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Usage Based Methodology for Calculating Of Complex Power Dynamic Distribution Factor

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ABSTRACT
In the environment of power market, It is an important index about system security performance and is the foundation for normal operation of power market. So, to calculate PDF precisely and quickly is of great significance. In this paper, an attempt has been made to provide a deterministic based approach to achieve deregulated power systems calculation by using Dynamic Distribution Factor (DDF) without violating line thermal limits.
Keywords – Distribution factor, Dynamic distribution factor, PTDF

I. INTRODUCTION

This paper does not address any issues associated with attempts to include dynamic constraints. Rather it focuses on a major simplification that has been in use for many years for studies where fast solutions are sought for the case involving static constraints only. This simplification is the use of linear methods to compute the line flow changes in response to bus injections (and in response to contingencies such as line outages)[8]–[11].. In order to avoid the problems encountered in existed papers, this paper attempts to analyze the distribution of source power from the energy space, derive and define the complex power dynamics distribution factors based on the circuit theory. The form of these factors shows that the power distribution is not only related to the network topology and circuit parameters, but also related to the state of the system. The source powers are linear distribution in the network according to these factors the branch flows and losses in the network are different forms of source powers. The example demonstrates that the results calculated by proposed method is unique and they satisfy complex power conservation, so it provides a new way to solve the series of economic problems in the electricity market such as determining the cost of transmission services and wheeling service cost.

II. THE MODEL OF ELECTRIC NETWORK

Considering the electric network with n nodes and q sources, where the number of source nodes is defined from 1to q and others are random. The sources are expressed as current sources I_{ks} (k =1,2,. q). Because the loads are regarded as the constant impedance to ground in the network, so the node voltage equation can be written as follows:

$$Y\dot{U} = \dot{I}_S \qquad (1)$$

Any voltage in the network can be described as:

$$U_{i=} \sum_{m=1}^{q} z_{mi} I_{ms} \qquad (i = 1,2 \dots . n) \qquad (2)$$

Where Zmi is the element in $\mathbf{Z} = Y^{-1}$ matrix.

A. Power Distribution based on the energy space

The electric energy just spread by the electromagnetic field from the sources to the wires and the loads, this process occurs ceaselessly in DC or AC circuit [16, 17]. Therefore, the physical basis is sufficient to analyze the distribution of source power based on the circuit theory. Physical definition about electric power is the speed of electric energy consumption. Power supplied by sources is equal to the rate of energy absorption in the network [18], the difference between power and electric energy is just a time factor, so they are equivalent in the unit time, therefore, the power is same to the energy and they all satisfies the superposition theorem and conservation law. The one-dimensional characteristic of energy makes the analysis of the power distribution into linear analysis, so that it can help to avoid the question of how to allocate the nonlinear function value to its independent variables. The proposed method in this paper provides a new way for analyzing the distribution of source power.

B. Power dynamic distribution factors in line flows

Using the network model provided in Section I, the flows on transmission line *ij* can be expressed as:

$$\dot{S}_{ij} = \dot{U}_i \dot{I}_{ij}^{*} = \dot{U}_i \left(\frac{\dot{U}_i - \dot{U}_j}{Z_{ij}}\right)^{*}$$

$$=\frac{1}{Z_{ij}^{*}}[(Z_{i1}-Z_{j1})\dot{I}_{1s}+(Z_{i2}-Z_{j2})\dot{I}_{2s}+..$$

$$+(Z_{iq}-Z_{jq})\dot{I}_{qs}]^{*}.(Z_{i1}\dot{I}_{1s}+Z_{i2}\dot{I}_{1s}+Z_{i2}\dot{I}_{2s}+...+Z_{iq}\dot{I}_{qs})$$

$$+Z_{i1}(Z_{i2}-Z_{j2})^{*}\dot{I}_{1s}\dot{I}_{2s}^{*}+..+Z_{iq}(Z_{i2}-Z_{j2})^{*}\dot{I}_{qs}\dot{I}_{2s}^{*}$$

$$+Z_{i1}(Z_{iq}-Z_{jq})^{*}\dot{I}_{1s}\dot{I}_{qs}^{*}+..+Z_{iq}(Z_{iq}-Z_{jq})^{*}\dot{I}_{qs}\dot{I}_{qs}^{*}]$$

$$=\frac{1}{Z_{ij}^{*}}\sum_{k=1}^{q}\sum_{m=1}^{q}Z_{im}(Z_{ik}-Z_{jk})^{*}\dot{I}_{ms}\dot{I}_{ks}^{*}$$

