Available Power Transfer Capability for Indian 62 Bus System in Contingency Constrained Conditions

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***Abstract*—This paper calculates total transfer capability (TTC) and available transfer capability (ATC) in different contingency conditions such as line outage and generator outage conditions. The most common continuous power flow method is utilised for TTC calculations. These calculations are useful for power wheeling in different power systems for power trading purposes in deregulated power systems. The methods are implemented for an Indian 62 bus power system considering three other outage conditions arbitrarily.**

Keywords—Contingency, TTC, ATC, Thermal limit, Outage

I. INTRODUCTION

The most commonly used deterministic security standard is arguably the N1 standard. This criterion specifies that operating conditions are specified by the rule in state N, that is when all elements of the energy system are operating. In general, this has been tested in a variety of traditional conditions and can take up to 1 minute at peak or low load of the system. It also means that the point of the operating system is within the scope of all sorts of incidents that can lead to confusion and contingency. Of only one element (generator, line, transformer, etc.) [1].

Most system failures are due to element overload, in addition to certain technical and operational errors. Emergency situations are preferably present as a result of single or multiple failures of system elements such as transformers, generators, power lines, etc., each of which is, for example, for example [2-3]:

- Generator: Overload due to increased demand, temperature limits, and technical failures
- Transmission line: Line overload challenges thermal limits, voltage drop limits, and steady-state stability limits
- Transformer: System transformer failures depend on thermal limiting challenges and other engineering failures

This emphasizes the power flow capacity of the transmission line in the event of a transmission line failure or a failure associated with a generator failure. Transmission capacity calculations are more important for deregulated power systems where multiple transactions occur in the electricity market. The grid operator needs to enter the actual state of the grid in order to smoothly operate the deregulated grid for the operation and planning of large power markets. For future markets, these precise capacity calculations are essential. This paper presents a continuous load current program designed to calculate the total transmission power (TTC). TTC is an important factor in calculating the available transmission capacity (ATC). TTC is calculated by executing different load current instances beginning with the base case and progressing until thermal stability, voltage, or transition limit is reached. For speedier computations for load flow analysis, this study employs the estimated DC power flow approach.

Some of the literature describing ATC and DC load flow analysis is described here. P. W. Sauer et al.,[3] This article discusses ATC definitions and definition guidelines approved by the North American Electrical Reliability Council (NERC) and introduces several concepts to address engineering challenges in computing. S. B. Panda et al.,[4] describe the DC load flow-based power system contingency analysis for the Indian 62 bus power system for multiple line contingencies. The article Mohamed Shaaban et al., [5] first presents the assumptions and considerations used throughout the study and then presents techniques for contingency analysis of power systems, the framework for TTC calculations.

II. TECHNIQUES FOR POWER SYSTEM CONTINGENCY ANALYSIS

Power system safety analysis is performed to create a number of control methods to ensure the safety and survival of the system in the event of an emergency and thus to operate at the lowest possible cost. To have a safe electrical system, the elements of the power system must operate under specified operating conditions such as voltage fluctuation limit, thermal limit, and reactive power limit in order to minimize any possible damage. dangerous incident.

It is also useful to assess power system security through redundancy analysis by calculating system performance metrics for pre-and post-backup scenarios. This calculation is essential for the system's preventive operating mechanism to withstand the system's emergency. This calculation can be performed using the following techniques:

- AC power flow
- DC power flow

Here in this paper, DC power flow has been discussed. DC power flow analysis yields faster results than many approximations for calculating power flows in lines under contingency conditions. This approximation does not affect the actual behaviour as the loadings in the lines are mostly considered for active power flow. Therefore, for the calculation of post contingent flows, DC analysis is used here [6]-[8].

DC power flow is typical for power system contingency analysis as it simplifies the computational time procedure. The simplification is because only actual power flow in the system network branches is revealed.

The specific DC load current has a shorter calculation time due to the effect of linearizing the power flow solution regarding the following assumptions:

- The difference in voltage angle between two buses is considerably small, so its approximate sine is equal to the angle, and the cosine is equal to one.
- The magnitudes of voltages are approximated to 1.00 p.u.
- System is lossless, i.e., ideal system.’

