

# Contingency Analysis of Power System

Veenavati jagadishprasad mishra  
M. Tec P.T. (EPS - VI Sem)  
Govt. College of Engineering, Amravati (MS),  
India

Manisha D. Khardennis  
Assistant Professor (Project Guide)  
Govt. College of Engineering, Amravati (MS),  
India

## ABSTRACT

In the past many wide spread blackouts have occurred in interconnected power systems therefore it is necessary to insure that power system should be operated most economically such that power is delivered reliably. Contingency analysis is a well known function in modern Energy Management Systems (EMS). The goal of this power system analysis function is to give the operator information about the static security [4]. Contingency Analysis of a power system is a major activity in power system planning and operation. In general an outage of one transmission line or transformer may lead to over loads in other branches and/or sudden system voltage rise or drop. Contingency analysis is used to calculate violations.

This paper shows the example on 6 bus power system which gives information of violations & remedial action to remove violations. Detailed studies have been carried out to work out the contingency plans.

## Keywords

Contingency analysis, LODFs, PTDFs, generation and transmission planning.

## 1. INTRODUCTION

Most power systems are designed with enough redundancy so that they can withstand all major failure event. Contingency analysis is one of the major components in today's modern energy management systems. For the purpose of fast estimating system stability right after outages, the study of contingency analysis involves performing efficient calculations of system performance from a set of simplified system conditions [10].

Contingency analysis is one of the most important tasks encountered by the planning and operation engineers of bulk power system.

The Line Outage Distribution Factor (LODF) is one of the important linear sensitivity factors which play a key role in finding the effect of the critical contingencies and hence suggesting possible preventive and corrective actions to solve the violations in the system.

- LODFs are used to approximate the change in the flow on one line caused by the outage of a second line
- Typically they are only used to determine the change in the MW flow compared to the pre-contingency flow
- LODFs are approximately independent of flows but do depend on the assumed network topology [9].
- Power transfer distribution factors (PTDFs) show the linear zed impact of a transfer of power.

The increasing load demand in power systems without accompanying investments in generation and transmission has

affected the analysis of stability phenomena, requiring more reliable and faster tools [1-2].

## 2. CONTINGENCY ANALYSIS

Contingency Analysis (CA) is one of the "security analysis" applications in a power utility control center that differentiates an Energy Management System (EMS) from a less complex SCADA system. Its purpose is to analyze the power system in order to identify the overloads and problems that can occur due to a "contingency".

Contingency analysis is abnormal condition in electrical network. It put whole system or a part of the system under stress. It occurs due to sudden opening of a transmission line. Generator tripping. Sudden change in generation. Sudden change in load value. Contingency analysis provides tools for managing, creating, analyzing, and reporting lists of contingencies and associated violations [6].

CA is used as a study tool for the off-line analysis of contingency events, and as an on-line tool to show operators what would be the effects of future outages.

- Security is determined by the ability of the system to withstand equipment failure.
- Weak elements are those that present overloads in the contingency conditions (congestion).
- Standard approach is to perform a single (N-1) contingency analysis simulation.
- A ranking method will be demonstrated to prioritize transmission planning [7].
- CA is therefore a primary tool used for preparation of the annual maintenance plan and the corresponding outage schedule for the power system.

## 3. TYPES OF VIOLATIONS

Line contingency and generator contingency are generally most common type of contingencies. These contingencies mainly cause two types of violations.

### A. Low Voltage Violations -

This type of violation occurs at the buses. This suggests that the voltage at the bus is less than the specified value. The operating range of voltage at any bus is generally 0.95-1.05 p.u. Thus if the voltage falls below 0.95 p.u then the bus is said to have low voltage. If the voltage rises above the 1.05 p.u then the bus is said to have a high voltage problem. It is known that in the power system network generally reactive power is the reason for the voltage problems. Hence in the case of low voltage problems reactive power is supplied to the bus to increase the voltage profile at the bus. In the case of the high voltage reactive power is absorbed at the buses to maintain the system normal voltage.