(i,j=1,2,…..,n) (3)

Because the current sources can be expressed by power sources that

$$\dot{I}_{ks}=(\frac{\dot{S}_{ks}}{\dot{U}_{ks}})^{*} \quad (4)$$

So (3) can be written as

$$\dot{S}_{ij}=\sum_{k=1}^{q}\sum_{m=1}^{q}\frac{Z_{im}(Z_{ik}-Z_{jk})^{*}}{Z_{ij}^{*}}(\frac{\dot{S}_{ms}}{\dot{U}_{ms}})^{*}.(\frac{\dot{S}_{ks}}{\dot{U}_{ks}}) \quad (5)$$

If $\frac{1}{Z_{ij}^{*}}Z_{im}(Z_{ik}-Z_{jk})^{*}=\alpha_{m/k}^{ij}$, (5) can be written as

$$:\quad \dot{S}_{ij}=\sum_{k=1}^{q}[\frac{1}{\dot{U}_{ks}}.\sum_{m=1}^{q}\alpha_{m/k}^{ij}(\frac{\dot{S}_{ms}^{*}}{\dot{U}_{ms}^{*}})].\dot{S}_{ks}$$

$$=\sum_{k=1}^{q}\chi_{ij-ks}.\dot{S}_{ks}$$

$$=\sum_{k=1}^{q}\dot{S}_{ij-ks} \quad (6)$$

χ ij-ks is defined as the dynamics power distribution factors of source *k* on line *ij* and *Sij _ ks* is the power component supplied by source *k* on line *ij* . The sum of components supplied by each source is equal to the flows on transmission lines.

C. Power dynamic distribution factors in net loss:

In this case find the distribution factor in lines loss which is connected source to the load. Using the network model provided in Section I[10], the flows on transmission line *ij* can be expressed as:

$$\dot{S}_{Lossij}=(\dot{U}_{i}-\dot{U}_{j})\dot{I}_{ij}^{*}=(\dot{U}_{i}-\dot{U}_{j})(\frac{\dot{U}_{i}-\dot{U}_{j}}{Z_{ij}})^{*}$$

$$=(Z_{iq}-Z_{jq})\dot{I}_{qs}].[(Z_{i1}-Z_{j1})\dot{I}_{1s}+$$

$$(Z_{i2}-Z_{j2})\dot{I}_{2s}+...+(Z_{iq}-Z_{jq})\dot{I}_{qs}]^{*}$$

$$=\frac{1}{Z_{ij}^{*}}\sum_{k=1}^{q}\sum_{m=1}^{q}(Z_{ik}-Z_{jk})^{*}(Z_{im}-Z_{jm})\dot{I}_{ms}\dot{I}_{ks}^{*}$$

(i,j=1,2,….,n) (7)

Similar to (5),(7) can be expressed as

$$\dot{S}_{Lossij}=\sum_{k=1}^{q}[\sum_{m=1}^{q}\frac{(Z_{ik}-Z_{jk})^{*}(Z_{im}-Z_{jm})}{Z_{ij}^{*}}(\frac{\dot{S}_{ms}}{\dot{U}_{ms}})].\frac{\dot{S}_{ks}}{\dot{U}_{ks}}$$

if $\frac{1}{Z_{ij}^{*}}(Z_{ij}-Z_{jk})^{*}(Z_{im}-Z_{jm})=\beta_{m/k}^{ij}$,the (7) can be written as

$$\dot{S}_{Lossij}=\sum_{k=1}^{q}[\frac{1}{\dot{U}_{ks}}.\sum_{m=1}^{q}\beta_{m/k}^{ij}(\frac{\dot{S}_{ms}}{\dot{U}_{ms}})].\dot{S}_{ks}$$

$$=\sum_{k=1}^{q}\zeta_{Lossij-ks}.\dot{S}_{ks}$$

$$=\sum_{k=1}^{q}\dot{S}_{Lossij-ks} \quad (8)$$

ζ_{ij-ks} is defined as the dynamics distribution factors of source *k* on line loss *ij* and $\dot{S}_{Lossij-ks}$ is the power component supplied by source *k* to losses on line *ij* . The sum of components supplied by each source is equal to the losses on transmission lines.