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- The transformer tap settings are ignored

Within the system, contingency analysis occurs by examining each conceivable contingency, i.e., N-1 contingency one at a time.

It must begin with a solved load flow scenario representing current conditions, followed by a contingency assessment, as seen in Fig.1.

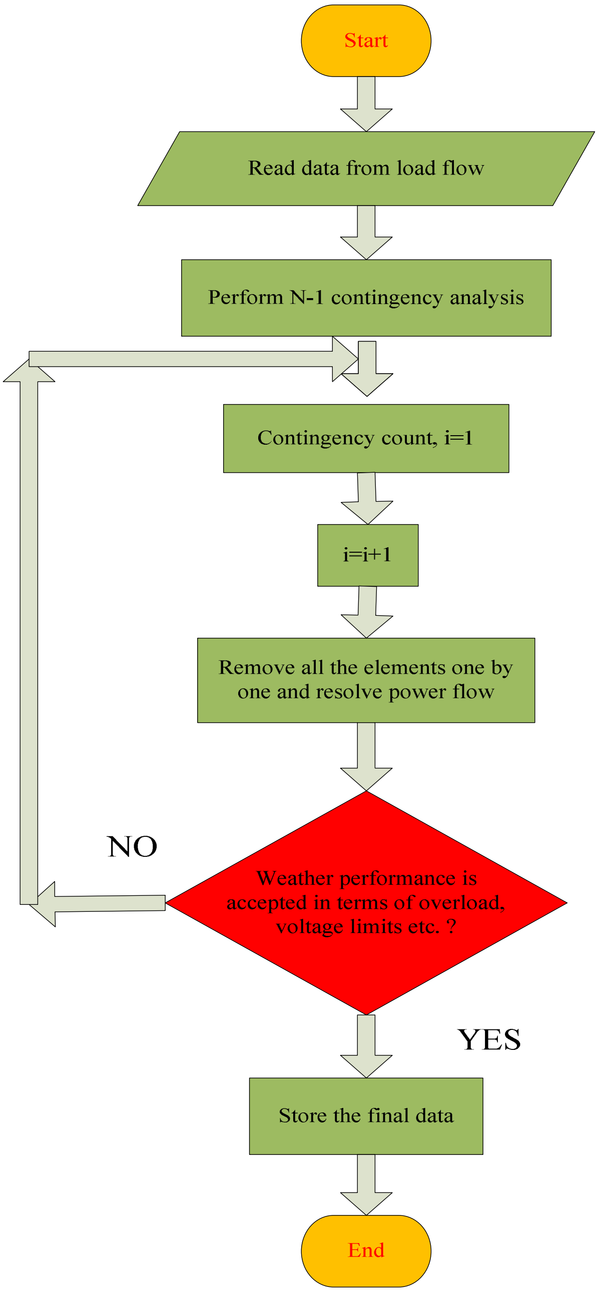

Fig.1: Flowchart for contingency assessment

A. Approximations to the power flow equations

Let's consider the general power flow equations as shown in Equation (1) [1]

$$P_k = \sum_{j=1}^{N} |V_k||V_j| \left(G_{kj}\cos(\theta_k - \theta_j) + B_{kj}\sin(\theta_k - \theta_j) \right)$$
$$Q_k = \sum_{j=1}^{N} |V_k||V_j| \left(G_{kj}\sin(\theta_k - \theta_j) - B_{kj}\cos(\theta_k - \theta_j) \right) \quad (1)$$

Considering that transmission line resistance is much less than react, Equation (1) Can be reduced to Equation (2).

$$P_k = \sum_{j=1}^{N} |V_k||V_j| \left(B_{kj}\sin(\theta_k - \theta_j) \right)$$
$$Q_k = \sum_{j=1}^{N} |V_k||V_j| \left(-B_{kj}\cos(\theta_k - \theta_j) \right) \quad (2)$$

Now, considering angular separation across any transmission line is very small, i.e., Equation (2) can be reduced to Equation (3).

$$P_k = \sum_{j=1}^{N} |V_k||V_j| \left(B_{kj}(\theta_k - \theta_j) \right)$$
$$Q_k = \sum_{j=1}^{N} |V_k||V_j| \left(-B_{kj} \right) \quad (4)$$

B_{kj} is an element of the Y-bus matrix.

