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Power System Contingency Analysis by using Voltage and Active Power Performance Index

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ABSTRACT

Now a days, power system protection is an important task for an operating engineer, which can be done by doing online security assessment. The contingency analysis technique is a prerequisite to predict the effects of various contingencies like failure of transformers, transmission lines, etc. To do contingency analysis first the operator has to know the parameters like voltage, power and voltage angle at each and every bus by doing load flow analysis on the system. Newton Raphson method is the best load flow method as it gives accurate results in less time. In this paper for each line outage contingency, load flow analysis has been done on the system and the active power and voltage performance indices have been calculated. These two performance indices will give the idea about the change in active power flow through the lines and voltages at the buses for a particular line outage. Summation of these two indices will give the performance index value through which ranking of severity will be given to the lines. Based on this, the ranking of most severe contingency has been done based on the values of performance indices. Simultaneously the value of bus voltages and active power flow before and after the most severe transmission line contingency has been analyzed. The effectiveness of the method has been tested on 5-Bus, 6-Bus, IEEE-14 Bus and IEEE-30 Bus test systems in MATLAB environment. This contingency analysis helps the operational engineer to know which line outage is dangerous to the system and what prior action is to be taken to minimize the effect of that particular line outage.

KEYWORDS:- *Contingency selection, Newton Raphson Method, Performance index, overload.*

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I. INTRODUCTION

Contingency is expressed as an unwanted event occurring in the power system for a short duration of time, which actually specify the loss or outage of one or more components of power system [1]. At the time of outage of any component or equipment in the power system, contingency analysis shows an indication, of what might be the position of power system [2]. It is fundamentally a software application run in power management system, simulating a speculative test on a list of notional cases, which would create power flow, voltage or reactive power violations in the sytem. These cases are recognized and ranked in order of their severity using contingency ranking approach [3]. Generally contingency analysis is separated into three parts, contingency creation, selection, and evaluation [4], but now a days the selection and the evaluation both are doing in same section. Many work has been done on contingency selection mainly, whose aim is to reduce the indigenous long list of contingencies by selecting only the outages with severe limit violations [5]. This selection is seasoned by mainly two methods, i.e. contingency ranking and contingency screening. The screening methods are local solution based study, which primarily gives importance to the most dangerous cases for complete ac analysis, simultaneously the non-severe cases are deleted from the list [6]. Alternative method is ranking method, which uses performance index as a scalar value to narrate the effects of an outage on the whole system [7]. In this work, the effort has been given on contingency ranking. At starting the contingency list is formed, which contains those cases whose probability of getting outage is found to be high. The list, which is generally large, is translated into electrical network changes, mostly generator and/or line outages. Contingency evaluation using load flow is then carrying out on the following individual outages in decreasing order of severity. The activity will be remained up to the point where no post contingency violations are undergone.

II. CONTINGENCY ANALYSIS

A. Contingency Creation

It is the initial step of contingency analysis. It is made up of all set of viable contingencies that may happen in a power system. This process consists of making contingency lists.

B. Contingency Selection

It is the second step in contingency analysis; it is the process which includes finding of severe contingencies from all that may cause to violate bus voltages and power through lines. Here in this procedure contingency list is reduced by rejection of least severe contingency and taking into consideration of most severe outages. In this process the performance index has been used to find the most severe ones.

C. Contingency Evaluation

It is the third step and the most significant step as it includes necessary control and security actions which are required in order to reduce the effects of most severe contingencies in a power system.

III. UTILIZED LOAD FLOW METHOD

The Newton-Raphson method is the most useful method for load flow solutions because of its different advantages. It has dominant convergence characteristics compared to remaining load flow methods. And has less calculation. The Newton-Raphson method is benefit for large power system networks as because computer storage requirements are less and increases almost linearly with size of problem.

The following equations are used in N- R method to measure voltage, current, active power and reactive power at different buses.

The current injected at the bus m is

$$I_m = \sum_{l=1}^{n} Y_{ml} V_l \tag{1}$$

Where n is the number of buses in the system.

Y_{ml} is the admittance between lines m and l.

V_l is the voltage at bus I.

In polar form we can write equation 1 as

$$I_m = \sum_{l=1}^{n} |Y_{ml}||V_l| \angle(\theta_{ml} + \delta_l) \tag{2}$$

Where θ_{ml} is the admittance angle between lines m and l.

