CHAPTER 6

LOAD FLOW ANALYSIS OF MEA'S DISTRIBUTION SYSTEM

6.1 Introduction

This chapter describes the test of the "SIMPOW"package program on MEA network system shown in table 6.1. The load flow analysis is divided into three cases.

1) A base case
2) Simulation of load increase
3) Simulation feeders out of operation divided into two types :
   - First contingency (one feeder out of operation)
   - Second contingency (two feeders out of operation)

6.2 Test of the SIMPOW package program

This thesis will analyze the load flow of MEA network system by using the SIMPOW software package program, executed on VAX-2000 computer installed at fourth floor room 405 of Electrical engineering building. The test is done by comparing the SIMPOW software calculation with field test measurements, used only 15 buses on "Sapandam area". (figure 6.1)

Table 6.1 shows the comparison between the SIMPOW calculation and the field test measurements. Differences up to say 8-10 % are acceptable indicating that the SIMPOW software package program can be used for calculation on MEA network system.

Table 6.1 comparison SIMPOW calculation with field measurements

POWER FLOW	SIMPOW calculation (MVA)	Field measurements (MVA)	Error %
SD11515-->74	0.025	0.024	4.17
SD11515-->77	0.025	0.027	7.40
SD11515-->78	0.043	0.041	4.87
SD21512-->79	0.025	0.024	4.17
SD42508-->78	0.043	0.044	2.27
80-->79	0.056	0.057	1.75

6.3 Load flow analysis of MEA's distribution system

The studied network is only part of MEA's distribution system in "Sapandam area". The studied area consists of :

number of nodes	183
number of lines	221
number of loads	77
number of transformers	37
number of shunt impedances	37

The bus (12 kV) is swing bus and load flow calculation used the SIMPOW software package program, executed on VAX-2000 computer which is described in chapter 3.

The preparation of input data file, network model and how to run the SIMPOW package program is described in chapter 4.

This thesis will analyze the secondary load flow of MEA distribution system. The analysis is divided into a base case and a set of modifications. The aim of the study is try to give answers to the two vital questions.

1) What will happen if a feeder is out of operation?

2) Can more customers be connected to the system without jeopardizing the service of current customers?

The load flow analysis of MEA network system is divided into three cases as follows :

1) A base case

2) Simulation of load increase

3) Feeders out of operation divided into two types

3.1 First contingency with only one feeder out of operation.

3.2 Second contingency where two feeders are out of operation simultaneously.

6.4 The load flow solution

6.4.1 A base case

The load flow computation of MEA network system in "Sapandam area" is divided into four sub-areas and with the bus (12 kV) as swing bus. The studied network system consists of :

- The eight feeders (12 kV) as follows : SD11, SD12, SD13 SD15, SD21, SD22, SD23 and SD24 supplying 37 transformers. (figure 5.3, 6.2)

The load flow solution of the studied network system shows in table 6.2 and next step is simulation of increased loads.

Table 6.2 The load flow results (base case)

(see also appendix 2.1)

Total production		MW	MVAR
Productions		9.76217	3.39412
Shunt capacitors		-	2.67374
Network generation		-	0.34233
Total	=	9.76217	6.41028
Load absorbed	=	9.59900	6.01300
Network losses	=	0.16317	0.39728

6.4.2 Simulation of increased loads

The simulation will study the increase of loads at nodes 30, 13507, 21509 and 12525 respectively, because these nodes have more load than other nodes. The simulation shows the power flow in the studied network area and the question is : How much can the load be increased without jeopardizing service ?

The simulation will increase loads in the following at :

- node 13507 (area 1)

		MW	MVAR	MVA
original load	=	0.595	0.369	0.700
increased load	=	0.906	0.565	1.066
% increase	~			50 %

- node 30 (area 2)

		MW	MVAR	MVA
original load	=	0.318	0.197	0.374
increased load	=	0.680	0.424	0.800
% increase	~			110 %

- node 21509 (area 2)

		MW	MVAR	MVA
original load	=	0.252	0.221	0.335
increased load	=	0.676	0.421	0.795
% increase	~			130 %

- node 12525 (area 3)

		MW	MVAR	MVA
original load	=	0.356	0.221	0.419
increased load	=	0.558	0.348	0.656
% increase	~			60 %

