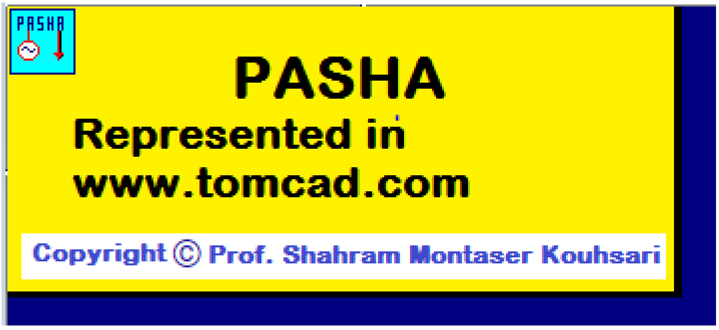


Chapter 6
The Load Flow and OPF section

The loadflow section of PASHA incorporates the fast decoupled loadflow algorithm as a default calculation method and has provisions for diagrammatic and tabular display of the results, outages, load changes and a direct entry to the fault level section.

The PASHA Load Flow Analysis program calculates the bus voltages, branch power factors, currents, and power flows throughout the electrical system. The program allows for swing, voltage regulated, and unregulated power sources with multiple utility and generator connections including remote voltage control and transformer tap settings. It handles both radial and loop systems.

Busbar voltage magnitudes and angles calculated in any loadflow are stored and form the starting point of any subsequent calculations. This approach minimizes the computing effort required when users examine alternative operating conditions, outages, contingency etc.

Multi-slacks provision in load flow study of PASHA provides the user with very flexible methods of network handling and calculation. Area load changing and load forecasting are two others PASHA load flow powerful options.

AC/DC load flow is a new inclusion in PASHA, please refer to chapter 17 to have more information about DC.

The load flow section can be entered in two ways:

(i) By selecting the [LOADFLOW CALCULATION] option from the main menu.

(ii) By selecting the [LOAD FLOW] option from other calculation options. At the present version it can be selected from the Fault Level section main menu (see 7.3.10), Reliability section main menu (see 12.7.1.7), and Harmonic analysis main menu (see 13.2.6) options.

Once selected the load flow section performs in the same way for either methods of entry, unless some outages have specified, (see 6.2.4).

The implementation of **Optimal Power Flow (OPF)**, initiates from load flow menu options, and is described in chapter 14. Please refer to this chapter for more information about optimal power flow facility.

6.1 The initial load flow solution

The loadflow calculation starts by checking the system parameters. If any essential data is found to be missing, an appropriate error message is displayed (see 6.3 for full details of error messages) and the solution process terminated. If these checks are passed a load flow solution is then found by using an iterative numerical technique. Figure 6.1 shows the display following a load flow calculation that has converged, and shows the number of iterations. Also shown are the load flow main options, which are automatically displayed after a satisfactory load flow solution has been found.

To control the load flow calculation various control parameters are available. These are described below.

6.1.1 The slack busbar

The load flow calculation determines the voltage profile and branch flows in a system for any specified loading and generation conditions. As the system losses are not known when the generator powers have to be specified, it is necessary to allow the power generated by one of the machines in the system to be adjusted so that the total generation balances the load and losses. This adjustment is done at the 'slack busbar'.

The slack busbar can be specified by entering the chosen busbar name in the Analysis Parameters page (see section 4.5.9). If it is not specified it is selected as follows:

(i) if there is an in-feeding transformer without a specified source, then a 'source' busbar is drawn automatically and that is taken as the main slack

(ii) if there is no such 'source', then the busbar to which the first generator drawn is connected, is taken as the main slack;

(iii) if there is no 'source' busbar and no generators have been drawn, the first busbar drawn is chosen as the main slack.

The slack busbar needs to have its voltage specified, this will be done in GENERATOR DATA 1. No powers need to be entered.

For the island (split) networks or connected networks, multi slack busbars can be specified. This is a powerful tool for analyzing the split networks (please refer to section 6.3.2).

The user may also adjust the angle of the slack busbars, i.e. to be no more zero. This is also useful since the transient studies use the load flow results. If the user needs to connect a line out of phase, he may use this feature and observe the damaging torque's enforce on the electrical machines. He may also use this feature for Automatic Generation Control (AGC) to be encountered in load flow or OPF studies.