δ_l is the voltage angle of bus l.

We can write current in terms of active and reactive Power

$$I_m = \frac{P_m - jQ_m}{V_m^*} \tag{3}$$

Where P_m is the active power injected into the system from bus m.

Q_m is the reactive power injected into the system from bus m.

V_m is the voltage magnitude at bus m.

After substitution of I_m value in equation 3 we can get

$$P_m - jQ_m = |V_m| \angle -\delta_m \sum_{l=1}^{n} |Y_{ml}||V_l| \angle(\theta_{ml} + \delta_l) \tag{4}$$

By separating real and imaginary terms, we get

$$P_m = \sum_{l=1}^{n} |Y_{ml}||V_l||V_m| \text{Cos}(\theta_{ml} - \delta_m + \delta_l) \tag{5}$$

$$Q_m = \sum_{l=1}^{n} |Y_{ml}||V_l||V_m| \text{Sin}(\theta_{ml} - \delta_m + \delta_l) \tag{6}$$

By neglecting higher order terms if we expand equation 5 and 6 by using Taylor's series we will get

$$\begin{bmatrix} \Delta P_2^K \\ \vdots \\ \Delta P_n^K \\ \Delta Q_2^K \\ \vdots \\ \Delta Q_n^K \end{bmatrix} = \begin{bmatrix} \begin{pmatrix} \frac{\partial P_2^K}{\partial \delta_2^K} & \cdots & \frac{\partial P_2^K}{\partial \delta_n^K} \\ \vdots & \ddots & \vdots \\ \frac{\partial P_n^K}{\partial \delta_2^K} & \cdots & \frac{\partial P_n^K}{\partial \delta_n^K} \end{pmatrix} & \begin{pmatrix} \frac{\partial P_2^K}{\partial |V_2|^K} & \cdots & \frac{\partial P_2^K}{\partial |V_n|^K} \\ \vdots & \ddots & \vdots \\ \frac{\partial P_n^K}{\partial |V_2|^K} & \cdots & \frac{\partial P_n^K}{\partial |V_n|^K} \end{pmatrix} \\ \begin{pmatrix} \frac{\partial Q_2^K}{\partial \delta_2^K} & \cdots & \frac{\partial Q_2^K}{\partial \delta_n^K} \\ \vdots & \ddots & \vdots \\ \frac{\partial Q_n^K}{\partial \delta_2^K} & \cdots & \frac{\partial Q_n^K}{\partial \delta_n^K} \end{pmatrix} & \begin{pmatrix} \frac{\partial Q_2^K}{\partial |V_2|^K} & \cdots & \frac{\partial Q_2^K}{\partial |V_n|^K} \\ \vdots & \ddots & \vdots \\ \frac{\partial Q_n^K}{\partial |V_2|^K} & \cdots & \frac{\partial Q_n^K}{\partial |V_n|^K} \end{pmatrix} \end{bmatrix} \begin{bmatrix} \Delta \delta_2^K \\ \vdots \\ \Delta \delta_n^K \\ \Delta |V_2|^K \\ \vdots \\ \Delta |V_n|^K \end{bmatrix} \quad (7)$$

The jacobian matrix will give the linear relationship between small changes in the angle $\Delta\delta_i^K$ and change in bus voltage ΔV_i^K with small variations in real power and reactive power ΔP_i^K and ΔQ_i^K

$$\begin{pmatrix} \Delta P \\ \Delta Q \end{pmatrix} = \begin{pmatrix} J_1 & J_2 \\ J_3 & J_4 \end{pmatrix} \begin{pmatrix} \Delta\delta \\ \Delta|V| \end{pmatrix} \quad (8)$$

The diagonal and off diagonal elements of J_1 are

$$\frac{\partial P_m}{\partial \delta_m} = \sum_{l \neq m} |V_m||V_l||Y_{lm}| \mathrm{Sin}\left(\theta_{ml} - \delta_m + \delta_l\right) \quad (9)$$

$$\frac{\partial P_m}{\partial \delta_m} = -|V_m||V_l||Y_{ml}| \mathrm{Sin}\left(\theta_{ml} - \delta_m + \delta_l\right), l \neq m \quad (10)$$

The power residuals ΔP_m^K , ΔQ_m^K can be written as

$$\Delta P_m^K = P_m^{sch} - P_m^K$$
$$\Delta Q_m^K = Q_m^{sch} - Q_m^K \quad (11)$$

Where P_m^{sch} is the scheduled active power at bus m.