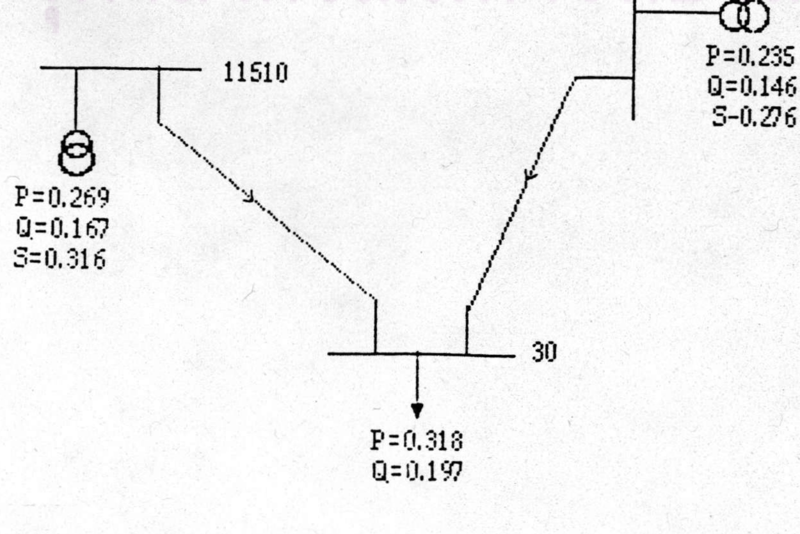
In the simulation load were increased as above from estimation as follows:

1) At node 13507 (area 1)

From one-line diagram as above. The load of transformers SD13507 and SD23518 (rated 500 kVA) were 378 kVA and 256 kVA respectively. The load could be increased by about 366 kVA. So in the simulation will the load increase be as follows :

original load	=	0.700 MVA (P = 0.595 MW, Q = 0.369 MVAR)
estimated load increase	=	0.366 MVA (0.122 + 0.244)
total load	=	1.066 MVA
% increased load	=	50 %

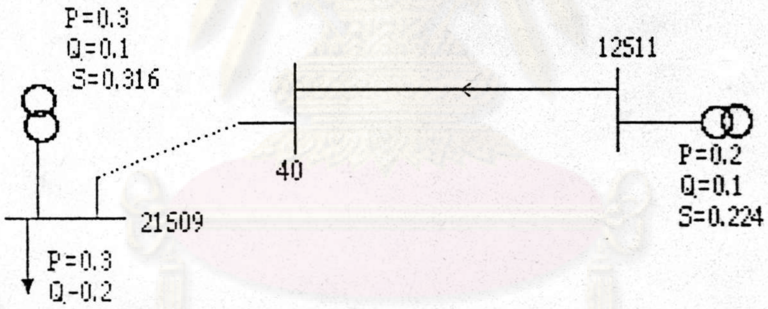
2) At node 30 (area 2)



From one-line diagram as above. The load of transformers SD 11510 and SD42507 (rated 500 kVA) were 316 kVA and 276 kVA respectively. The load could be increased by above 408 kVA. So in the simulation will the load increase be as follows :

original load	=	0.374 MVA (P = 0.318 MW, Q = 0.197 MVAR)
estimated load increase	=	0.408 MVA (0.184 + 0.224)
total load	=	0.782 MVA
% increased	~	110 %

3) At node 21509 (area 2)



From one-line diagram as above. The load of transformers SD 12511 and SD 21509 (rated 500 kVA) were 224 kVA and 316 kVA respectively. The load could be increased by about 460 kVA. So in the simulation will the load increase be as follows :

original load	=	0.335 MVA (P = 0.252 MW, Q = 0.221 MVAR)
estimated load increase	=	0.460 MVA (0.276 + 0.184)
% increase	~	130 %

* Result from measurement
# Result from calculation (SIMPOW)