Figure 6.1

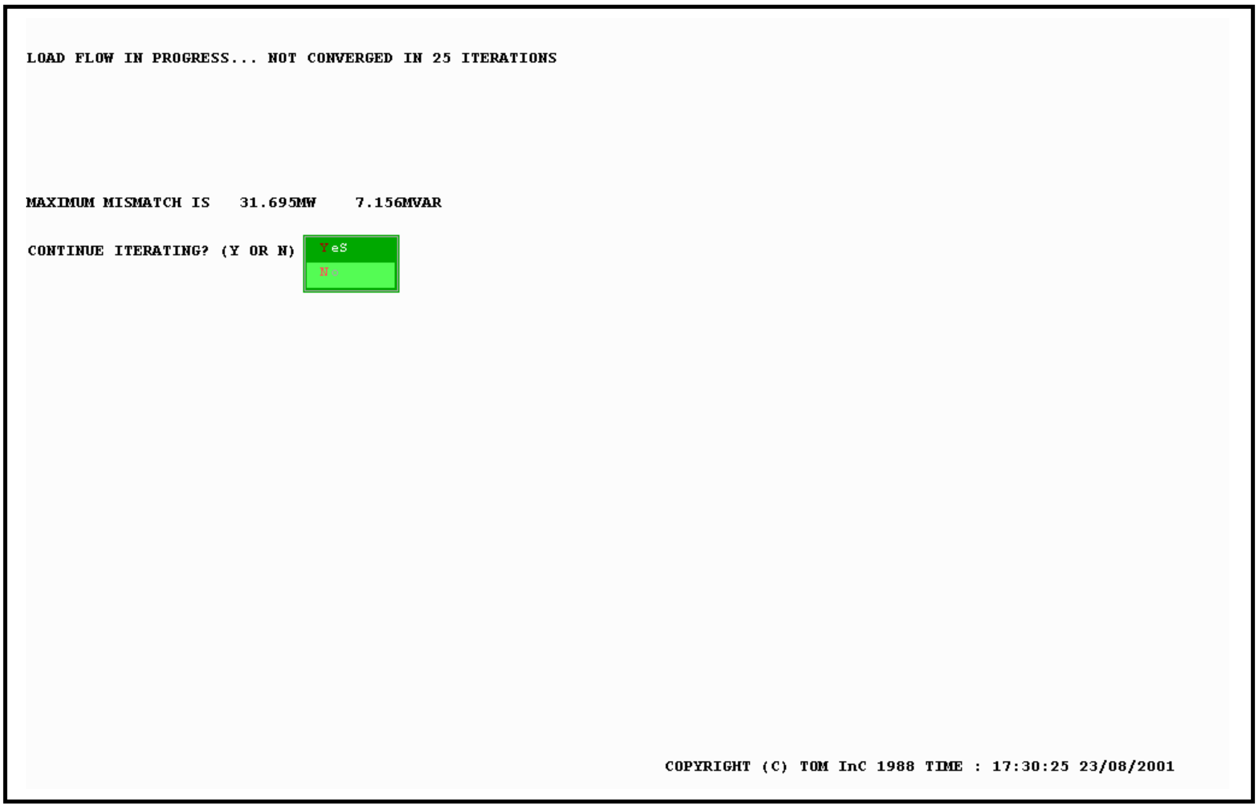


Figure 6.2

6.1.2 The iteration limits

To guide the solution process, two analysis parameters are available. The first of these is the 'Maximum number of iterations' which temporarily halts the solution after this number of iterations has been carried out. This is to give user the chance to terminate the solution process if it appears that a solution is not going to be found. To judge the convergence the maximum power mismatch is displayed, when the iteration limit is reached, as shown in figure 6.2. The user can then continue iterating if required, by replying <Y><CR>.

For newly entered systems the loadflow usually converges in 5 to 15 iterations. Very high resistance to reactance ratio circuits, which sometimes occur in distribution system, increase the number of iterations necessary, but present no problems. Complex controls involve additional adjustments (and control back-off attempts) and may also increase the number of iterations marginally.

The maximum number of iterations can be changed by accessing the ANALYSIS PARAMETER DATA 1 page in the edit section (section 4.5.9). It has a default value, which is 25.