Q_m^{sch} is the scheduled reactive power at bus m.

From the power residuals and jacobian matrix we can get the voltage magnitude $|V_m^K|$ and voltage angle δ_m^K .

The new values of voltages and angles are

$$\left|V_m^{(K+1)}\right| = \left|V_m^K\right| + \Delta\left|V_m^K\right|$$
(12)

$$\delta_m^{(K+1)} = \delta_m^K + \Delta\delta_m^K$$
(13)

IV. SYSTEM PERFORMANCE INDEX

The deviation of power system variables like bus voltages, power flows, from its rated value is measured by the system performance index. It is also used to evaluate the relative stability of a contingency [8].

1. Voltage performance index (PI_V)
2. Active power performance index (PI_{Mw})

A. Voltage Performance Index (PI_V):

The power system deficiency due to violation of bus voltages is described by the voltage performance index [2].

$$PI_v = \sum_{i=1}^{n} \left(\frac{W}{2z}\right) \left\{ \frac{\left(|V_i| - |V_i^{sp}|\right)}{\Delta V_i^{\lim}} \right\}^{2z} \quad (14)$$

Where $|V_i|$ is the ith bus voltage magnitude.

$|V_i^{sp}|$ is the i^th bus specified voltage magnitude.

$\Delta V_i^{\lim}$ is the voltage deviation limit which we can measure by taking average value of minimum and maximum allowable voltages at bus i.

z is exponent of the penalty function and value is (=1).

n is the number of buses in the given power system.

W is the real non negative weighting factor and value is (=1)

Here to calculate $\Delta V_i^{\lim}$ maximum voltage limit is 1.05 p.u and minimum voltage limit is 0.95 p.u since ±5% deviation in voltage is allowed. This voltage performance index will give the information about the change in voltage at each and every bus.

B. Active Power Performance Index (PI_{Mw}):

For identify the power over flows through the transmission lines the indices used is active power performance index [9].

$$PI_{MW} = \sum_{i=1}^{N_L} \left(\frac{W}{2z}\right) \left\{ \frac{P_l}{P_l^{\max}} \right\}^{2z} \quad (15)$$

Where, P_l is the power flow (MW) through the line l.

$P_l^{\max}$ is the maximum capacity of power flow through the line l.

N_L is the number of the transmission lines of the power system

W is the real non-negative weighting facto and value is (=1)

z is exponent of penalty function and value is (=1)

$$P_l^{max} = \frac{V_i * V_j}{X} \quad (16)$$

Where V_i is the voltage at bus i.

V_j is the voltage at bus j.

X is the reactance of the line between bus i and bus j.

V. TEST CASES

To perform contingency analysis, IEEE standard 5 bus, 6 bus, 14 bus and30 bus systems are considered.

Test case 1: 5 BUS SYSTEM

TABLE 1.1: SYSTEM DATA

From Bus	To Bus	R (p.u.)	X (p.u.)	B/2 (p.u.)	Real Power Capacity(p.u.)
1	2	0.02	0.06	0.030	0.8
1	3	0.08	0.24	0.025	0.3
2	3	0.06	0.25	0.020	0.2
2	4	0.06	0.18	0.020	0.2
2	5	0.04	0.12	0.015	0.6
3	4	0.01	0.03	0.010	0.1
4	5	0.08	0.24	0.025	0.1

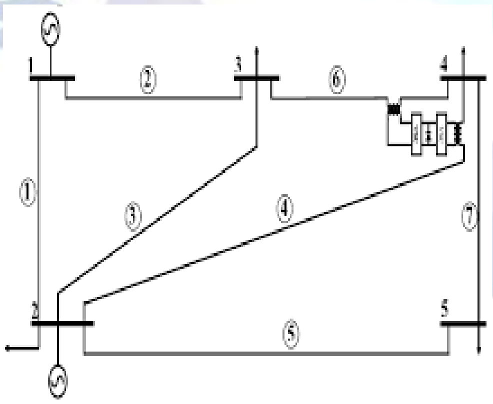

Fig. I: Five-bus Network

For analysis IEEE standard 5 bus system is considered. Bus 1 is slack bus, bus 2 is generator and 3,4, and 5 are load buses. Now for each line outage the load flow method has been carried out and the active power performance index and voltage performance index have been calculated using equations 14 and 15. The ranking has been given based on the Performance Index (P. I).

