Lab1 Phase-2: Contingency Analysis Study

Anupam Gopal and Dagmar Niebur
Electrical and Computer Engineering Dept.
Drexel University

Problem Description:

The following case study was proposed and published as part of design problem 4.1, 5.1 and 10.1 in A. R. Bergen and V. J. Vittal *Power Systems Analysis*, Prentice Hall, 2000.

This contingency analysis study will be conducted on the test system presented below using Mat Power software, We will use the third version of Mat Power for the design exercise published in J. D. Glover and M. S. Sarma, *Power Systems Analysis and Design*, 3rd, Brooks/Cole, Pacific Grove, CA 2001. This textbook is used for the junior class ECE P 354 on Energy Management Systems.

MATPOWER is a public domain Matlab based software which can be downloaded from www.pserc.cornell.edu/matpower/ or http://blackbird.pserc.cornell.edu/matpower/2.0/download.html.

System Specification(Same as the base case developed in phase-1) :

The base system introduced consists of an existing transmission system that contains 161 kV and 69 kV transmission lines which run through both urban and rural service territory. The existing load at the various buses in the system is specified. The parameters of the existing transmission lines in the system are also provided. The load centers and the power sources of the Eagle Power System are shown in Fig.1.1. The figure is scaled based on the distances given in Table 1.1.Note the urban area of the system. Table 1.1 specifies the transmission line and transformer data. Table 1.2 provides the load data.

System Bus Names and Loads:

Buses 1-3 are power sources at 161 kV
Buses 4-8 are urban load buses
Buses 9-15 are rural load buses
Buses with loads under 30MVA should be served at 69 kV and buses with loads over 50 MVA should be served at 161 kv. Other buses can be served at either voltage,

A base case system is provided. The details of the base case system are as follows:

There are 69kV-161kV 60MVA transformers at the Siskin and Crow buses. Each of the buses is split into two parts. At Siskin, the high voltage side is labeled bus 9, while the low voltage side is labeled bus 17. At Crow, the high voltage side is labeled bus 15, while the low voltage side is labeled bus 16.

A. *Generation:*

1. Make OWL (bus 1) the swing bus.

2. For the generation at SWIFT (bus 2) and at PARROT (bus 3),set the reactive power limits Q_{min} = -100.0 MVAr, and Q_{max} = 250.0 MVAr for both generators. Set both active power limits P_{max} = 430 MW.

3. For the generation at SWIFT (bus 2) and at PARROT (bus 3),set both active generation as P_{gen} = 190 MW. Since the voltage magnitudes is usually highest at generators and since 1.04 is at the upper limit of acceptable voltage magnitudes, schedule the voltage magnitudes on the three generators at or near 1.04 p.u.

B. *Lines*

Take the short-line model, i.e. ignore the shunt capacitances given implicitly through the BMVA parameters. The maximum current carrying capacity (or *ampacity*) of the conductors are:

- Partidge: 475A
- Hawk 659A
- Dove 726A
- Drake 907A
- Cardinal 996A

C. *Transformer*

For the transformers we have X_T =0.08 pu at 60 MVA Base. Assume a limit of 20MVA.

D. *Areas:*

Assign urban buses to a different area than rural buses. Use area interchange data for each area (this is needed if your power flow program provides this option), including the maximum and minimum acceptable voltages.

E. *Title:*

For each power flow case you run, title lines should be used to describe the case.

F. *Data Checking:*

Since data *must* be in the correct columns in data input to the MATPOWER power flow program, spend time checking the computer output. Also check to see that all lines are connected to the correct buses. Send the Matpower case to the TA for verification.

G. *Power Flow Control Parameters:*

Choose MATPOWER's default values, i.e. an accuracy of 10^{-8} and a maximum number of iterations of 10. (Control parameters are specified in MATPOWER's file mpoption.m.)

System with base loads and regulating transformers

Regulating Transformers: Set each transformer to regulate the voltage on the 69-kV bus. Select a scheduled voltage and include it in the bus data. Specify a tap range of (0.9 to 1.1 per unit) 62.1 kV to 75.9 kV.

Contingency Analysis

This design exercise will test the steady-state performance of the system following contingencies. The exercise demonstrates the use of the power flow programs in analyzing the performance of the system and tests its ability to perform within specified guidelines following disturbances. This will be an exhaustive contingency analysis. You will need to consider the failure of each transmission line, transformer and generator.