The second control parameter governs the accuracy of the calculation, i.e. it sets the tolerance for load flow convergence. The default setting is 0.01 MVA, which is generally sufficient for most studies. It can be changed by accessing analysis parameters data page in the edit section (section 4.5.9). It should be noticed that reducing the tolerance will increase the accuracy of the calculation but will also increase the number of iterations required to find a solution.

6.1.3 Busbar types and voltage control

The loadflow identifies three basic busbar types as the conventional slack, PV and PQ types in the following ways:

SLACK BUSBAR : The slack busbar is already described in section 6.1.1.

PV BUSBARS : Busbars with generators are taken as PV busbars if the voltage is specified in the associated generator data.

PQ BUSBARS : All busbars without any generators and busbars with generators for which voltage is not specified in the data, are taken to be PQ busbars.

Three additional types of busbars can be specified by entering some control data on the LOADFLOW CONTROL DATA page in the edit section (see section 4.5.8). Voltage and MVAR controls can be imposed on busbars by specifying V and Q limits. This creates three further busbar types:

PVQ BUSBARS : Local control of Q to within a specified MVAR range, is applied on a PV busbar by allowing the local voltage to vary.

PQV BUSBARS : Local control of voltage to within a specified V range, is applied on a PQ busbar by allowing the local MVAR to vary.

PQRV BUSBARS : Remote control of voltage to within a specified V range, is applied on a PQ bus by varying Q on a specified 'controlling' PV busbar.

The loadflow program can also introduce busbar voltage control through automatic tap changing in transformers. This is applied by inserting the required voltage and tapping range values in the TRANSFORMER DATA 1 page in the edit section (see 4.5.3).

Phase shifters may also be included inside any transformer through phase shifting transformer with controlling power. This is applied by inserting the required power and tapping range values in TRANSFORMER DATA 1 page in the phase shifting part.

6.2 The load flow main menu

The loadflow main menu is displayed automatically after each loadflow calculation and can also be called up after the diagrammatic display of results by pressing the <O> key or a click of mouse. Figure 6.1 shows a successful load flow calculation and the full list of options available. These are described in turn below.

The power system, which is used to demonstrate the load flow results is the example system introduced in chapters 3 and 4.

6.2.1 [V-MVA DIS]

Selection of this option draws the system diagram and displays the branch MVA flows and the busbar voltages on the diagram. The voltages are displayed immediately beneath the busbar names, and the MVA flows are displayed next to the lines, as shown in figure 6.3. Among the sending end and receiving end MVA the maximum is shown in this figure. If you would like to have both sending and receiving ends you can set DOUBLE BRANCH FLOWS in [SET COLOURS AND SYMBOLS] described in chapter 2 section 2.15.6. The result is shown in figure 6.4.

Other distribution of the flows may also be asked for. You may use the display option from the green box to show various flow of MW, MVAR, etc. The options that can be selected from the green box menu, contains the same options described in the [DISP MODE] section 6.2.2 which is another way of viewing different flows of power.

6.2.2 [DISP MODE]

The display mode option enables various loadflow quantities to be displayed on the system diagram. In the new version of PASHA you may select most of the options associated with display mode from the in-line green box menu.

However, If the [DISP MODE] option is selected another display subsection is entered. Figure 6.5 shows the display menu, after initial entry.

To select a particular mode position the cursor over the required option title and:

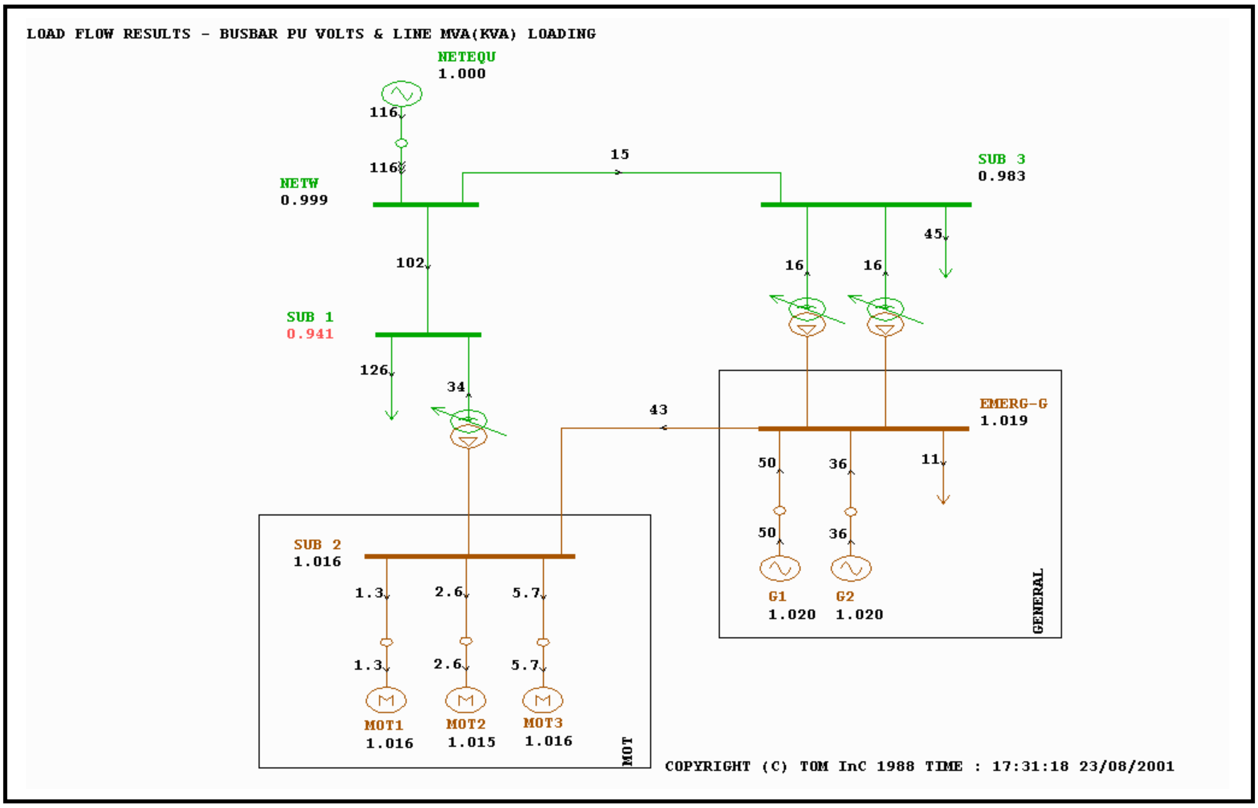


Figure 6.3

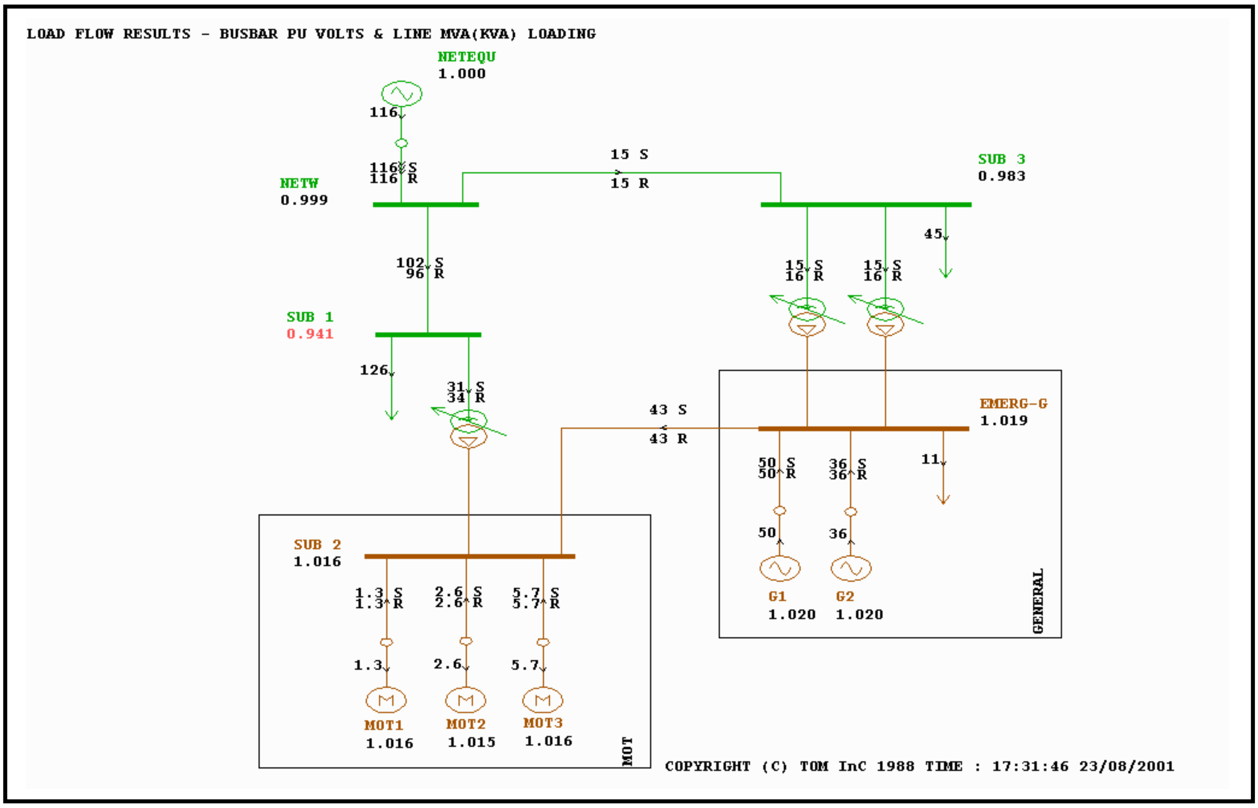


Figure 6.4

```
LOADFLOW RESULTS DISPLAY MODES



DISPLAY MODE CHANGES - HELP INFORMATION

POSITION THE HORIZONTAL CURSOR OVER THE REQUIRED OPTION TITLE AND:-
 -PRESS THE SPACE BAR TO CHANGE THE DISPLAY MODE AND REDISPLAY THIS PAGE
 -OR PRESS X TO SELECT THE MODE AND PRODUCE THE NEW DIAGRAMMATIC DISPLAY


THE DISPLAY MODES CAN ALSO BE CONTROLLED DIRECTLY FROM THE MAIN LOADFLOW
SECTION.  POSITION THE CURSOR ON THE 'DISP MODE' OPTION AND:-
   -PRESS KEY 1 TO DISPLAY BUS LOADS-MVA  FLOWS ON THE DIAGRAMS
   -PRESS KEY 2 TO DISPLAY BUS VOLTS- MW  FLOWS ON THE DIAGRAMS
   -PRESS KEY 3 TO DISPLAY BUS VOLTS-MVAR FLOWS ON THE DIAGRAMS
   -PRESS KEY 4 TO DISPLAY BUS VOLTS/ANGLE-MW/MVAR FLOWS ON THE DIAGRAMS
   -PRESS KEY 5 TO DISPLAY BUS VOLTS/ANGLE-MW/MVAR FLOWS & TAP SETTINGS

NOTE:- THE BRANCH FLOWS DISPLAYED ON THE DIAGRAMS ARE THE MAXIMUM VALUES
    FOR EACH BRANCH I.E. MAY RELATE TO THE SENDING OR THE RECEIVING END.
OPTIONS:
SUMMATION OF FLOWS