TABLE 1.2: RANKING OF THE LINES for 5-bus system

Tripped line	PI_V	PI_{MW}	PI	Rank
1-2	2.4587	0.1386	2.5973	3
1-3	3.2521	0.0276	3.2797	2
2-3	2.2540	0.0295	2.2834	6
2-4	2.3784	0.0293	2.4077	4
2-5	11.1376	0.0811	11.2186	1
3-4	2.2836	0.0235	2.3070	5
4-5	2.1436	0.0230	2.1666	7

TABLE 1.3: PRE CONTINGENCY AND POST CONTINGENCY STATE Bus VOLTAGES FOR THE LINE OUTAGE (2-5)

Bus No.	Pre-Contingency Voltage (p.u.)	Post-Contingency Voltage (p.u.)
1	1.0600	1.0600
2	1.0000	1.0000
3	0.9873	0.9602
4	0.9841	0.9503
5	0.9717	0.8579

TABLE 1.4: POST CONTINGENCY POWERFLOWS

From Bus	To Bus	When 2-5 line is tripped	Real Power Capacity (p.u.)
		Post-Contingency Power (p.u.)	
1	2	0.8147	0.8
1	3	0.5604	0.3
2	3	0.4517	0.2
2	4	0.5399	0.2
2	5	0	0.6
3	4	0.5215	0.1
4	5	0.6398	0.1

After the (2-5) line is tripped, all the transmission lines are overloaded as shown in the above table.

Test case 2: 6 BUS SYSTEM

TABLE 2.1: SYSTEM DATA

From Bus	To Bus	R (p.u.)	X (p.u.)	B/2 (p.u.)	Real Power Capacity (p.u.)
1	2	0.10	0.20	0.02	0.3
1	4	0.05	0.20	0.02	0.5
1	5	0.08	0.30	0.03	0.4
2	3	0.05	0.25	0.03	0.2
2	4	0.05	0.10	0.01	0.4

2	5	0.10	0.30	0.02	0.2
2	6	0.07	0.20	0.025	0.3
3	5	0.12	0.30	0.025	0.2
3	6	0.02	0.10	0.01	0.6
4	5	0.20	0.40	0.04	0.2
5	6	0.10	0.30	0.03	0.2

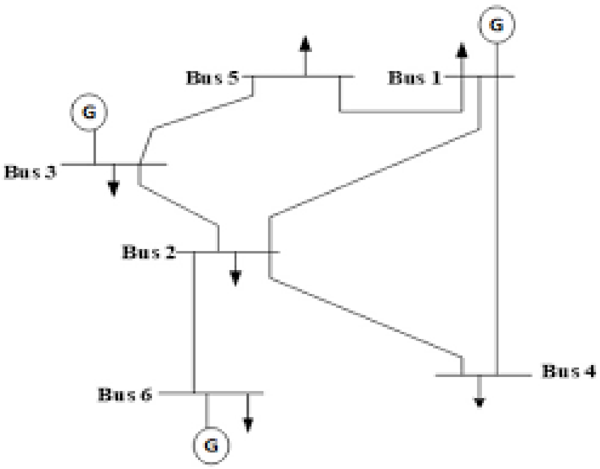

Fig.2: Six-bus Network

For analysis IEEE standard 6 bus system is considered. Bus 1 is slack bus, 2, 3 buses are generator and 4, 5, and 6 are load buses. Now for each line outage the load flow method has been carried out and the active power performance index and voltage performance index has been calculated using equations 14 and 15. The ranking has been given based on the Performance Index (P. I).