- If $k \neq j$, then $B_{kj} = -b_{kj}$, i.e., Y-bus element in row *k* and column *j* is the negative of susceptance of the transmission line connecting bus *k* and bus *j*.
- If $k = j$, then $B_{kk} = b_{kk} + \sum_{j=1, j\neq k}^{N} b_{kj}$

Therefore, Equation (4) can be rewritten as in Equation (5)

$$P_k = \sum_{j=1}^{N} |V_k||V_j| \left(B_{kj}(\theta_k - \theta_j) \right)$$
$$Q_k = -|V_k|^2 b_k + \sum_{j=1, j\neq k}^{N} |V_k||b_{kj}| \left(|V_k| - |V_j| \right) \quad (5)$$

Again, by considering, $|V_k|$ and $|V_j|$ are very close to 1.0 p.u. Equation (5) can be modified as in Equation (6).

$$P_k = \sum_{j=1}^{N} \left(B_{kj}(\theta_k - \theta_j) \right)$$
$$Q_k = -b_{kk} + \sum_{j=1, j\neq k}^{N} |b_{kj}| \left(|V_k| - |V_j| \right) \quad (6)$$

By considering the above equation, it can be concluded that $P_{kj} \gg Q_{kj}$ in any, line. Therefore, the active power flow can only be targeted in DC flow analysis.

where,

P_k, Q_k =Active and reactive power injection at bus '*k*'

$|V_k|$, $|V_j|$ = Voltage magnitude at bus '*k*' and '*j*' respectively

θ_k and θ_j = Voltage angles at bus '*k*' and '*j*' respectively

B. Generalization of the DC power flow

The network with the following information needs to be given for this analysis.

i. The total number of lines to be M and the total number of nodes to be N.

ii. Bus Number one is identified as a reference bus and assumes real power injections at all buses except bus no.-1.

iii. The network topology along with admittances for all lines.

The DC power flow analysis based on Equation (6) can be expressed in a matrix form, as shown in Equation (7).

$$\overline{P} = \overline{B'}\overline{\theta} \quad (7)$$

Where $\overline{P}$ = Vector of bus injections for buses 2…. N

$\overline{B'}$ = B-prime matrix

$\overline{\theta}$ = Vector of bus phase angles for buses 2…. N

The B' matrix can be formed from the Y-bus by neglecting the resistances, as shown in Fig.2.

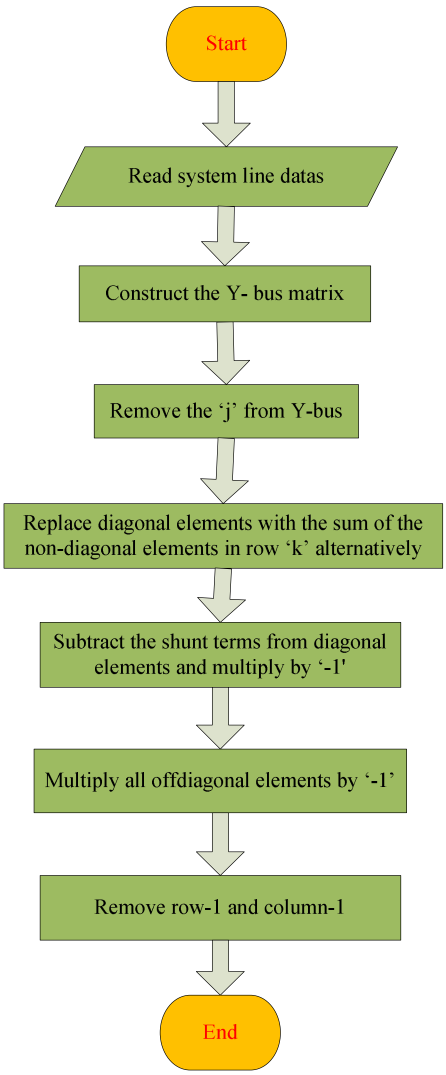

Fig.1: Flowchart for B' matrix construction

III. TTC Calculation in Power System

TTC is the amount of electrical energy that can be reliably transmitted through a connected transmission system after all system constraints are satisfied. This is important because delivered power values govern critical decision making for many power system planning and operations. As a result, utilities must accurately assess total transmission capacity (TTC) to ensure system reliability is maintained in a deregulated power system.

