation. The same four graphs are shown at the end of the simulation. Again, note the lowest bus frequency and lowest per unit bus voltage magnitude. Save a copy of the graph showing the frequency at all buses for your report. In your report contrast the two contingencies. Based on these two results, do the responses seem to be proportional to the amount of generation lost?

3. Next, change the contingency to “Gen Drop 2550 MW Separate.” This contingency also simulates the loss of 2550 MW of generation. However, now the losses occur in two different locations in the system (the original 1200 MW nuclear power plant from step 1 located and then another nuclear power plant at a different location). Again, note the lowest bus frequency and lowest per unit bus voltage magnitude, and save a copy of the graph showing the frequency at all buses for your report. In your report contrast the two double generator contingencies. Which one seems to be the more severe contingency?

4. Finally, an issue that is currently confronting the electric power industry is the transient stability impacts due to the retirements of potentially large amounts of mostly coal generation. In this step you will briefly consider the impact of retirements on our lab 8 synthetic grid. Using the table shown on the right side of the oneline, open at least 2000 MW of generator capacity (your choice of which ones to open), and then rerun the “Gen Drop 2400 MW Together” contingency. Again, note the lowest bus frequency and lowest per unit bus voltage magnitude, and save a copy of the graph showing the frequency at all buses for your report. In your report contrast the two contingencies. To open a generator from the oneline table you will need to right-click on a field, select **Generator Dialog**, change its **Status** to Open, and click **OK.** Opening generators will change the power flow solution with the change in generation picked up at all the other generators in the system except the ones involved in the transient stability contingencies.

Report:

For both the APL and TSGC systems, provide a summary of the procedures you followed and the results you obtained.