1. Transformers: For all cases, set each transformer to regulate the voltage on the 69KV bus.

2.
Generation: For cases where you remove lines or transformers, set the power generation at bus 2 and at bus 3 to 270 MW. For the generator outage cases, you should select the power schedules (suggest that the two remaining generators share the load approximately equally). Also for the generator outage cases, change the bus at which you drop a generator to a *P, Q* bus with zero load. (It is not sufficient to set *P* generated to zero; it would continue to regulate voltage and output voltamperes reactive). For the cases at which you schedule each generator at its maximum, lower the generation at the other two buses (suggest that the two share the remaining generation approximately equally).

3.
You should check the cases for overloads and for satisfactory voltages (0.96 to 1.04). If your system is not satisfactory, change it so that it will be satisfactory. Keep in mind that a change that solves one problem may create problems in other cases.

Contingency Analysis Report

The report should be typed. Use of a word processor would be helpful since portions of the report will need to be updated in other phases of the design project.

This report should include the following:

1. The power flow output of all contingency case and of the system with no outages

2. Number and title all figures and tables.

Starters Guide:

B. In order to successfully run mat power in the lab please follow the following steps in sequential order:

1. Login to the system as student.
2. Open matlab.
3. Change the current directory location to “D:\Matpower-3”.
4. The list of files in the folder Matpower-3 appears on the left side of the screen in the “Current Directory” window.
5. Open one of the existing cases (M- file) by double clicking on it.
6. After making necessary modifications to the file run it in matlab by typing the command “runpf(‘caseXX’).
7. Result of the power flow is displayed in the command window.

Remarks:

- Please turn in the mat lab data file before running the power flow on it. This would help in validating the data and making corrections if any.
- Please run the Matpower simulation before running the Power world simulation as it would help in debugging the data in case if the solution doesn't converge.