TTC can be calculated using a variety of nonlinear methods, including computer simulation. Among them, repeated power flow (RPF), optimal power flow (OPF), and continuous power flow (CPF) approaches are widely utilised nowadays since all of these methods take thermal, voltage, and stability constraints into account [9]-[10].

Continuation is one way to compute the transfer capability with a software model. Power flow solutions are sought from the solved base case for increasing amounts of transfer in the specified direction.

Fig.3 shows the flowchart for total transfer capability calculation in the lines.

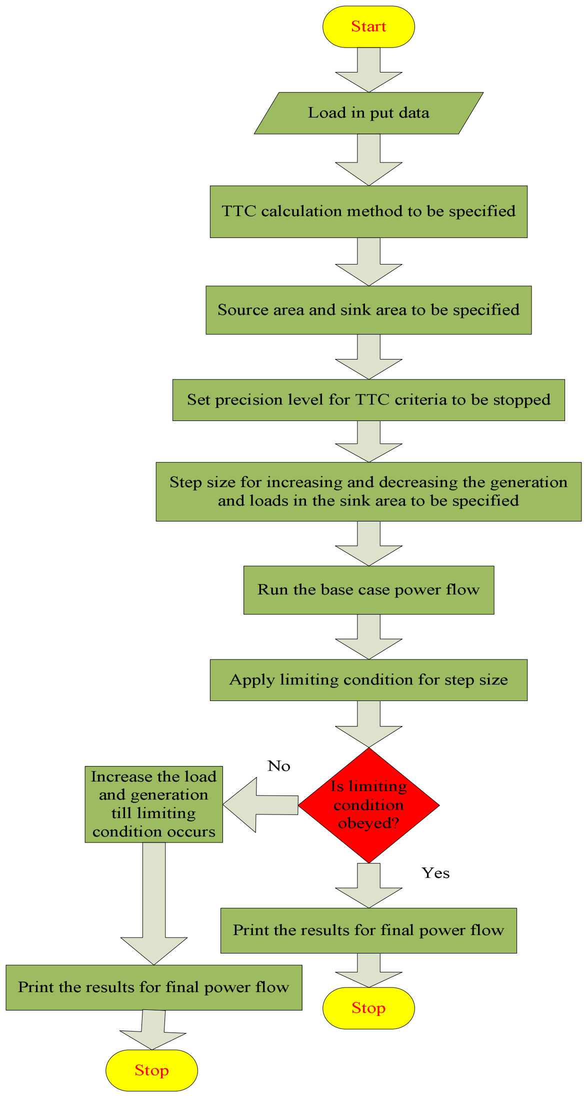

Fig.3 Flowchart for TTC Calculation

Here, the Continuous power flow (CPF) method based on TTC calculation is used for the analysis in this paper.

Available Transmitted Power (ATC) is the amount of electricity that can be transferred with the current. This is the largest possible incremental MW transfer between two regions of the power system without violating regulatory limits such as thermal limits, voltage limits, etc. It is the difference between TTC the and amount of current flow. i.e.

ATC= TTC- ETC - Reliability constraints (8)

Where, ETC= Existing transfer commitments

For calculation of ATC, the Indian power system is divided into three areas, as shown in Table I. The tie-lines interconnect the areas. This paper calculates the ATC for the tie-lines for different contingency conditions described in the following section. Table I shows the other buses present in each area of the system [10].