TABLE 2.2: RANKING OF THE LINES

Tripped line	PI_V	PI_{MW}	PI	Rank
1-2	4.0842	0.0455	4.1296	11
1-4	5.0979	0.0561	5.1539	3
1-5	4.7019	0.0511	4.7530	5
2-3	4.0974	0.0337	4.1311	10
2-4	8.9559	0.0500	9.0059	2
2-5	4.5972	0.0384	4.6356	6
2-6	4.2595	0.0396	4.2991	7
3-5	4.9139	0.0421	4.9560	4
3-6	9.6332	0.0811	9.7143	1
4-5	4.1636	0.0344	4.1980	9
5-6	4.2344	0.0335	4.2679	8

TABLE 2.3: PRE CONTINGENCY AND POST CONTINGENCY STATE Bus VOLTAGES FOR THE LINE OUTAGE (3-6)

Bus No.	Pre-Contingency Voltage (p.u.)	Post-Contingency Voltage (p.u.)
1	1.0500	1.0500
2	1.0500	1.0500
3	1.0700	1.0700
4	0.9894	0.9854
5	0.9854	0.9574
6	1.0044	0.8898

TABLE 2.4: POST CONTINGENCY POWERFLOWS

From Bus	To Bus	When 3-6 line is tripped	Real Power Capacity (p.u.)
		Post-Contingency Power (p.u.)	
1	2	0.3218	0.3
1	4	0.4602	0.5
1	5	0.3626	0.4
2	3	0.2132	0.2
2	4	0.3187	0.4
2	5	0.1500	0.2
2	6	0.5550	0.3
3	5	0.3847	0.2
3	6	0	0.6
4	5	0.0498	0.2
5	6	0.1990	0.2

Test case 3: 14 BUS SYSTEM

TABLE 3.1: SYSTEM DATA

From Bus	To Bus	R (p.u.)	X (p.u.)	B/2 (p.u.)	Real Power Capacity (p.u.)
1	2	0.01938	0.05917	0.02640	0.6
2	3	0.04699	0.19797	0.02190	0.7
2	4	0.05811	0.17632	0.01870	0.8
1	5	0.05403	0.22304	0.02460	0.5
2	5	0.05695	0.17388	0.01700	0.4
3	4	0.06701	0.17103	0.01730	0.3
4	5	0.01335	0.04211	0.0064	0.2
5	6	0.0	0.25202	0.0	0.5
4	7	0.0	0.20912	0.0	0.4
7	8	0.0	0.17615	0.0	0.2
4	9	0.0	0.55618	0.0	0.2
7	9	0.0	0.11001	0.0	0.2
9	10	0.03181	0.08450	0.0	0.2
6	11	0.09498	0.19890	0.0	0.3
6	12	0.12291	0.25581	0.0	0.2
6	13	0.06615	0.13027	0.0	0.2
9	14	0.12711	0.27038	0.0	0.2
10	11	0.8205	0.19207	0.0	0.2
12	13	0.22092	0.19988	0.0	0.2
13	14	0.17093	0.34802	0.0	0.2