BUS LOADS, MVA FLOWS
BUS VOLTS, MW FLOWS
BUS VOLTS, MVAR FLOWS
BUS VOLTS/ANGLE, MW/MVAR FLOWS
BUS VOLTS/ANGLE, MW/MVAR ,TAPS
HELP
RETURN
                                  COPYRIGHT (C) TOM InC 1988 TIME : 17:32:06 23/08/2001
```

Figure 6.5

```
LOADFLOW RESULTS DISPLAY MODES

OPTIONS:
SUMMATION OF FLOWS
BUS LOADS, MVA FLOWS              <----- PRESENT MODE
BUS VOLTS, MW FLOWS
BUS VOLTS, MVAR FLOWS
BUS VOLTS/ANGLE, MW/MVAR FLOWS
BUS VOLTS/ANGLE, MW/MVAR ,TAPS
HELP
RETURN
                                  COPYRIGHT (C) TOM InC 1988 TIME : 17:33:01 23/08/2001
```

Figure 6.6

Press the <SP> key or a click to change the display mode or Press <X> to select the mode and produce the new diagram display.

For example, if the cursor is positioned over the [BUS LOADS, MVA FLOWS] option and the <SP> key or a click is pressed, then display mode is changed, and this is indicated by an arrow, shown in figure 6.6. When the [RETURN] option is selected, the diagram is immediately re-displayed with the selected information on it. This is shown in figure 6.7.