TABLE I. DIFFERENT AREAS CONSIDERED IN THE 62 BUS INDIAN SYSTEM

Area	Bus Numbers
1	1,23,4,5,6,7,8,9,10,11,12,13,14,15,16,18,19,20
2	17,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36, 37,38,39,40,41,42,43,45,46
3	44,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62

IV. RESULTS AND DISCUSSIONS

The procedure for contingency assessment and B’ matrix calculation described in Section II are used to arrive at Table II to Table V for the Indian 62 bus power system. Table II shows the power flows in each line in the Indian 62 bus power system for base case loadings. The negative power flow signifies the reverse direction of the branches [4].

TABLE II. ACTIVE POWER FLOW THROUGH EACH LINE FOR THE BASE CASE

Sl. No	Line		Active Power Flow	Sl. No	Line		Active Power Flow
	From Bus	To Bus			From Bus	To Bus	
1	1	2	-0.24244	46	30	40	-0.54091
2	1	4	1.138519	47	31	32	-0.47888
3	1	6	-0.13487	48	32	33	-0.03402
4	1	9	-0.12203	49	32	34	-0.0251
5	1	10	2.019174	50	32	35	1.028776
6	1	14	3.044552	51	32	36	-0.10621
7	2	3	1.553786	52	32	37	-0.23298
8	2	6	0.109723	53	32	46	-0.33873
9	3	4	1.153148	54	33	34	0.027102
10	4	5	-1.44261	55	34	35	0.066785
11	4	14	1.896005	56	34	37	-0.54722
12	4	15	1.803049	57	34	38	0.613562
13	5	6	0.508356	58	36	46	-0.37044
14	5	8	0.606371	59	37	38	1.11391
15	6	7	0.483315	60	37	39	0.610181
16	7	8	0.483514	61	37	46	-1.88886
17	10	11	1.601107	62	39	42	0.283441
18	11	12	1.178187	63	40	41	-0.8321
19	11	16	-1.23019	64	41	42	-0.26488
20	12	13	-1.29708	65	41	45	-0.69005
21	12	20	1.234507	66	42	43	0.277776
22	12	58	-0.36807	67	42	44	-0.658
23	12	60	0.100551	68	44	46	0.23952
24	13	14	-2.04064	69	44	59	-2.09642
25	13	17	-1.06260	70	46	47	-2.55188
26	14	15	-0.10162	71	47	48	-2.60226
27	14	16	2.314987	72	48	49	-1.91825
28	14	18	1.057182	73	48	50	-2.73497
29	14	19	1.44547	74	48	54	0.470666
30	16	17	1.149724	75	49	50	0.736357
31	17	21	1.957718	76	51	53	1.707137
32	20	23	0.343413	77	51	54	-0.98066
33	21	22	1.904069	78	51	55	0.052731
34	22	23	1.195458	79	52	53	0.823589
35	23	24	2.477163	80	52	61	-0.62155
36	23	25	0.481048	81	55	58	-0.92255
37	24	41	0.880692	82	56	57	-0.67638
38	24	45	0.935447	83	56	58	0.670245
39	25	26	1.185751	84	57	58	1.513128
40	25	27	1.446853	85	58	60	1.41759
41	25	28	0.658004	86	58	61	2.809741
42	25	62	-0.42220	87	59	61	-2.1374
43	27	29	0.547596	88	60	61	1.471886
44	29	30	0.470877	89	61	62	1.418782
45	30	31	0.121051				

A. *Different Contingency Conditions*

In this study, three different arbitrary contingency conditions have been evaluated.

i. Generator at bus no.-2 is an outage

Suppose an outage is created on the generator connected to bus no.-2. Therefore, the power from this generator will be redistributed among the other generators as the total load on the system remains constant. Thus, the lines in the system will now carry different powers to meet the load. Table III shows the new power flows in the lines.