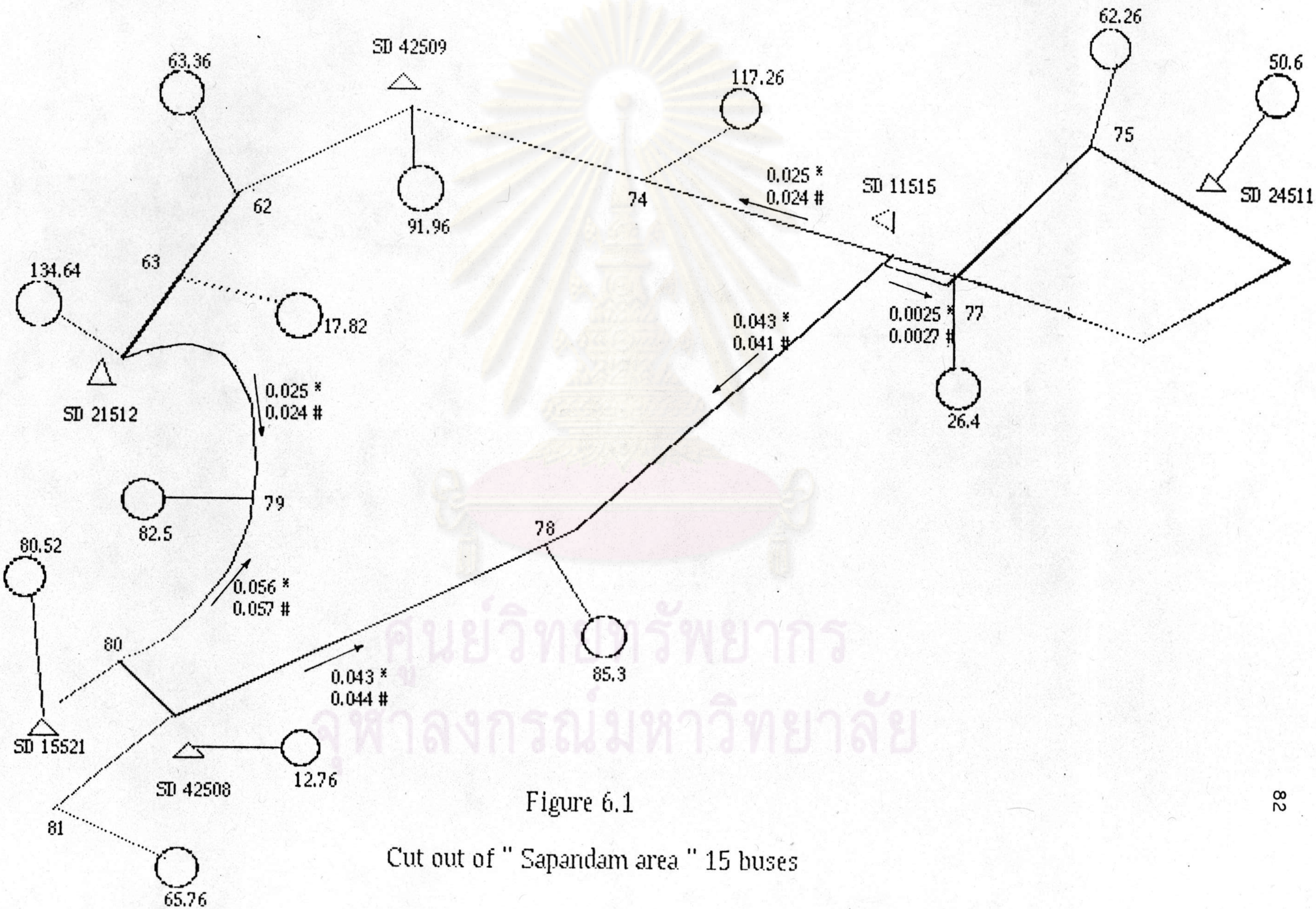
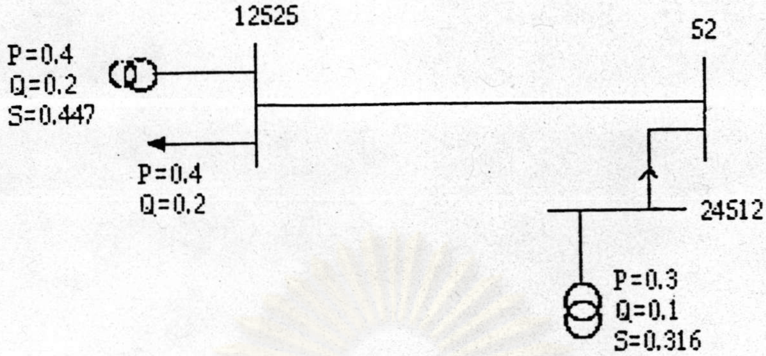


