Contingency Ranking and Analysis using Power System Analysis Toolbox (PSAT)

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Abstract
In this paper according to the increasing utilization in power system, the transmission lines and power plants often operate in stability boundary and system probably lose its stable condition by over loading or occurring disturbance. According to the reasons that are mentioned, the prediction and recognition of voltage instability in power system has particular importance and it makes the network security stronger. This paper, by considering of power system contingencies based on the maximum loading parameter point is focused in order to analyze the static voltage stability using continuation power flow method. The study has been carried out on IEEE 14-Bus Test System using Power System problem has been solved by using PSAT with Matlab and results are presented.
Keywords- Contingency ranking, Continuation Power Flow, Psat Voltage Stability

1.**Introduction**

Voltage stability assessment [1,2] is becoming an essential task for power system planning and operation. Power system security analysis [3] forms an integral part of modern energy management system. Security is a term used to reflect a power system's ability to meets its load without unduly stressing its apparatus or allowing variables to stray from prescribed range under the apparatus or allowing variables to stray from prescribed range under certain pre-specified credible contingencies. The contingencies [4,5] are in the form of network outage such as line or transformer outage or in the form of equipment outage e.g. a generator outage. The outages, which are important from limit violation viewpoint, are branch flow for line security or MW security and bus voltage magnitude for voltage security. Voltage stability has become a very important limit in assessing voltage security. The importance of voltage stability in determining system security and performance will continue to increase due to the increased loadings and interconnections brought about by economic and environmental pressures which have let to increasingly complex power systems that must operate closer to their stability limits. The conventional methods for voltage security assessment are based on load flow solution where full ac load flow is made to run for all contingencies. The results obtained were accurate but these methods were found to be slow, as for all contingencies the load flow had to be run. But in the present day, due to large interconnection and stressed operation power utilities are facing severe problems of maintaining the required security. Today more emphasis is made on the greater utility of generation and transmission capacity, which has made the system to operate much closer to their limits. So it has become, indispensable to do voltage security assessment accurately and instantaneously, to avoid the system from voltage collapse. The concept of security in system operation may be divided into three components, monitoring, assessment and control. Security monitoring starts with measurement of real time system data to provide up to date information of the current condition of power system. Security assessment is the process whereby any violation of operating limits is detected. It has two functions. The first is the detection of violation of the actual system operating states. The second, much more demanding function of security assessment is contingency analysis. this paper is also be consider in the psat and run the program of continuation power flow and to result for selction and ranking of contingency.

2. Power System Analysis Toolbox (PSAT)

The Power System Analysis\ Toolbox (PSAT), an open source Matlab and GNU/Octavebased software package for analysis and design of small to medium size electric power systems. PSAT includes power flow, continuation power flow, optimal power flow, small signal stability analysis and time domain simulation as well as several static and dynamic models, including non-conventional loads, synchronous and asynchronous machines, regulators and FACTS. PSAT is also provided with a complete set of user-friendly graphical interfaces and a Simulink-based editor of one-line network diagrams. Basic features, algorithms and a variety of case studies are presented in this paper to illustrate the capabilities of the presented tool and its suitability for educational and research purposes that is several Matlab-based commercial, research and educational power system tools have been proposed, such as Power System Toolbox (PST) [3], Mat Power [4], Toolbox (VST) [5], Mat EMTP [6], Sim Power Systems (SPS) [7], Power Analysis Toolbox (PAT) [8], and the Educational Simulation Tool (EST) [9].

2.1 PSAT Features

PSAT has been thought to be portable and open source. At this aim, PSAT has been developed using MATLAB, which run son the commonest operating systems, such as Unix, Linux, Windows and Mac OS X. Nevertheless, PSAT would not be completely open source if it run only on Matlab, which is a proprietary software. At this aim PSAT can run also on the latest GNU/Octave releases [12], which is basically a free Matlab clone. In the knowledge of the author, PSAT is actually the first *free software* project in the field of power system analysis.

3. Contingency Ranking and Analysis

The IEEE 14-bus system is used to show the practicability of the proposed algorithm and to find the contingency ranking and analysis using PSAT for power system security. The IEEE 14-bus system is shown in Figure 1. Bus is the swing bus, bus 2, 3, 6 & 8 are PV buses, and loads are connected at buses 4,5,7,9,10,11,12,13, &14.