D. Power dynamic distribution factors on loads:

In this case find the distribution factor on loads which is connected source to the load. Using the network model provided in Section I[9], the flows on transmission line *ij* can be expressed as:

The load flows on bus *i* can be written

$$\text{as } \dot{S}_{Loadi}=\dot{U}_{i}.\dot{I}_{i}^{*}=\dot{U}_{i}.(\frac{\dot{U}_{i}}{Z_{i}})^{*}$$

$$=\frac{1}{Z_{i}^{*}}.(Z_{i1}\dot{I}_{1s}^{*}+...+Z_{ik}\dot{I}_{ks}+...+Z_{iq}\dot{I}_{qs}).$$

$$(Z_{i1}\dot{I}_{1s}+...+Z_{ik}\dot{I}_{ks}+...+Z_{iq}\dot{I}_{qs})^{*}$$

$$=\frac{1}{Z_{i}^{*}}.[Z_{i1}(Z_{i1})^{*}\dot{I}_{1s}\dot{I}_{1s}+...+Z_{iq}(Z_{i1})^{*}\dot{I}_{qs}\dot{I}_{1s}^{*}+$$

$$Z_{i1}(Z_{i2})^{*}\dot{I}_{1s}\dot{I}_{2s}^{*}+...+Z_{iq}(Z_{i2})^{*}\dot{I}_{qs}\dot{I}_{2s}^{*}+.....$$

$$+Z_{i1}(Z_{iq})^{*}\dot{I}_{1s}\dot{I}_{qs}^{*}+.......+Z_{iq}(Z_{iq})^{*}\dot{I}_{qs}\dot{I}_{qs}^{*}]$$

$$=\sum_{k=1}^{q}\sum_{m=1}^{q}\frac{Z_{ik}^{*}}{Z_{i}^{*}}Z_{im}\dot{I}_{ms}\dot{I}_{ks}^{*} \quad \text{(i,j=1,2,…..,n)} \quad (9)$$

Similar to (5),(9) can be expressed as

$$\dot{S}_{Loadi-ks} = \sum_{k=1}^{q}[\sum_{m=1}^{q} \frac{Z_{ik}^*}{Z_i^*} Z_{im} (\frac{\dot{S}_{ms}^*}{\dot{U}_{ms}^*})].\frac{\dot{S}_{ks}}{\dot{U}_{ks}}$$

If $\gamma_{m/k}^i = \frac{Z_{ik}^*}{Z_i^*} Z_{im}$, the (9) can be written as

$$\dot{S}_{Loadi} = \sum_{k=1}^{q}[\frac{1}{\dot{U}_{ks}}.\sum_{m=1}^{q}\gamma_{m/k}^i(\frac{\dot{S}_{ms}}{\dot{U}_{ms}})].\dot{S}_{ks}$$

$$= \sum_{k=1}^{q}\tau_{Loadi-ks}.\dot{S}_{ks}$$

$$= \sum_{k=1}^{q}\dot{S}_{Loadi-ks} \qquad (10)$$

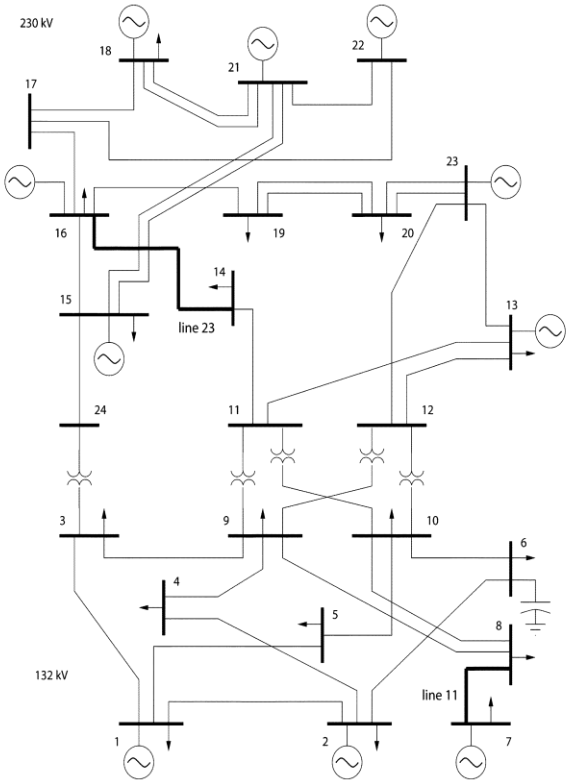
$\tau_{Loadi-ks}$ is defined as the dynamics distribution factors of source k on load i and $\dot{S}_{Loadi-ks}$ is the power component supplied by source k to load i . The sum of components supplied by each source is equal to the flows on load.