Figure 6.1

Cut out of " Sapandam area " 15 buses

4) At node 12525 (area 3)



From one-line diagram as above. The load of transformers SD 12525 and SD 24512 (rated 500 kVA) were 447 kVA and 316 kVA respectively. The load could be increased by about 237 kVA. So in the simulation will the load increase be as follows :

original load	=	0.419 MVA (P = 0.356 MW, Q = 0.221 MVAR)
estimated load increase	=	0.237 MVA (0.053 + 0.184)
% increase	~	60 %

In the simulation loads were increased as above. The load flow solution of the network system indicated problems as follows :

- The transformer SD12525 (area 3) rated 500 kVA was over loaded

load	=	612 kVA
% over load	=	22.38 %

- Low voltage nodes at :

voltage at node 43 (400 V) decreased to = 380.226 V

= 4.94 % (emergency voltage)

voltage at node 87 (400 V) decreased to = 379.854 V

= 5.04 % (emergency voltage)

The standard voltage of MEA network are :

- Normal (400 V) max. 412 V.
  min. 388 V. (+ 3%)

- Emergency (400 V) max. 420 V.
  min. 380 V. (+ 5%)

In order to correct the promblem modification were introduces as follows :

<u>Modification no.1</u>

1) Node 21509 (area 2)

		MW	MVAR	MVA
original load	=	0.252	0.221	0.335
increased load	=	0.500	0.300	0.583

% increase down to ~ 80 % from 130 %

2) Node 12525 (area 3)

		MW	MVAR	MVA
original load	=	0.356	0.221	0.419

		MW	MVAR	MVA
increased load	=	0.500	0.300	0.583

% increase down to ~ 40 % from 60 %

After modification (no.1). The load computed flow still had problems as follows :

- Over load of the transformer SD12525 rated 500 kVA

load	=	550 kVA
% over load	=	10 %

- Low voltage at node :

Voltage at node 43 (400 V) decreased to = 380.398 V

= 4.9 %

(emergency voltage)

In order to correct the problems (as above) modification were introduces as follows :

<u>Modification no.2</u>

1) Node 21509 (area 2)

		MW	MVAR	MVA
original load	=	0.252	0.221	0.335

	MW	MVAR	MVA
increased load =	0.470	0.290	0.552

% increase down to ~ 65 % from 80 %

2) Node 12525 (area 3)

	MW	MVAR	MVA
original load =	0.356	0.221	0.419
increased load =	0.460	0.290	0.544

% increase down to ~ 30 % from 40 %

At nodes 30 and 13507 the load increase is kept at about 110 % and 50 % respectively from original load.

After the modification as above, the studied network system can operate without problems and the next step is the first contingency.

Table 6.3 The load flow result after the network system load increase

(Appendix 2.2)

Total production	MW	MVAR
Productions	10.8132	4.08951
Shunt capacitors	-	2.65856
Network generation	-	0.35429

Total	10.8132	7.10235
Load absorbed	10.6080	6.59900
Network losses	0.2052	0.50335

6.4.3 The first contingency

The first contingency is when only one feeder is disconnected from the network system. The load flow simulation shows as follows :

6.4.3.1 The feeder SD12 disconnected

The feeder SD12 disconnected from the network system. The load flow solution indicated problems as follows : (see appendix 2.7)

- Over load of the transformer SD 23514 rated 500 kVA.

  load = 501.24 kVA

  % over load = 0.25 %

- Over load lines 51-23514 and 52-24512

  capacity of line = 400 A

  load = 520 A

  % over load = 30 %

In order to do something about this the network system was MEA did so, modified by introducing two new feeders SD41 and SD43 and the transformers SD12510 and SD12525 were moved to SD43510 and SD41525 respectively. This solved the problem.