Transformer	Between Buses	Tap Setting
1	4 – 7	0.978
2	4 – 9	0.969
3	5 – 6	0.932

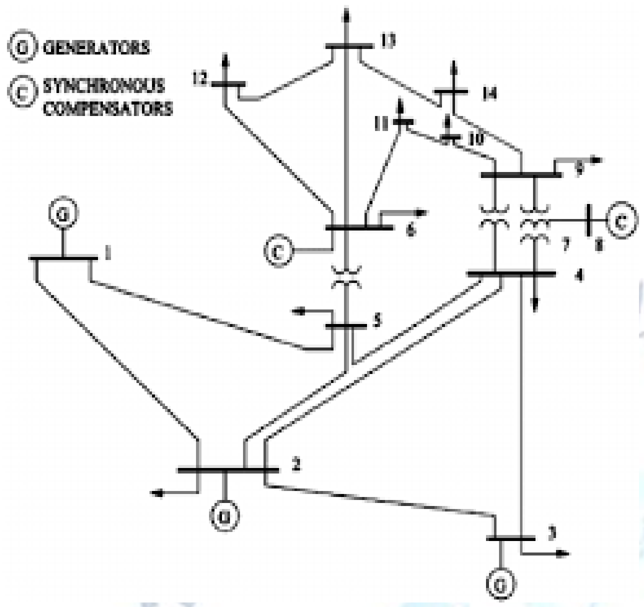

Fig. 3: Fouteen-bus Network

TABLE 3.2: RANKING OF THE LINES

Tripped line	PI_V	PI_{MW}	PI	Rank
1-2	13.8951	0.4008	14.2958	15
2-3	14.8189	0.2016	15.0204	10
2-4	14.4829	0.1589	14.6418	13
1-5	14.8244	0.1034	14.9278	11
2-5	14.8244	0.1034	14.9278	11
3-4	15.9340	0.0929	16.0269	2
4-5	14.3103	0.0953	14.4056	14
6-11	13.5478	0.0859	13.6338	17
6-12	14.1924	0.0849	14.2773	16
6-13	12.3364	0.1160	12.4524	20
7-8	12.6066	0.1014	12.7081	19
7-9	13.0923	0.0977	13.1900	18
9-10	15.0850	0.1025	15.1875	8
9-14	15.6176	0.1010	15.7186	4
10-11	15.3310	0.1046	15.4356	7
12-13	15.6541	0.0992	15.7533	3
13-14	14.9609	0.1023	15.0631	9
4-7	15.5247	0.1012	15.6259	5
4-9	15.2109	0.1079	15.3188	6
5-6	17.5626	0.1634	17.7260	1

TABLE 3.3: PRE CONTINGENCY AND POST CONTINGENCY STATE Bus VOLTAGES FOR THE LINE OUTAGE (5-6)

Bus No.	Pre-Contingency Voltage (p.u.)	Post-Contingency Voltage (p.u.)
1	1.0600	1.0600
2	1.0450	1.0450
3	1.0100	1.0100
4	1.0177	1.0181
5	1.0195	1.0272
6	1.0700	1.0700
7	1.0615	1.0656
8	1.0900	1.0900
9	1.0559	1.0682
10	1.0510	1.0614
11	1.0569	1.0623
12	1.0552	1.0543
13	1.0504	1.0525
14	1.0355	1.0422

TABLE 3.4: POST CONTINGENCY POWERFLOWS

From Bus	To Bus	When 5-6 line is tripped	Real Power Capacity (p.u.)
		Post-Contingency Power (p.u.)	
1	2	1.6147	0.6
2	3	0.7584	0.7
2	4	0.6166	0.8
1	5	0.7420	0.5
2	5	0.3771	0.4
3	4	0.2085	0.3
4	5	0.9963	0.2
5	6	0.0000	0.5
4	7	0.5613	0.4
7	8	0.0000	0.2
4	9	0.3191	0.2
7	9	0.5739	0.2
9	10	0.3349	0.2
6	11	0.1969	0.3
6	12	0.0455	0.2
6	13	0.0394	0.2
9	14	0.2733	0.2
10	11	0.2418	0.2
12	13	-0.0159	0.2
13	14	-0.1127	0.2

Test case 4: 30 BUS SYSTEM

TABLE 4.1: SYSTEM DATA

From Bus	To Bus	R (p.u.)	X (p.u.)	B/2 (p.u.)	Real Power Capacity (p.u.)
1	2	0.0192	0.0575	0.0528	1.0400
1	3	0.0452	0.1652	0.0408	1.0400
2	4	0.0570	0.1737	0.0368	0.5200
3	4	0.0132	0.0379	0.0084	1.0400
2	5	0.0472	0.1983	0.0418	1.0400
2	6	0.0581	0.1763	0.0374	0.5200
4	6	0.0119	0.0414	0.0090	0.7200
5	7	0.0460	0.1160	0.0204	0.5600
6	7	0.0267	0.0820	0.0170	1.0400
6	8	0.0120	0.0420	0.0090	0.2560
6	9	0.0	0.2080	0.0	0.5200