$$\sum_{i,j\in n}\zeta_{ij-ks} + \sum_{i\in m}\tau_{Loadi-ks} = 1$$

$$\dot{S}_{ks} = \sum_{i,j\in n}\Delta \dot{S}_{ij-ks} + \sum_{i\in m}\dot{S}_{Loadi-ks}$$

Where n and m denote the bus and load number respectively. The power supplied by source k equal to the consumption of network, which shows that the proposed method satisfies power conversation.

IEEE 24-Buses reliability test system



The above fig shows that IEEE 24 bus system for three cases:

(a) Distribution of source components on line flows
(b) Distribution of source power components on loss
(c) Distribution of source power components on loads

Distribution of source components on line flows (power)

	GEN 1	GEN 2	GEN 3	TOTAL
1-2	146.025+115.68i	0.0000+0.0000i	0.0000+0.000i	146.025+115.68i
1-3	92.782+65.489i	-16.981-13.880i	31.204+3.161i	107.00+51.647i
1-5	68.151+49.774i	20.660+4.721i	-28.126-2.847i	60.685+51.647i
2-4	26.854+23.233i	-81.066-6.691i	-46.81-11.224i	-101.02+49.810i
2-6	21.559+22.06i	92.310+14.335i	-40.613+13.41i	73.256+49.810i
3-9	24.8479+18.11i	-31.648-6.326i	-109.64-16.48i	-116.80-31.702i
3-24	-21.009-16.70i	30.321+7.326i	-114.03-22.32i	-104.80-31.702i
4-9	0.0000+0.0000i	184.50+40.540i	0.000+0.000i	184.506+40.540i
5-10	0.000+0.0000i	0.000+0.000i	245.18+81.14i	245.18+81.140i
6-	116.894+1	0.000+0.0	0.000+0.	162.54+1

10	27.46i	00i	000i	08.7i
7-8	80.841+57.061i	-16.971-3.878i	29.780+3.016i	94.55+56.837i
8-9	67.095+49.002i	17.421+3.981i	-29.77-3.015i	56.070+50.942i
8-10	26.611+23.023i	-68.148-5.624i	-47.139-11.30i	-90.44+4.565i
9-11	24.000+24.559i	94.221+14.632i	-42.800+14.13i	77.521+55.476i
9-12	21.683+15.812i	-34.995-6.995i	-97.55-14.66i	-110.09-5.286i
10-11	-22.039-17.45i	33.994+8.213i	-120.75-23.63i	-107.49-31.847i
10-12	0.000+0.000i	166.87+36.665i	0.000+0.000i	166.87+36.665i
11-13	0.000+0.000i	0.000+0.000i	250.39+182.8i	250.39+82.864i
11-14	160.894+127.46i	0.000+0.000i	0.000+0.000i	160.89+127.460i
12-13	80.848+57.065i	-20.075-4.587i	28.20+2.85i	88.970+55.331i
12-13	67.0956+49.0025i	17.359+3.966i	-32.65-3.306i	51.801+49.663i
13-23	26.611+23.023i	-78.213-6.455i	-42.79-10.261i	-94.39+6.306i
14-16	24.000+24.55i	90.140+13.998i	-45.23+14.940i	68.904+53.49i
15-16	21.683+15.812i	-33.471-6.691i	-93.40+14.041i	-105.19-4.919i
15-21	-22.039-17.452i	32.8950+7.947i	-131.49-25.73i	-120.636-35.24i
15-21	0.000+0.000i	186.783+41.040i	0.000+0.000i	186.76+41.040i
15-24	0.000+0.000i	0.000+0.000i	224.6+74.34i	224.66+74.348i
16-17	151.439+119.97i	0.000+0.000i	0.000+0.000i	151.43+119.97i
16-19	89.467+63.149i	-19.9652-4.562i	32.62+3.304i	102.12+61.892i
17-18	72.664+53.07i	20.034+4.578i	-31.83-3.22i	60.865+540425i
17-22	24.468+21.169i	-83.114-6.860i	-46.881-1.214i	-105.52+3.068i
18-21	24.017+24.576i	96.983+15.061i	-43.773+14.44i	77.267+54.081i
18-21	21.783+15.883i	-30.718-6.140i	-99.82-5.006i	-108.28-31.164i
19-20	-21.343-16.901i	34.450+8.323i	-115.38-22.58i	-102.280-31.16i
19-20	0.000+0.000i	158.03+34.724i	0.000+0.000i	158.103+34.724i
20-	0.000+0.0	0.000+0.0	248.73+	248.73+8
23	00i	00i	82.316i	2.396i
20-23	0.000+0.000i	158.57+34.841i	0.000+0.000i	158.17+34.84i
21-22	0.000+0.000i	0.000+0.000i	207.70+68.736i	207.70+68.73i