TABLE III. POWER FLOW THROUGH LINES AFTER A GENERATOR AT BUS NO-2 OUTAGE

Sl. No	Line		Active Power Flow	Sl. No	Line		Active Power Flow
	From Bus	To Bus			From Bus	To Bus	
1	1	2	0.798691	46	30	40	-0.54288
2	1	4	1.337278	47	31	32	-0.47665
3	1	6	0.389928	48	32	33	-0.03316
4	1	9	-0.12204	49	32	34	-0.02512
5	1	10	2.058138	50	32	35	1.029151
6	1	14	3.228659	51	32	36	-0.10691
7	2	3	1.293126	52	32	37	-0.23440
8	2	6	-0.4949	53	32	46	-0.34035
9	3	4	0.892079	54	33	34	0.02627
10	4	5	-1.35987	55	34	35	0.066824
11	4	14	1.787965	56	34	37	-0.55062
12	4	15	1.759885	57	34	38	0.612593
13	5	6	0.553161	58	36	46	-0.37219
14	5	8	0.643878	59	37	38	1.115912
15	6	7	0.447875	60	37	39	0.603076
16	7	8	0.447022	61	37	46	-1.89142
17	10	11	1.639722	62	39	42	0.2759
18	11	12	1.205523	63	40	41	-0.83469
19	11	16	-1.2198	64	41	42	-0.25745
20	12	13	-1.30873	65	41	45	-0.69544
21	12	20	1.242812	66	42	43	0.278202
22	12	58	-0.3512	67	42	44	-0.66008
23	12	60	0.115241	68	44	46	0.245173
24	13	14	-2.05792	69	44	59	-2.10596
25	13	17	-1.06993	70	46	47	-2.55544
26	14	15	-0.04634	71	47	48	-2.60685
27	14	16	2.327566	72	48	49	-1.93274
28	14	18	1.048803	73	48	50	-2.77376
29	14	19	1.451143	74	48	54	0.46861
30	16	17	1.175314	75	49	50	0.740122
31	17	21	1.974636	76	51	53	1.7045
32	20	23	0.35013	77	51	54	-0.97238
33	21	22	1.919823	78	51	55	0.045752
34	22	23	1.209986	79	52	53	0.827237
35	23	24	2.490554	80	52	61	-0.62615
36	23	25	0.487159	81	55	58	-0.93039
37	24	41	0.886627	82	56	57	-0.67640
38	24	45	0.941549	83	56	58	0.67011
39	25	26	1.186157	84	57	58	1.512961
40	25	27	1.452148	85	58	60	1.416642
41	25	28	0.658463	86	58	61	2.817762
42	25	62	-0.42427	87	59	61	-2.14773
43	27	29	0.552127	88	60	61	1.484517

44	29	30	0.474234	89	61	62	1.422076
45	30	31	0.124611				

ii. Lines 13-14, 23-24 and 58-61 get outage

The 62 bus Indian utility system consists of 89 lines. Suppose an outage is created on three lines: line 13-14, line 23-24 and line 58-61. Then the power flowing through these lines will be diverted to some other lines in order to meet the load as the total load remains constant. Hence in some lines, power flows close to its limit. If this is the case, then the system may be unstable. The power flows in the lines for this condition are shown in Table IV.