6.4.3.2 The feeder SD24 disconnected

If the feeder SD24 was disconnected from the network system, the load flow solutions indicated problems as follows : (see appendix 2.8)

- Over load of the transformer SD41525 rated 500 kVA

load	=	629.57 kVA
% over load	=	25.9 %

- Over load of the line 52-41525

capacity of line	=	400 A
load	=	507 A
% over load	=	26.75 %

- Low voltage nodes :

voltage at nodes 52, 57, 58, 59, 24512 and 42524

voltage to	=	380 V. (400 V.)
% voltage decrease	=	5 % (Emergency voltage)

Modification the network system (after modification in 6.4.2.1) by installation of new transformer :

- SD11552 at node 52
- SD11557 at node 57

After these modification has be made the load flow solution showed that the network system can operate without problem.

6.4.3.3 The feeder SD15 disconnected

The feeder SD15 disconnected from the network system. The load flow solutions indicated problems as follows :

- Low voltage nodes at :

voltage at nodes 20, 42, 43 and 72 to = 379 V. (400 V.)

% voltage decrease = 5 % (Emergency voltage)

6.4.3.4 The feeder SD21 disconnected

The feeder SD21 disconnected from the network system. The load flow solutions indicated problems as follows :

- Low voltage nodes at :

voltage at nodes 33, 42 and 43 to = 380 V.

% voltage decrease = 5 % (Emergency voltage)

6.4.3.5 The feeder SD22 disconnected

The feeder SD22 disconnected from the network system. The load flow solutions indicated problems as follows :

- Low voltage nodes at :

voltage at node 20 to = 379 V. (5.25 % emergency voltage)
voltage at nodes 42, 43 to = 380 V. (5% emergency voltage)

<u>Summary</u>

The MEA network system have been modified due to the first contingency results as follows :

1) Changed the supply feeder for network transformer from SD12510 to SD43510 and SD12525 to SD41525

2) Installed the new transformers at

node 52 is SD11552

node 57 is SD11557

3) Installed shunt capacitor

25 kVAR at node 33

55 kVAR at node 72

60 kVAR at nodes 20, 43

After modification as above the network system can operate without problem when the first contingency occurs. The next step is the studied network system increased load when the first contingency occurs.

Table 6.4 The load flow result of base case modified as above in the first contingency case.

(Appendix 2.3)

Total production	MW	MVAR
Productions	9.74694	2.98434
Shunt capacitors	-	3.01588
Network generation	-	0.37572
Total	9.74694	6.37594
Load absorbed	9.59900	6.37594
Network losses	0.14794	0.36294

6.4.4 The network system increased load when the first contingency occurs.

The simulation of network system increased load (when the first contingency occurs) at node 30, 13507, 21509 and 41525 as follows :

1) Node 13507 (area 1)

		MW	MVAR	MVA
original load	=	0.595	0.369	0.700
increased load	=	0.800	0.400	0.894
% increase down to			~	28 % from 50 %

2) Node 30 (area 2)

		MW	MVAR	MVA
original load	=	0.318	0.197	0.374
increased load	=	0.500	0.400	0.640
% increase down to			~	70 % from 130 %

3) Node 21509 (area 2)

		MW	MVAR	MVA
original load	=	0.252	0.221	0.335
increased load	=	0.450	0.300	0.541
% increase down to			~	60 % from 65 %

4) Node 41525 (area 3)

		MW	MVAR	MVA
original load	=	0.356	0.221	0.419
increased load	=	0.500	0.300	0.583
% increase down to			~	40 % from 60 %

The load flow computation of the network system shows problems as follows :

1) The feeder SD11 disconnected

The feeder SD11 disconnected from network system and the load flow solutions shows problems as follows : (see appendix 2.9)

- Over load of the transformer SD41525 rated 500 kVA

load = 511 kVA

% over load = 2.2 %

2) The feeder SD13 disconnected

The feeder SD13 disconnected from the network system and the load flow solution shows problems as follows :

- Low voltage node :

voltage at node 16 (400 V) decrease to = 379.94 V.

= 5.01 % (Emergency voltage)

3) The feeder SD15 disconnected

The feeder SD15 disconnected from the network system and shows problems as follows :

- Over load of the transformer SD21509 rated 500 kVA

load = 502 kVA

% over load = 0.004 %

- Low voltage nodes : (normal voltage = 400 V.)

voltage at node 20 decrease to = 379 V.