The table represents complex power flows in each individual generators with respective all the lines and total power flow in the system**.**

Distribution of source power components on line flows (PDF):

S-	GEN 1	GEN 2	GEN 3
1-2	1.2789+	0.0000+	0.0000+0.0000i
1-3	0.6492-	-0.1556-	0.1894-0.0422i
1-5	0.5792-	0.1346+	-
2-4	0.2163+	-	-
2-6	0.2023+	0.6992-	-
3-9	0.1700+	-	-
3-	-	0.2655+	-
4-9	0.0000+	1.555+0	0.0000+0.0000i
5-	0.00000	0.0000+	1.3695+0.0000i
6-	1.4226+	0.0000+	0.0000+0.0000i
7-8	0.6702+	-0.1722-	0.1550-0.0346i
8-9	0.6985-	0.1690+	-
8-	0.2019+	-	0.2422+0.0209i
9-	0.2412+	0.6722-	0.2761+0.0001i
9-	0.1744+	-	-
10-	-	0.2756+	-
10-	0.0000+	1.3088+	0.0000+0.0000i
11-	0.0000+	0.0000+	1.4697+0.0000i
11-	1.3739+	0.0000+	0.0000+0.0000i
12-	0.7184-	-0.1562-	0.1969-0.0439i
12-	0.6842-	0.1544+	-
13-	0.2111+	0.65675	-
14-	0.2288+	0.6790-	-
15-	0.2084+	-	-
15-	-	0.2732+	-
15-	0.0000+	1.3824+	0.0000+0.0000i
15-	0.0000+	0.0000+	1.462+0.0000i
16-	1.2364+	0.0000+	0.0000+0.0000i
16-	0.7907-	-0.1576-	0.1939-0.0433i
17-	0.6209-	0.1482+	-
17-	0.2009+	-	-
18-	0.2223+	0.8212-	-
18-	0.1718+	-	-0.5787+0.997i
19-	-	0.2713+	-
19-	0.0000+	1.3471+	0.0000+0.0000i
20-	0.0000+	0.0000+	1.2193+0.0000i
20-	0.0000+	1.2554+	0.0000+0.0000i
21-	0.0000+	0.0000+	1.5389+0.0000i

The table represents distribution factors of each individual generator with respect to all line connected to that bus.

Distribution of source power components on loss (power component):