TABLE IV. POST CONTINGENT POWER FLOW THROUGH LINES AFTER LINES 13-14, 23-24, AND 58-61 GET OUTAGE

Sl. No	Line		Active Power Flow	Sl. No	Line		Active Power Flow
	From Bus	To Bus			From Bus	To Bus	
1	1	2	0.563535	46	30	40	0.909693
2	1	4	2.230211	47	31	32	0.06033
3	1	6	0.464371	48	32	33	0.089415
4	1	9	-0.12204	49	32	34	0.067984
5	1	10	4.764288	50	32	35	1.13042
6	1	14	5.824691	51	32	36	-0.1881
7	2	3	2.353874	52	32	37	-0.35619
8	2	6	0.11514	53	32	46	-0.54157
9	3	4	1.952427	54	33	34	-0.07077
10	4	5	-2.04353	55	34	35	0.019369
11	4	14	3.538121	56	34	37	-0.8825
12	4	15	2.619055	57	34	38	0.535179
13	5	6	0.179657	58	36	46	-0.58923
14	5	8	0.333393	59	37	38	1.328192
15	6	7	0.758798	60	37	39	1.038569
16	7	8	0.757749	61	37	46	-3.36372
17	10	11	4.321658	62	39	42	0.653498
18	11	12	5.096384	63	40	41	0.535439
19	11	16	-2.49023	64	41	42	-1.87429
20	12	13	-1.89605	65	41	45	0.749475
21	12	20	1.375252	66	42	43	0.336818
22	12	58	1.565244	67	42	44	-2.17045
23	12	60	2.631003	68	44	46	1.216516
24	13	14	**OUTAGE**	69	44	59	-4.8206
25	13	17	-5.05206	70	46	47	-3.90151
26	14	15	-0.80895	71	47	48	-4.08271
27	14	16	9.622214	72	48	49	-3.66915
28	14	18	0.930645	73	48	50	-7.42085
29	14	19	1.531136	74	48	54	-0.7033
30	16	17	7.309592	75	49	50	1.191227
31	17	21	4.049184	76	51	53	1.422776
32	20	23	0.342624	77	51	54	0.906299
33	21	22	3.910594	78	51	55	-1.69998
34	22	23	3.103687	79	52	53	1.221611
35	23	24	**OUTAGE**	80	52	61	-1.1276
36	23	25	4.722901	81	55	58	-2.76612
37	24	41	-0.47518	82	56	57	-0.67946
38	24	45	-0.40156	83	56	58	0.656694
39	25	26	1.220178	84	57	58	1.496501
40	25	27	4.03332	85	58	60	4.122235
41	25	28	0.696919	86	58	61	**OUTAGE**
42	25	62	0.988645	87	59	61	-4.95716
43	27	29	3.058616	88	60	61	6.588072
44	29	30	2.858547	89	61	62	0.127492
45	30	31	0.832036				

iii. Lines 13-14, 23-24 and 58-61 get outage along with generator at bus no.-2 outage

In this case, the generator outage at bus no-2 has been considered in addition to the outage of three lines, as viewed in the previous section. Table V shows the power flow for both generator and line outages.

TABLE V. POST CONTINGENT POWER FLOW THROUGH LINES AFTER LINES 13-14, 23-24, AND 58-61 GET OUTAGE ALONG WITH OUTAGE OF THE GENERATOR AT BUS NO.-2

Sl. No	Line		Active Power Flow	Sl. No	Line		Active Power Flow
	From Bus	To Bus			From Bus	To Bus	
1	1	2	1.610023	46	30	40	0.916116
2	1	4	2.436223	47	31	32	0.065989
3	1	6	0.993152	48	32	33	0.091075
4	1	9	-0.1220t4	49	32	34	0.068506
5	1	10	4.822407	50	32	35	1.131433
6	1	14	6.027267	51	32	36	-0.18934
7	2	3	2.098529	52	32	37	-0.35847
8	2	6	-0.48945	53	32	46	-0.54452
9	3	4	1.696668	54	33	34	-0.07225
10	4	5	-1.96478	55	34	35	0.019126
11	4	14	3.440989	56	34	37	-0.88817
12	4	15	2.581312	57	34	38	0.533666
13	5	6	0.222279	58	36	46	-0.59241
14	5	8	0.369087	59	37	38	1.331633
15	6	7	0.725189	60	37	39	1.033211
16	7	8	0.723079	61	37	46	-3.37505
17	10	11	4.379257	62	39	42	0.647321
18	11	12	5.151045	63	40	41	0.540697
19	11	16	-2.48861	64	41	42	-1.87564
20	12	13	-1.91675	65	41	45	0.752083
21	12	20	1.384509	66	42	43	0.33763
22	12	58	1.596053	67	42	44	-2.18174
23	12	60	2.661049	68	44	46	1.228612
24	13	14	**OUTAGE**	69	44	59	-4.84734
25	13	17	-5.08868	70	46	47	-3.91298
26	14	15	-0.75837	71	47	48	-4.09608
27	14	16	9.68706	72	48	49	-3.69533
28	14	18	0.921425	73	48	50	-7.49094
29	14	19	1.537378	74	48	54	-0.71208
30	16	17	7.379459	75	49	50	1.198031
31	17	21	4.080526	76	51	53	1.417603
32	20	23	0.349306	77	51	54	0.926123
33	21	22	3.940179	78	51	55	-1.71698
34	22	23	3.131361	79	52	53	1.22856
35	23	24	**OUTAGE**	80	52	61	-1.13623
36	23	25	4.75452	81	55	58	-2.78462
37	24	41	-0.4767	82	56	57	-0.67950
38	24	45	-0.40278	83	56	58	0.656463
39	25	26	1.220823	84	57	58	1.496218
40	25	27	4.054413	85	58	60	4.131221
41	25	28	0.697649	86	58	61	**OUTAGE**
42	25	62	0.994588	87	59	61	-4.98532
43	27	29	3.078434	88	60	61	6.625184
44	29	30	2.876358	89	61	62	0.123583
45	30	31	0.84016				