6	10	0.0	0.5560	0.0	0.2560
9	10	0.0	0.1100	0.0	0.5200
4	12	0.0	0.2560	0.0	0.5200
12	14	0.1231	0.2559	0.0	0.2560
12	15	0.0662	0.1304	0.0	0.2560
12	16	0.0945	0.1987	0.0	0.2560
14	15	0.2210	0.1997	0.0	0.1280
16	17	0.0524	0.1923	0.0	0.1280
15	18	0.1073	0.2185	0.0	0.1280
18	19	0.0639	0.1292	0.0	0.1280
19	20	0.0340	0.0680	0.0	0.2560
10	20	0.0936	0.2090	0.0	0.2560
10	17	0.0324	0.0845	0.0	0.2560
10	21	0.0348	0.0749	0.0	0.2560
10	22	0.0727	0.1499	0.0	0.2560
21	22	0.0116	0.0236	0.0	0.2560
15	23	0.1000	0.2020	0.0	0.1280
22	24	0.1150	0.1790	0.0	0.1280
23	24	0.1320	0.2700	0.0	0.1280
24	25	0.1885	0.3292	0.0	0.4800
25	27	0.1093	0.2087	0.0	0.1280
28	27	0.0	0.3960	0.0	0.5200
27	29	0.2198	0.4153	0.0	0.1280
27	30	0.3202	0.6027	0.0	0.1280
29	30	0.2399	0.4533	0.0	0.1280
8	28	0.0636	0.2000	0.4028	0.2560
6	28	0.0169	0.0599	0.0130	0.2560
9	11	0.0	0.2080	0.0	0.5200
12	13	0.0	0.1400	0.0	0.5200
25	26	0.2544	0.3800	0.0	0.1280

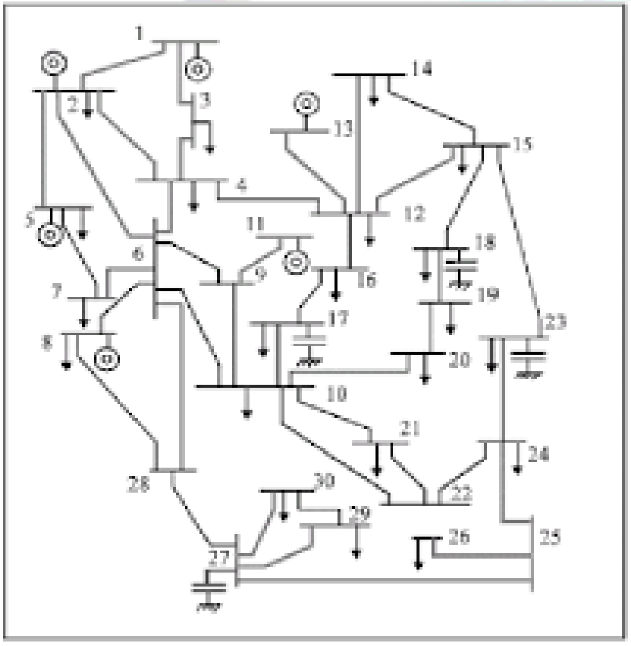

Fig. 4: Thirty-bus Network

TABLE 4.2: RANKING OF THE LINES

Tripped line	PI_V	PI_{MW}	PI	Rank
1-2	15.7079	0.1711	15.8791	33
1-3	15.5330	0.0479	15.5809	37
2-4	15.9123	0.0539	15.9661	31
3-4	16.4893	0.0606	16.5499	18
2-5	15.9673	0.0785	16.0458	30
2-6	15.9956	0.0529	16.0484	29
4-6	16.4688	0.0451	16.5139	19
5-7	16.2322	0.0418	16.2740	25
6-7	16.7208	0.0377	16.7585	16
6-8	16.0930	0.0470	16.1400	28
6-9	17.8893	0.0456	17.9348	5
6-10	15.1647	0.0433	15.2081	39
9-11	14.8014	0.0575	14.8589	41
9-10	14.9948	0.0524	15.0472	40
4-12	17.0075	0.0518	17.0593	9
12-13	17.7687	0.0690	17.8377	8
12-14	15.6947	0.0483	15.7430	35
12-15	16.3546	0.0514	16.4060	20
12-16	15.5754	0.0473	15.6227	36
14-15	16.2498	0.0445	16.2943	23
16-17	16.2244	0.0448	16.2692	26
15-18	15.9033	0.0448	15.9481	32
18-19	16.1722	0.0445	16.2167	27
19-20	16.6997	0.0469	16.7466	17
10-20	16.8525	0.0498	16.9022	15
10-17	15.7424	0.0468	15.7892	34
10-21	16.9585	0.0516	17.0101	12
10-22	16.3407	0.0485	16.3892	21
21-22	16.2294	0.0461	16.2755	24
15-23	17.8131	0.0487	17.8619	7
22-24	20.7223	0.0495	20.7718	4
23-24	17.0005	0.0476	17.0481	11
24-25	24.0833	0.0472	24.1305	1
25-26	15.2487	0.0422	15.2909	38
25-27	17.8429	0.0458	17.8887	6
27-28	17.0075	0.0518	17.0593	9
27-29	22.2469	0.0502	22.2971	2
27-30	21.9454	0.0502	21.9956	3
29-30	16.9006	0.0422	16.9428	14
8-28	16.3068	0.0600	16.3668	22
6-28	16.9376	0.0585	16.9961	13