S-	GEN 1	GEN 2	GEN 3	TOTAL
1-	0.0000+33.6	0.0000+0.00	0.0000+0.00i	0.0000+33.6
1-	0.7066+16.3	-1.3675-	3.39992+5.42i	2.7384+18.8
1-	3.5442+12.1	1.8632+2.25	-2.9893-2.82i	2.4181+11.5
2-	5.7481-	1.2982+22.4	-1.3676+13.6i	5.7388+27.2
2-	-	3.1329+10.8	-0.4940-4.21i	1.3334+10.0
3-	3.4792-	0.9150+13.1	3.8617+32.60i	8.2559+36.5
3-	-	-1.3485-	7.1274+32.38i	4.3672+29.9
4-	0.0000+0.00	0.0000+31.2	0.0000+0.00i	0.0000+31.2
5-	0.0000+0.00	0.0000+0.00	0.0000+53.40i	0.0000+53.4
6-	0.0000+46.0	0.0000+0.00	0.0000+0.00i	0.0000+46.0
7-	0.6775+15.6	-1.3110-	2.9575+4.72i	2.3241+17.5
8-	3.2259+11.0	1.7509+2.11	-3.0488-2.87i	1.9281+10.2
8-	5.3692-	1.2967+22.4	-1.1896+12.4i	5.4736+26.5
9-	-	3.0612+10.5	-0.5470-4.6i	1.3249+9.07
9-	3.9749-	0.9651+13.8	4.7263+39.90i	9.6663+43.3
10	-	-1.4098-	5.3953+24.5i	2.3301+22.6
10	0.0000+0.00	0.0000+36.4	0.0000+0.00i	0.0000+36.4
11	0.0000+0.00	0.0000+0.00	0.0000+51.16i	0.0000+51.1
11	0.0000+38.8	0.0000+0.00	0.0000+0.00i	0.0000+38.8
12	0.7202+16.6	-1.3830-	2.7616+4.41i	2.0988+18.0
12	3.6044+12.3	1.6130+1.95	-3.241-0.0580i	1.9764+11.2
13	5.3355-	1.3265+22.9	-	5.5832+25.9
14	-	2.7813+9.61	-0.5760-	1.1036+7.62i
15	4.0681-	0.8604+12.3	5.0893+42.97	10.0178+44.
15	-	-1.4161-	6.4947+29.50	3.323028.00i
15	0.0000+0.00	0.0000+30.8	0.0000+0.000	0.0000+30.8
15	0.0000+0.00	0.0000+0.00	0.0000+50.63	0.0000+50.6
16	0.0000+37.6	0.0000+0.00	0.0000+0.000	0.0000+37.6
16	0.7417+17.1	-1.3546-	2.9284+4.676	2.3155+18.9
17	3.9051+13.3	1.6208+1.95	-3.772-3.5591i	1.7538+11.7
17	5.3789-	1.4502+25.1	-	5.6396+29.2
18	-	2.7461+9.49	-0.5807-	0.8469+8.03i
18	4.0665-	0.7523+10.8	4.0478+34.17	8.8660+34.2
19	-	-1.3439-	6.8206+30.98	3.9910+28.8
19	0.0000+0.00	0.0000+35.9	0.0000+0.000	0.0000+35.9
20	0.0000+0.00	0.0000+0.00	0.0000+55.46	0.0000+55.4
20	6.2112-	1.0930+18.9	-	6.0133+22.7
21	-	2.7555+9.53	-0.5818-	0.8794+7.99i

The table represents complex power loss in each individual generators with respective all the lines and total power loss in the system.

Distribution of source power components on loss (power distribution factor):

S-	GEN 1	GEN 2	GEN 3	TOTAL
1-	0.0000+33.	0.0000+0.	0.0000+0.00i	0.0000+33.6
1-	0.7066+16.	-1.3675-	3.39992+5.42	2.7384+18.8
1-	3.5442+12.	1.8632+2.	-2.9893-2.82i	2.4181+11.5
2-	5.7481-	1.2982+22	-	5.7388+27.2
2-	-	3.1329+10	-0.4940-4.21i	1.3334+10.0
3-	3.4792-	0.9150+13	3.8617+32.60	8.2559+36.5
3-	-	-1.3485-	7.1274+32.38	4.3672+29.9
4-	0.0000+0.0	0.0000+31	0.0000+0.00i	0.0000+31.2
5-	0.0000+0.0	0.0000+0.	0.0000+53.40	0.0000+53.4
6-	0.0000+46.	0.0000+0.	0.0000+0.00i	0.0000+46.0
7-	0.6775+15.	-1.3110-	2.9575+4.72i	2.3241+17.5
8-	3.2259+11.	1.7509+2.	-3.0488-2.87i	1.9281+10.2
8-	5.3692-	1.2967+22	-	5.4736+26.5
9-	-	3.0612+10	-0.5470-4.6i	1.3249+9.07
9-	3.9749-	0.9651+13	4.7263+39.90	9.6663+43.3
10	-	-1.4098-	5.3953+24.5i	2.3301+22.6
10	0.0000+0.0	0.0000+36	0.0000+0.00i	0.0000+36.4
11	0.0000+0.0	0.0000+0.	0.0000+51.16	0.0000+51.1
11	0.0000+38.	0.0000+0.	0.0000+0.00i	0.0000+38.8
12	0.7202+16.	-1.3830-	2.7616+4.41i	2.0988+18.0
12	3.6044+12.	1.6130+1.	-3.241-	1.9764+11.2
13	5.3355-	1.3265+22	-	5.5832+25.9
14	-	2.7813+9.	-0.5760-	1.1036+7.62i
15	4.0681-	0.8604+12	5.0893+42.97	10.0178+44.
15	-	-1.4161-	6.4947+29.50	3.323028.00i
15	0.0000+0.0	0.0000+30	0.0000+0.000	0.0000+30.8
15	0.0000+0.0	0.0000+0.	0.0000+50.63	0.0000+50.6
16	0.0000+37.	0.0000+0.	0.0000+0.000	0.0000+37.6
16	0.7417+17.	-1.3546-	2.9284+4.676	2.3155+18.9
17	3.9051+13.	1.6208+1.	-3.772-	1.7538+11.7
17	5.3789-	1.4502+25	-	5.6396+29.2
18	-	2.7461+9.	-0.5807-	0.8469+8.03i
18	4.0665-	0.7523+10	4.0478+34.17	8.8660+34.2
19	-	-1.3439-	6.8206+30.98	3.9910+28.8
19	0.0000+0.0	0.0000+35	0.0000+0.000	0.0000+35.9
20	0.0000+0.0	0.0000+0.	0.0000+55.46	0.0000+55.4
20	6.2112-	1.0930+18	-	6.0133+22.7
21	-	2.7555+9.	-0.5818-	0.8794+7.99i