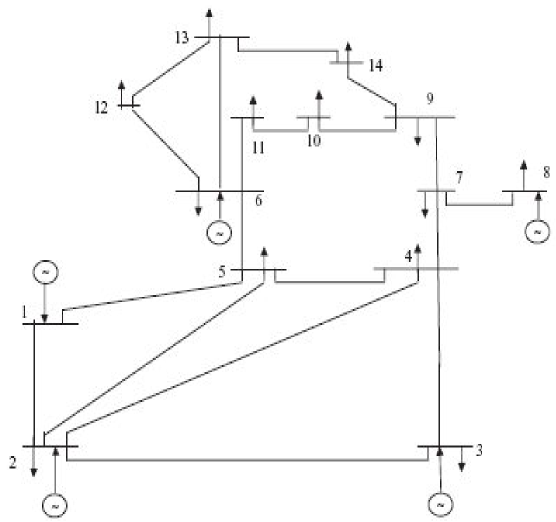

Figure 1. IEEE 14-Bus System

4. Results and Discussion

The voltage security assessment involves contingency analysis, which can be performed by continuation power flow using PSAT for line outage, one important thing here to notice that when we remove the one line other lines are there original values. Contingency analysis is performed on selected buses are identified and are ranked in order of their severity.

Table 1: shows maximum loading parameter for each removal of lines one by one

S.no.	Removal of line	From bus	To bus	Maximum loading parameter
1	1	2	5	1.408
2	2	6	12	1.3614
3	3	12	13	1.4286
4	4	6	13	1.0457
5	5	6	11	1.2666
6	6	11	10	1.3191
7	7	09	10	1.4876
8	8	9	14	1.6338
9	9	14	13	1.3515
10	10	7	09	1.0237
11	11	1	2	1.3375
12	12	03	2	1.3536
13	13	3	4	1.4387
14	14	1	5	1.3964
15	15	5	4	1.2946
16	16	2	4	1.3452
17	17	5	6	1.456
18	18	4	9	1.3755
19	19	4	7	1.3699
20	20	8	7	1.1686

4.1 Contingency Ranking of Selected Severe Lines for IEEE-14 bus system

There are 20 radial lines; out of these lines most of the lines do not reduce the loading parameter margin much below base case. Therefore 20 severe lines are selected for on-line ranking .This contingency ranking is based on the line outage in system. Line outage which resulted in voltage instability is ranked the highest .Therefore the contingency ranking assist the engineer to take necessary action in order to avoid the occurrence of voltage collapse in the system if actual line outage occur in respective lines shown in table 2.

Table 2 : Contingency ranking for IEEE-14 bus system

Rankings of Severe line	Line no.	From Bus	To Bus	Loading Parameter Margin
1	10	7	9	1.0237
2	4	6	13	1.0457
3	20	8	7	1.1686
4	5	6	11	1.2666
5	15	5	4	1.2946
6	6	11	10	1.3191
7	12	1	2	1.3375
8	16	2	4	1.3452
9	9	14	13	1.3515
10	12	3	2	1.3536
11	2	6	12	1.3614
12	19	4	7	1.3699
13	18	4	9	1.3755
14	16	2	4	1.3964
15	1	2	5	1.408
16	3	12	13	1.4286
17	13	3	4	1.4387
18	17	5	6	1.456
19	7	9	10	1.4876
20	8	9	14	1.6338

From table no.2 it has to be cleared that line number 10 connected between bus 7 to bus 9 is most severe line among all lines in our study after that line 4 connected between bus 6 and bus 13 is severe and so all. Contingency ranking analysis helps the power system engineer to give the most priority to notice or monitoring the line flows to which line and monitoring other lines flow in descending order.

5. Conclusion

In this paper, the method for contingency ranking using PSAT was praposed. The proposed algorithm has been applied to practical IEEE 14-Bus system. The study of contingency ranking and analysis is very important from the view point of power system security. Here we have obtain the contingency ranking for IEEE 14 Bus system. For IEEE-14 Bus system line number 10 connected between Bus 7 to Bus 9 is most severe line among all 20 lines. Table 2 shows the contingency ranking for IEEE-14 Bus system This identification being able to significantly improve the secure performance of power systems and to reduce the chances of failure of system. Good planning helps to ensure that reliability and security of the system. Contingency ranking analysis helps the power system engineer to give the most priority to notice or monitoring the line flows to which line and monitoring other lines flow in descending order.

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