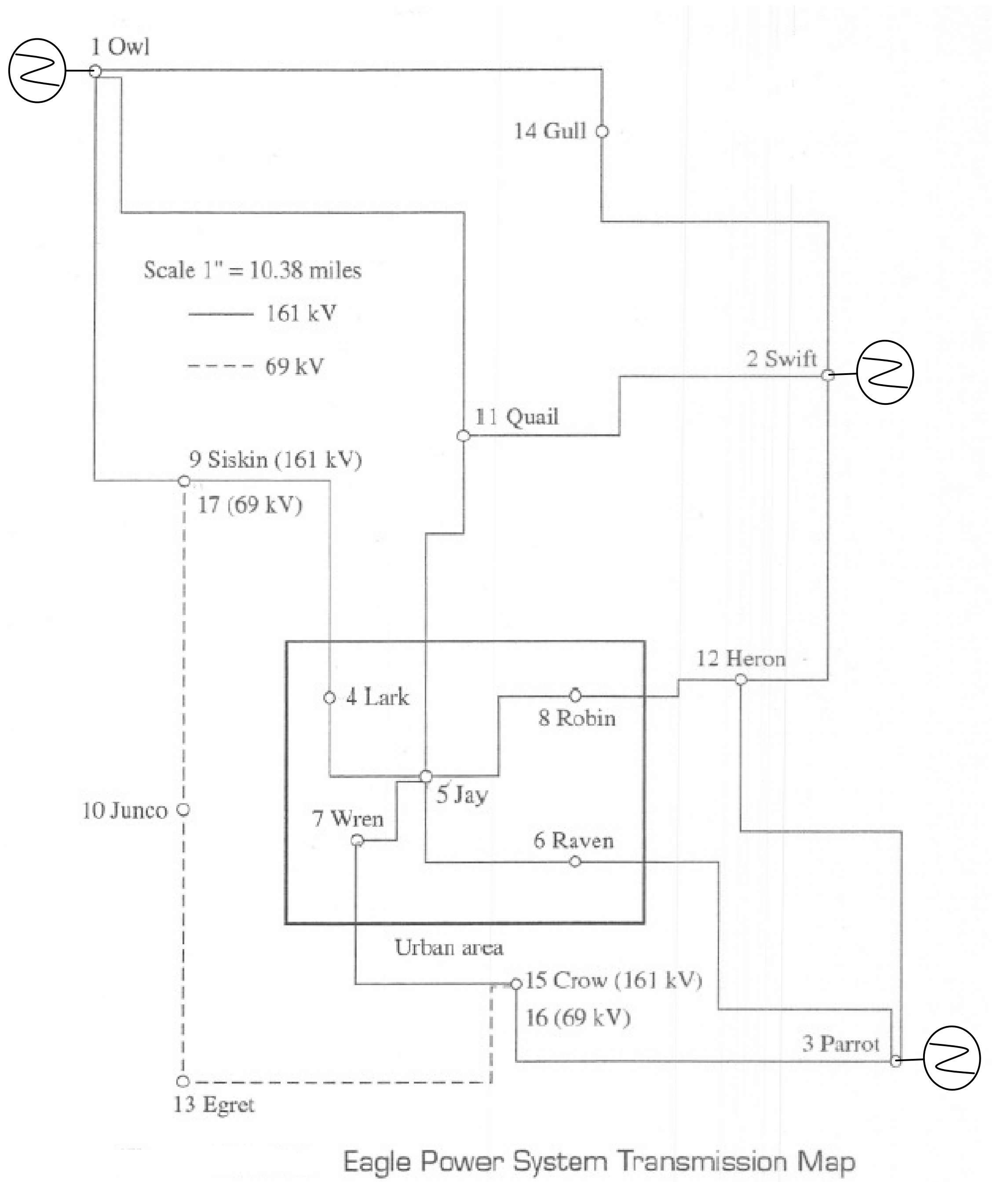

Figure:1.1 Eagle Power System Transmission Map

Table 1.1 Transmission Line Parameters

Bus#	Bus#	Bus Name	Bus Name	Miles	Conductor	*R*-Ω	*X*-Ω	BMVA[1]
1	9	Owl 161	Siskin 161	24.0	Drake	3.085	17.47	3.629
1	11	Owl 161	Quail 161	36.7	Drake	4.718	26.70	5.550
1	14	Owl 161	Gull 161	28.2	Drake	3.629	20.53	4.264
2	11	Swift 161	Quail 161	21.5	Drake	2.774	15.66	3.251
2	12	Swift 161	Heron 161	20.3	Drake	2.618	14.78	3.070
2	14	Swift 161	Gull 161	24.0	Drake	3.085	17.47	3.629
3	6	Parrot 161	Raven 161	27.6	Drake	3.551	20.09	4.174
3	12	Parrot 161	Heron 161	27.6	Drake	3.551	20.09	4.174
3	15	Parrot 161	Crow 161	23.6	Drake	3.033	17.16	3.569
4	5	Lark 161	Jay 161	8.4	Dove	1.529	6.30	1.232
4	9	Lark 161	Siskin 161	18.8	Drake	2.411	13.69	2.843
5	6	Jay 161	Raven 161	10.8	Dove	1.970	8.09	1.584
5	7	Jay 161	Wren 161	6.0	Dove	1.089	4.48	.880
5	8	Jay 161	Robin 161	10.9	Dove	1.996	8.17	1.599
7	15	Wren 161	Crow 161	14.6	Drake	1.866	10.63	2.208
8	12	Robin 161	Heron 161	9.8	Drake	1.270	7.13	1.482
5	11	Jay 161	Quail 161	19.5	Drake	2.514	14.18	2.949
10	13	Junco 69	Egret 69	14.3	Hawk	3.033	10.15	.408
10	17	Junco 69	Siskin 69	16.2	Hawk	3.433	11.49	.462
13	16	Egret 69	Crow 69	21.9	Hawk	4.642	15.54	.624

1The BMVA is the volt-amperes reactive generated by the total susceptance corresponding to the line charging of the transmission line at the rated voltage.

Table 1.2 Existing Loads at Various Busses

Bus #	Bus Name	Load-MW	Load-MVAr
1	Owl		
2	Swift		
3	Parrot		
4	Lark	60	10
5	Jay	100	30
6	Raven	80	15
7	Wren	90	20
8	Robin	40	5
9	Siskin	10	5
10	Junco	15	10
11	Quail	75	15
12	Heron	40	15
13	Egret	30	10
14	Gull	35	10
15	Crow	10	0
		585	145