= 5.25 %

voltage at node 42, 43 decrease to = 378 v.

= 5.5 %

voltage at node 70 decrease to = 379.9 V.

= 5.025 %

voltage at node 71 decrease to = 380 V.

= 5 %

voltage at node 72 decrease to = 377.8 V.

= 5.55 %

voltage at node 15511 decrease = 380 V.

= 5 %

These nodes as above show an voltage below normal voltage (400 V.) of about 5 % which is emergency voltage level.

4) The feeder SD21 disconnected

The feeder SD21 disconnected from the network system and shows problems as follows :

- Over load of the transformer SD13507 rated 500 kVA

load = 534.54 kVA

% over load = 6.90 %

- Low voltage nodes at : (normal 400 V)

node 33 decrease to = 379.1 V. (5.225 %)

node 42 decrease to = 379.6 V. (5.100 %)

node 43 decrease to = 379.0 V. (5.250 %)

node 21509 decrease to = 378.2 V. (5.450 %)

(Emergency voltage level)

5) The feeder SD22 disconnected

The feeder SD22 disconnected from the network system and the load flow solutions shows problems as follows :

- Over load of the transformer SD13507 rated 500 kVA

load = 543 kVA

% over load = 8.6 %

- Low voltage nodes at : (normal voltage = 400 V.)

node 16 and 20 decrease to = 380.3 V.

= 4.925 %

node 42 and 43 decrease to = 380.2 V.

= 4.950 %

All nodes are emergency voltage level.

6) The feeder SD23 disconnected

The feeder SD23 disconnected from the network system and the load flow solutions shows problems as follows :

- Over load of the transformer SD13507 rated 500 kVA

load	=	527 kVA
% over load	=	5.4 %

- Low voltage node :

voltage at nodes 42 and 43 (400 V) = 379 V.

= 5.25 % (Emergency voltage)

In order to correct the problems (as above) modification were introduces as follows :

<u>Modification no.1</u>

- Node 13507 (area 1)

		MW	MVAR	MVA
original load	=	0.595	0.369	0.70
increased load	=	0.600	0.400	0.72

% increase further down to ~ 3 % from 28 %

- Node 30 (area 2)

		MW	MVAR	MVA
original load	=	0.318	0.197	0.374
increased load	=	0.400	0.200	0.447

% increase further down to ~ 20 % from 70 %

- Node 21509 (area 2)

		MW	MVAR	MVA
original load	=	0.252	0.221	0.335
increased load	=	0.400	0.200	0.447

% increase further down to ~ 30 % from 60 %

- Node 41525 (area 3) modified by :

		MW	MVAR	MVA
original load	=	0.356	0.221	0.419
increased load	=	0.450	0.200	0.492

% increase further down to ~ 17 % from 40 %

After modification no.1 (at above). The network system can operate without problem and next step is the second contingency.

Table 6.5 The load flow solution of the network system calculated in base case (The network system increased load when the first contingency occurs)

(Appendix 2.4)

Total production	MW	MVAR
Productions	10.0843	3.06675
Shunt capacitors	-	3.01299
Network generation	-	0.37569
Total	10.0843	6.45544
Load absorbed	9.9280	6.06900
Network losses	0.1563	0.38644

6.4.5 The second contingency

The second contingency is when two feeders are disconnected from the network system simultaneously. The simulation in the second contingency case will use the data from the first contingency case which was modified due to changes in the network as follows :

1) Changed the feeders SD12510 is SD43510
SD12525 is SD41525

2) Installed the new transformers at :

node 52 is SD11552
node 57 is SD11557

3) Installed the shunt capacitors :

25 kVAR at node 33
55 kVAR at node 72
60 kVAR at nodes 20 and 43

The simulation in the second contingency case will study only ten cases as followed :

1) The feeders SD11 and SD12 are disconnected
2) The feeders SD12 and SD24 are disconnected
3) The feeders SD43 and SD41 are disconnected
4) The feeders SD43 and SD24 are disconnected

5) The feeders SD13 and SD15 are disconnected

6) The feeders SD11 and SD41 are disconnected

7) The feeders SD12 and SD21 are disconnected

8) The feeders SD22 and SD23 are disconnected

9) The feeders SD15 and SD22 are disconnected

10) The feeders SD13 and SD23 are disconnected

The load flow solution of case (1-4) is without problem and the network system can operated.