**TABLE II Results of Contingency Analysis**

Total # of contingencies	7	Start Time	31/12/2011 5:26:11 PM
# Processed	7	End Time	31/12/2011 5:26:11 PM
# Unsolvable	0	Total Run Time	0.23 Seconds
# Violations	21	Avg. Time per Ctg	0.033 Seconds

**TABLE III LODFs of 6 Bus System**

Sr. No.	From Line	To Line	% LODF	MW From	MW To
1	1	2	-100	-86.2	89.2
2	1	5	100	87.6	-84.6
3	2	4	-100	10.3	-10.2
4	3	5	-100	16.1	-15.4
5	3	6	100	-21.3	21.9
6	5	4	0	0	0
7	6	4	100	-121.9	128.1

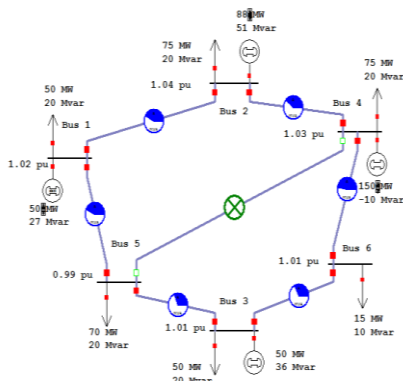
**TABLE IV PTDFs of 6 Bus System**

Sr. No	From line	To line	% PTDF from	% PTDF To
1	1	2	50	-50
2	1	5	50	-50
3	2	4	50	-50
4	3	5	-50	50
5	3	6	50	-50
6	6	4	-50	50

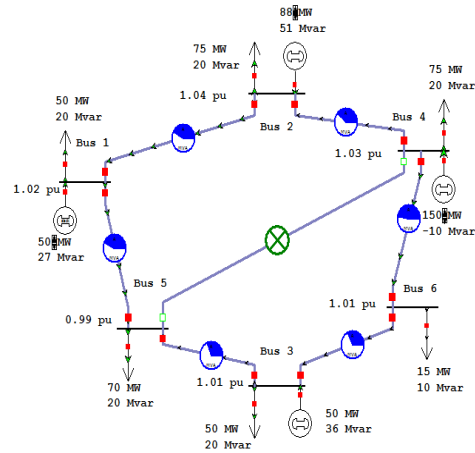
The table (I) show the contingency analysis when 4 to 5 line is open. The Overloaded Line is As Shown in fig. (2). the numbers of violations are 21 as shown in table (II). The LODF and PTDF calculations for 6 bus system are shown in table (III) & table (IV) resp.

Results, when corrective and preventive remedial actions taken to solve the violations are given below.

## 7. AFTER REMEDIAL ACTION TAKEN ON 6 BUS SYSTEM



**Fig 3: N-1 Line contingency on 6 bus system**



**Fig 4: N-1 line violations solved after action taken on 6bus system.**

A. Result & discussion for violations solved after action taken on 6 bus system:

**TABLE V Contingency Analysis violations solved after action taken on 6bus system.**

Sr. No	Line details	Violations	Max branch % MVA limit
1	000001-000002	0	-
2	000001-000005	0	-
3	000002-000004	0	-
4	000003-000005	0	-
5	000003-000006	0	-
6	000005-000004	0	-
7	000006-000004	0	-

**TABLE VI Result of Contingency Analysis violations solved after action taken on 6bus system.**

Total # of contingencies	7	Start Time	31/12/2011 6:02:19 PM
# Processed	7	End Time	31/12/2011 6:02:19 PM
# Unsolvable	0	Total Run Time	0.22 Seconds
# Violations	0	Avg. Time	0.031 Seconds