TABLE 4.3: PRE CONTINGENCY AND POST CONTINGENCY STATE Bus VOLTAGES FOR THE LINE OUTAGE (24-25)

Bus No.	Pre-Contingency Voltage (p.u.)	Post-Contingency Voltage (p.u.)
1	1.0500	1.0500
2	1.0338	1.0338
3	1.0290	1.0291
4	1.0236	1.0237
5	1.0058	1.0058
6	1.0219	1.0216

7	1.0075	1.0074
8	1.0230	1.0230
9	1.0418	1.0443
10	1.0356	1.0409
11	1.0913	1.0913
12	1.0432	1.0457
13	1.0883	1.0883
14	1.0280	1.0317
15	1.0230	1.0280
16	1.0327	1.0364
17	1.0293	1.0341
18	1.0152	1.0203
19	1.0137	1.0189
20	1.0184	1.0236
21	1.0212	1.0284
22	1.0211	1.0289
23	1.0099	1.0196
24	1.0010	1.0169
25	0.9797	0.9412
26	0.9613	0.9220
27	0.9753	0.9506
28	1.0208	1.0177
29	0.9544	0.9290
30	0.9423	0.9166

TABLE 4.4: POST CONTINGENCY POWERFLOWS

From Bus	To Bus	When 24-25 line is tripped	Real Power Capacity (p.u.)
		Post-Contingency Power (p.u.)	
1	2	0.9077	1.0400
1	3	0.4786	1.0400
2	4	0.2920	0.5200
3	4	0.4452	1.0400
2	5	0.5814	1.0400
2	6	0.3785	0.5200
4	6	0.3877	0.7200
5	7	0.1300	0.5600
6	7	0.3623	1.0400
6	8	0.0093	0.2560
6	9	0.1522	0.5200
6	10	0.1204	0.2560
9	10	0.3292	0.5200
4	12	0.2698	0.5200
12	14	0.0776	0.2560
12	15	0.1777	0.2560
12	16	0.0682	0.2560
14	15	0.0148	0.1280
16	17	0.0328	0.1280
15	18	0.0568	0.1280
18	19	0.0244	0.1280
19	20	0.0706	0.2560
10	20	0.0937	0.2560
10	17	0.0575	0.2560
10	21	0.1645	0.2560
10	22	0.0805	0.2560
21	22	0.0117	0.2560
15	23	0.0517	0.1280
22	24	0.0682	0.1280
23	24	0.0194	0.1280
24	25	0	0.4800
25	27	0.0355	0.1280
28	27	0.1620	0.5200
27	29	0.0621	0.1280
27	30	0.0712	0.1280
29	30	0.0371	0.1280
8	28	0.0407	0.2560
6	28	0.1288	0.2560
9	11	0.1793	0.5200
12	13	0.1691	0.5200
25	26	0.0355	0.1280

VI. CONCLUSION

To give the contingency ranking, performance index has been used as a measuring tool. Newton Raphson power flow method is found most appropriate method in the approach of contingency selection, as it played a vital role in rejecting the large number of contingency cases and concentrated on the most severe contingency case. From the results, it is seen that the calculation of performance indices gives a good measure of the cases, which has the highest potential to form the system
parameters to go beyond their limits, calculation of PI are also obtained for the sake of increase in the accuracy of the sorting and ranking technique of the contingency analysis process.

VII. FUTURE SCOPE

From the above one can judge the state of power system if any equipment gets outage from the system. So by forecasting the effect of any outage, the operator come to know the prior action what should be done for the particular outage. Especially at this condition "FACT' devices will help to control the power flow and to maintain good voltage profile at each and every bus. TCSC will be used to control the power flow through the lines which is getting overloaded and ST ATCOM, SVC will be used to maintain good voltage profile by giving

reactive power or by taking reactive power from the bus. So we can extend this work by placing "FACT' devices in our system.

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