The other case (5-10), the load flow solution shows as follows :

Case 5

The feedrs SD13 and SD15 are disconnected from the network system simultaeously and the load flow solution shows problems as follows : (see appendix 2.10)

1) Over load of the transformer SD11510 rated 500 kVA

load = 519.216 kVA

% over load = 3.84 %

2) Low voltage nodes at : (normal voltage 400 V.)

Nodes	low voltage level (v.)	%
16	380.19	4.95

Nodes	low voltage level (V.)	%
42	380.38	4.905
43	379.85	5.03
69	380.09	4.98
70	378.90	5.275
71	379.39	5.15
72	377.99	5.5
79	379.74	5.06
81	376.75	5.81
82	376.38	5.9
83	377.32	5.67
11511	379.58	5.105

All nodes are emergency voltage level.

Case 6

The feeders SD11 and SD41 are disconnected from the network system simultaneously and the load flow solution shows problems as follows :

1) Low voltage nodes : (normal voltage 400 V.)

voltage at node 11552 decrease to = 378.74 V.

= 5.315 %

voltage at node 41525 decrease to = 376.285 V.

= 5.93 %

(Emergency voltage level)

Case 7

The feeders SD12 and SD21 are disconnected from the network system simultaneously and the load flow solution shows problems as follows : (see appendix 2.11)

1) Over load of the transformer SD13507 rated 500 kVA

load = 507.17 kVA

% over load = 1.43 %

2) Low voltage nodes : (normal 400 V.)

voltage at node 33 decrease to = 380.1 V.

= 4.975 %

voltage at node 43 decrease to = 380.05 V.

= 4.987 %

(Emergency voltage level)

Case 8

The feeder SD22 and SD23 are disconnected from the network system simultaneously and the load flow solution shows problems as follows :

1) Over load of the transformer SD13507 rated 500 kVA

load = 565 kVA

% over load = 13 %

2) Low voltage nodes at : (normal voltage 400 V.)

Nodes	low voltage level (v.)	%
16	378.7	5.325
19	378.8	5.300
20	380.06	4.985
42	378.59	5.350
43	378.99	5.250

All nodes are emergency voltage level.

<u>Case 9</u>

The feeders SD15 and SD22 disconnected from the network system simultaneously and the load flow solution shows problems as follows :

1) Over load of the transformer SD13507 rated 500 kVA

load = 517.18 kVA

% over load = 3.43 %

2) Low voltage nodes at : (normal 400V.)

Nodes	low voltage level (v.)	%
1	376.41	5.89
2	378.907	5.27
16	380.06	4.985
19	375.65	6.09
20	373.52	6.62
21	374.76	6.31
22	375.62	6.095
42	378.86	5.28
43	378.51	5.37
72	379.96	5.01
15512	378.34	5.415
22517	375.23	6.19

(Emergency voltage level)

Case 10

The feeder SD13 and SD23 are disconnected from the network system simultaneously and the load flow solution show problems as follows:

1) Low voltage nodes : (normal 400 V.)

voltage at node 16 decrease to = 378.47 V.

= 5.38 %

voltage at node 13507 decrease to = 380.27 V.

= 4.93 %

In order to these problems modification (as above) were introduces as follows :

Modification no.1

- Installed the new transformer as follows :

1) SD 43521 at node 21
2) SD 43536 at node 36
3) SD 43570 at node 70
4) SD 41516 at node 16
5) SD 41581 at node 81

The load flow solution of the network system when the second contingency occurs is without problems, except in case (6 and 9) as follows :

Case 6

The feeders SD11 and SD41 are disconnected from the network system simultaneously, the load flow solution shows problems as follows :

Low voltage node :

voltage at node 41525 (400 V) decrease to = 380.381 V.