The above tables show that base case power flow and generator outage power flow are different for a few lines connected to or nearing bus no-2, as the generator at bus no-2 gets outage. Similarly, for line outage and generator with line outage conditions, the appreciable difference is for only a few lines connected to or near bus no-2. Here it can be seen that when there is an outage of a line, the power flow in other lines is much different than the base case. The outage for lines 13-14, 23-24, and 58-61 have been considered. So, the lines connected to the buses of 13, 14, 23, 24, 58 and 61 are affected most as these lines are nearby lines of the outage lines; and these lines have to carry more power than the base case in order to meet the load in post contingent power flow.

B. *Available Transfer Capability in different contingency conditions*

In order to calculate the ATC, the voltage limit has been considered 0.95 to 1.1 p.u as per the voltage regulation used limit [2]. The thermal limit is considered absent. The loading has been increased continuously by 5% till the voltage limiting conditions arrive. The TTC and ATC are calculated through MATLAB 2019 software programming.

Table VI to VII shows the available transfer capabilities in the tie-lines for the contingency conditions described in the previous section. The negative ATC offers that the power can be transferred in reversed direction.

TABLE VI. ATC FOR GENERATOR OUTAGE

Area	Tie-Lines Connecting Buses	ATC of Connecting Lines in MW	ATC of Tie-Lines Connecting Ares in MW
1-2	13-17	-4.983271	1.476315
	16-17	4.021886	
	20-23	2.4377	
2-3	25-62	-0.262926	-6.28247
	42-44	-0.615217	
	46-44	-5.404327	
1-3	12-58	-2.143903	-9.238071
	12-60	-1.689841	

TABLE VII. ATC FOR LINE OUTAGE

Area	Tie-Lines Connecting Buses	ATC of Connecting Lines in MW	ATC of Tie-Lines Connecting Ares in MW
1-2	13-17	-1.001143	-0.671259
	16-17	-2.112392	
	20-23	2.442276	
2-3	25-62	-1.675845	-5.213675
	42-44	0.895154	
	46-44	-4.432984	
1-3	12-58	-4.060344	-8.265947
	12-60	-4.205603	

TABLE VIII. ATC FOR BOTH GENERATOR AND LINE OUTAGES

Area	Tie-Lines Connecting Buses	ATC of Connecting Lines in MW	ATC of Tie-Lines Connecting Ares in MW
1-2	13-17	-0.964521	-0.711186
	16-17	-2.182259	
	20-23	2.435594	
2-3	25-62	-1.681788	-5.196234
	42-44	0.906442	
	46-44	-4.420888	
1-3	12-58	-4.091153	-8.326802
	12-60	-4.235649	

V. CONCLUSION

The most common continuous power flow method based on DC power flow analysis has been utilised in this paper in order to calculate the total transfer capability and the available transfer capability of the tie-lines connected to different areas of 62 bus Indian power systems. The DC power flow analysis is significantly faster and more accurate than calculating active power flows. The study has been carried out for different contingency conditions, such as generator outages and various line outages. It can be been seen from the analysis that the elements which are present in the nearby locations of the outage elements are affected the most along with minor changes to the faraway elements.

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