The display modes can also be controlled directly from the main loadflow section which produces a diagram with the selected flows displayed on it (it overrides the display mode menu page). To do this position the cursor on the [DISP MODE] option and:

Press key <1> to display BUS LOADS-MVA flows (see figure 6.7)
Press key <2> to display BUS-VOLTS-MW flows (see figure 6.8)
Press key <3> to display BUS VOLTS-MVAR flows (see figure 6.9)
Press key <4> to display BUS VOLTS/ANGLE-MW/MVAR flows (see figure 6.10)
Press key <5> to display BUS VOLTS/ANGLE-MW/MVAR flows and TAP SETTINGS (see figure 6.11)

For the first, second and third options of the above the DOUBLE FLOWS as described above, may also be used to be in action. In these cases the diagrams shows sending and receiving ends flows separated by S, R indicators respectively. An example is shown in figure 6.12 for MW flows.

Note: The branch flows displayed on the diagrams are the maximum values for each branch i.e. may relate to the sending or the receiving end, please see section 2.5.16 for more option, please look for 'branch flows'. If you need sending and receiving flows separately, you can either refer to the full list or you can set DOUBLE BRANCH FLOWS in [SET COLOURS AND SYMBOLS] described in chapter 2 section 2.15.6.

The number of circuits or elements of the diagram together with their associated flows can also be displayed if the option SUMMATION FLOWS is changed to the option MULTIPLE FLOWS. This may be achieved if you press any key while the cursor is located on this option. The number of circuits are those which are entered in LINE DATA 3.

6.2.3 [SCALE]

Allows the system diagram to be re-scaled and recentered. Different sections of a large system can thus be displayed on the screen, with the appropriate loadflow results. For further details on scaling see section 3.4.

By introducing zoom and scroll bars facilities like those described in chapters 2 and 3, using mouse right click or using the key <Z>, an easier facility has been provided for scaling. However, there are certain uses of this facility, e.g. bringing a substation in center of the screen by using its name.