**TABLE VII LODFs violations solved after action taken on 6bus system.**

Sr. No.	From Line	To Line	% LODF	MW From	MW To
1	1	2	-100	-40.4	41.1
2	1	5	100	40.7	-40.0
3	2	4	-100	27.8	28.3
4	3	5	-100	30.4	-30.0
5	3	6	100	-30.4	30.8
6	5	4	0	0	0
7	6	4	100	-45.8	46.7

**TABLE VIII** PTDFs violations solved after action taken on 6bus system.

Sr. No	From line	To line	% PTDF from	% PTDF To
1	1	2	50	-50
2	1	5	50	-50
3	2	4	50	-50
4	3	5	-50	50
5	3	6	50	-50
6	6	4	-50	50

As shown in figure (2). Some of the lines have been carrying the power more than the limit. Action should be taken to solve these MVA violations. After reducing the generation at bus(4) to 150MW and also shedding the load at buses(2&4) to 75MW, bus 5 to 70MW and at bus (6) to 15MW, at bus(1&3) to 50MW the MW on the lines have come back to within its operational limits. As seen in table (V), the MVA limit of the lines and all line flows are within operating limits. The LODF and PTDF after action taken is shown in table (VII) and table (VIII) resp.

With proposed study various sets of system adjustment are identified based on type of violations and the type of contingency being applied. The corrective actions effectively removed the limit violations in the system. More importantly can identify location in system where new generation can provide grid reliability benefits [5].

## 8. CONCLUSION

The corrective actions effectively removed the limit violations in the system. The results obtained through the proposed algorithm are found to be quite accurate and thus, this work provides new tool for developing remedial control actions for higher order contingencies. Contingency analysis study helps to strengthen the initial basic plan. It is also helpful to develop system operators to improve their ability to resolve problem. This tool helps especially the busy power system operators.

## 9. REFERENCES

- [1] K. Bhattacharya, M. Bollen, and J. Daalder, Operation of Restructured Power Systems (Kluwer Academic Publishers, 2001).
- [2] Loi Lei Lai, Power System Restructuring and deregulation (John Wiley & Sons, 2002).
- [3] P. Pentayya, P. Mukhopadhyay, S. Banerjee, M.K.Thakur, Contingency Analysis for Eastern Regional Grid of India, 16th National Power Systems Conference, pp359-363, 2010.
- [4] R. Bacher, "Graphical Interaction and Visualization for the Analysis and Interpretation of Contingency Analysis Results", Proceedings of IEEE Power Industry Computer Application Conference, 1995, pp. 128-134, May 1995.
- [5] M.K. Enns, J.J. Quada, and B. Sackett, "Fast Linear Contingency Analysis," IEEE Trans. On PAS, Vol. PAS-101, No. 4, pp. 783-791, April 1982.
- [6] V. Brandwajn, "Efficient Bounding Method for Linear Contingency Analysis", IEEE Transactions On Power Systems, Vol. 3, No.1, February 1988.
- [7] G. C. Ejebe and B.F. Wollenberg, "Automatic Contingency Selection", IEEE Trans. on. PAS-98, pp. 97-109, Jan/Feb 1979.
- [8] Guide for Remedial Action Schemes, "WECC remedial Action Scheme Design Guide," November 28, 2006.
- [9] T. Guler, G. Gross, M. Liu, "Generalized Line Outage Distribution Factors", Power Systems, EEE Trans. Vol. 22, Issue 2, May 2007, pp.879 – 881.
- [10] Chia-Chi Chu, Sheng-Huei Lee, & Husun-Yuan Chuang "Efficient Look-Ahead Load Margin and Voltage Profiles Contingency Analysis Using the Tangent Vector Index Method". Department of Electrical Engineering, Chang Gung University Kwei-San, Tao-Yuan 333, Taiwan, R.O.C.
- [11] K. Radha Rani, J. Amarnath, and S. Kamakshaiyah, "Contingency Analysis under Deregulated Power Systems", ICGST-ACSE Journal, Volume 11, Issue 2, November 2011.