= 4.9 %

(emergency voltage)

Case 9

The feeders SD22 and SD23 are disconnected from the network system simultaneously, the load flow solution shows problems as follows :

Low voltage node : (normal 400 V)

voltage at node 42 decrease to	=	379.998 V.
	=	5 %
voltage at node 43 decrease to	=	380.399 V.
	=	4.9 %

(Emergency voltage level)

After modification (no.1) as above, the network system had still problems. In order to correct the problems modification (as above) were introduces as follows :

Modification no.2

1) Installed the new transformer

SD 43551 at node 51

2) Installed shunt capacitor 25 kVAR at node 43 :

original capacitor at node 43	=	60 kVAR
increase capacitor at node 43	=	25 kVAR
total capacitor at node 43	=	85 kVAR

After modification as above, the network system can operate without problems when the second contingency occurs. The next step is possible increase load when the second contingency occurs.

Table 6.6 The load flow solution of the network system after modification as above when the second contingency occurs.

(Appendix 2.5)

Total production	MW	MVAR
Productions	9.71811	2.42978
Shunt capacitors	-	3.50166
Network generation	-	0.38168
Total	9.71811	6.31312
Load absorbed	9.59900	6.01300
Network losses	0.11911	0.30012

6.4.6 Possible increase load when the second contingency occurs

The simulation of the studied network system (the second contingency case) will study the increase of load at node 30, 13507, 21509 and 41525. The increase of load will use the data in the first contingency case (6.4.4 modification no.1) as follows :

1) Node 13507 (area 1)

		MW	MVAR	MVA
original load	=	0.595	0.369	0.700
increased load	=	0.600	0.400	0.720

% increase ~ 3 %

2) Node 30 (area 2)

		MW	MVAR	MVA
original load	=	0.318	0.197	0.374
increased load	=	0.400	0.200	0.447

% increase ~ 20 %

3) Node 21509 (area 2)

		MW	MVAR	MVA
original load	=	0.252	0.221	0.335
increased load	=	0.400	0.200	0.447

% increase ~ 30 %

4) Node 41525 (area 3)

		MW	MVAR	MVA
original load	=	0.356	0.221	0.419
increased load	=	0.450	0.200	0.492

% increase ~ 17 %

The load flow solution of the studied network system with increased loads (as above) when the second contingency occurs indicated problems as follows :

1) The feeders, SD15 and SD22 were out of operation simultaneously from the network system. The load flow solution shows problems as follows :

Voltage at node 43 decreased to	=	380.34 V. (400 V.)
	=	4.91 %
		(Emergency voltage level)

The other second contingency case are without problems. In order to correct the problem modification (as above) was introduces as follows :

Modification no.1

1) At node 21509 (area 2)

		MW	MVAR	MVA
original load	=	0.252	0.221	0.335
increased load	=	0.340	0.210	0.399

% increase down to ~ 20 % from ~ 30 %

2) At node 41525 (area 3)

		MW	MVAR	MVA
original load	=	0.356	0.221	0.419
increased load	=	0.410	0.250	0.480

% increase down to ~ 15 % from ~ 17 %

After modification (no.1). The load flow solution still shows problems as follows :

- When the feeders SD22 and SD23 were out of operation simultaneously from the network system. The load flow solution shows problems as follows :

Voltage at node 42 decrease to = 380.1 V. (400 V.)

% voltage decrease = 5 %

(Emergency voltage level)

The others case are without problems. In order to correct the problem modification (as above) was introduces as follows :

Modification no.2

1) At node 30 (area 2)

		MW	MVAR	MVA
original load	=	0.318	0.197	0.374
increased load	=	0.330	0.210	0.391

% increase down to ~ 5 % from ~ 20 %

2) At node 21509 (area 3)

		MW	MVAR	MVA
original load	=	0.252	0.221	0.335
increased load	=	0.290	0.180	0.341

% increase further down to ~ 3 % from ~ 20 %

At node 13507 (area 1) and 41525 (area 3) the load increase is kept at about 3 % and 15 % respectively from original load.

After the modification (no.2). The studied network system (when the second contingency occurs) can operate wihtout problems.

Table 6.7 The load flow solution of the network system were increased loads when the second contingency occurs. (Appendix 2.6)

Total production	MW	MVAR
Productions	9.83012	2.53619
Shunt capacitors	-	3.49940
Network generation	-	0.38167
Total	9.83012	6.41726
Load absorbed	9.70800	6.10900
Network losses	0.12212	0.30826

Figure 6.2

SAPANDAM SUBSTATION