The table represents loss distribution factors of each individual generator with respect to all line connected to that bus.

Distribution of source power components on loads (power component):

S	GEN 1	GEN 2	GEN 3	TOTAL
1	16.8477+9	18.1405+	15.9325+	50.9208+1
2	13.6377+9	11.7505+	20.7513+	46.1395+5
3	13.4294+1	11.6558+	24.4659+	49.5510+1
4	18.7247+1	14.0935+	22.6138+	55.4320+1
5	12.9584+8	9.4318+1.	13.5799+	35.9700+1
6	10.6818+9	17.6419+	23.9876+	52.1313+1
7	16.8435+9	12.2704+	18.4108+	47.5247+1
8	8.8941+5.	9.0802+1.	12.8604+	30.8346+1
9	12.7445+1	14.9303+	15.6324+	43.3073+1
1	14.0680+7	10.6798+	12.6611+	37.4089+1
1	15.1020+1	12.7463+	21.8390+	49.6873+1
1	12.8813+1	15.8052+	23.8538+	52.5402+1
1	17.6815+9	18.5091+	12.0076+	48.1982+1
1	15.2221+1	13.1711+	22.5219+	50.9152+1
1	11.5983+1	14.7740+	23.6692+	50.0415+1
1	11.5540+6	13.9415+	22.8127+	48.3082+1

The table represents complex load power in each individual generators with respective all the lines and total power load in the system

Distribution of source power components on loads (dynamic distribution factor):

S-	GEN 1	GEN 2	GEN 3
1	0.1691-0.0276i	0.1982-	0.1776-
2	0.1572-0.0121i	0.1211-	0.1619-
3	0.1106+0.0057i	0.1881-	0.1844-
4	0.1858-0.0303i	0.2031-	0.2024-
5	0.1754-0.0134i	0.1537-	0.1874-
6	0.1614+0.0084i	0.1176-	0.1245-
7	0.2001-0.0326i	0.1594-	0.1884-
8	0.1199-0.0092i	0.1508-	0.1584-
9	0.1054+0.0055i	0.1868-	0.1513-
10	0.1127-0.0184i	0.1600-	0.1218-
11	0.1113-0.0085i	0.1171-	0.1114-
12	0.1214+0.0063i	0.1206-	0.1816-
13	0.1377-0.0225i	0.1653-	0.1731-
14	0.1486-0.0114i	0.1492-	0.1404-
15	0.1148+0.0059i	0.1724-	0.2058-
16	0.1858-0.0142i	0.1234-	0.1174-

The table represents load distribution factors of each individual generator with respect to all line connected to that bus.

III. Conclusion

The dynamic distribution factor (DDF) method is compared with power transfer distribution factor (PTDF) methods with and without reactive powers. It has been shown the deregulated power systems calculation using dynamic distribution factor dynamic distribution factor (DDF) method is much precise and accurate without violating the line thermal limits. The method applied to 4- bus and IEEE 24- bus system and implemented using MATLAB software package.

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