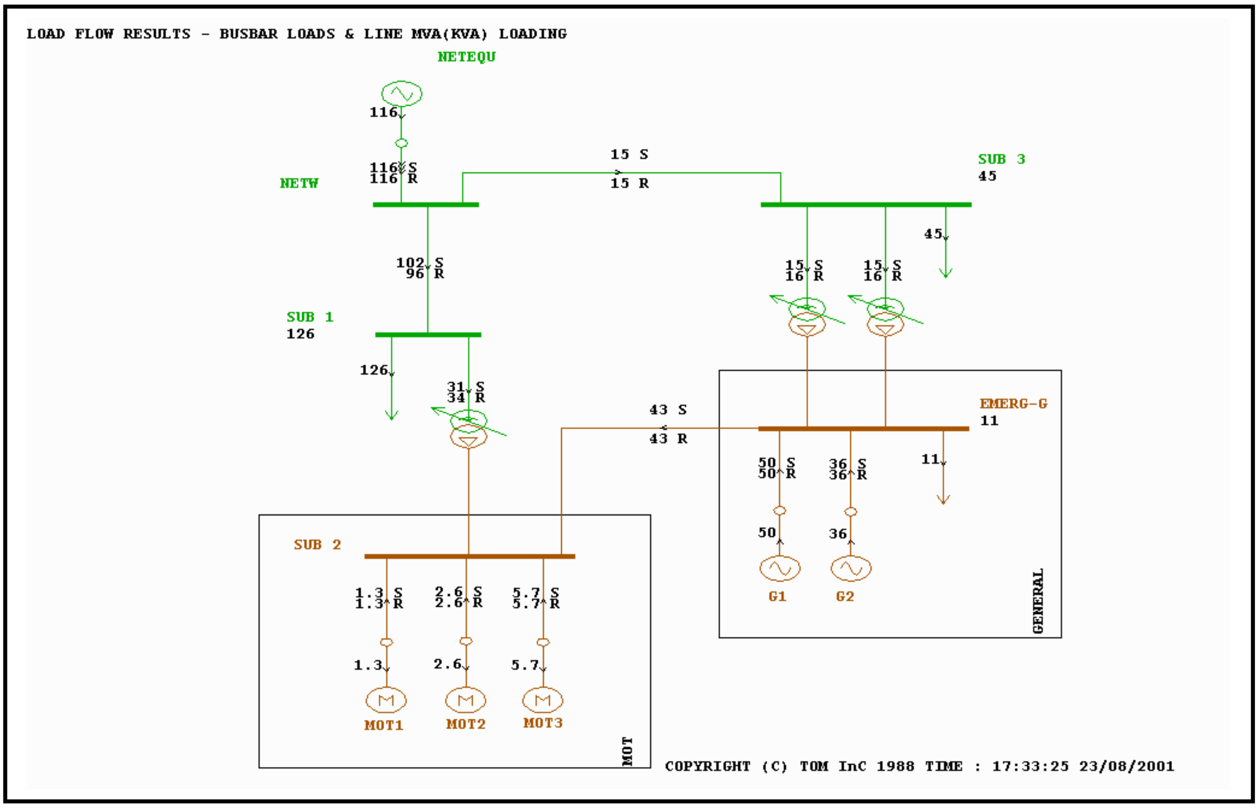


Figure 6.7

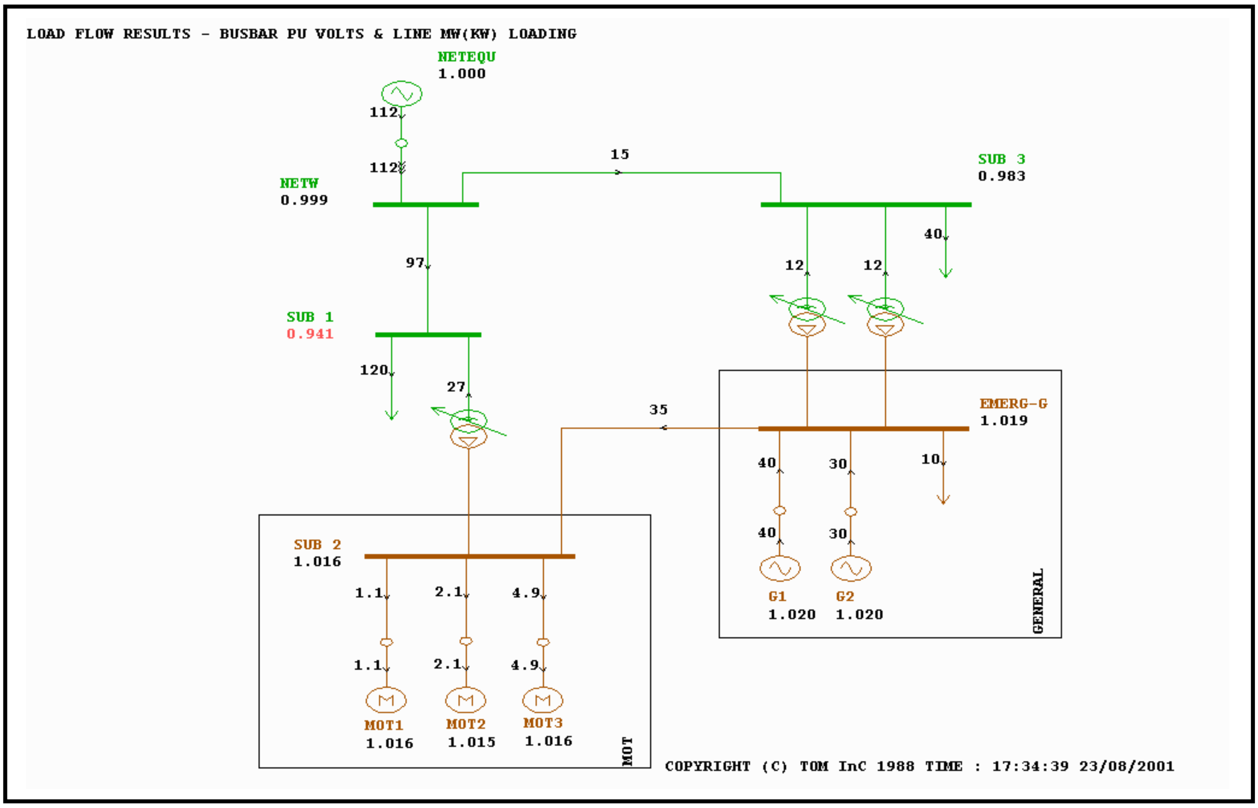


Figure 6.8

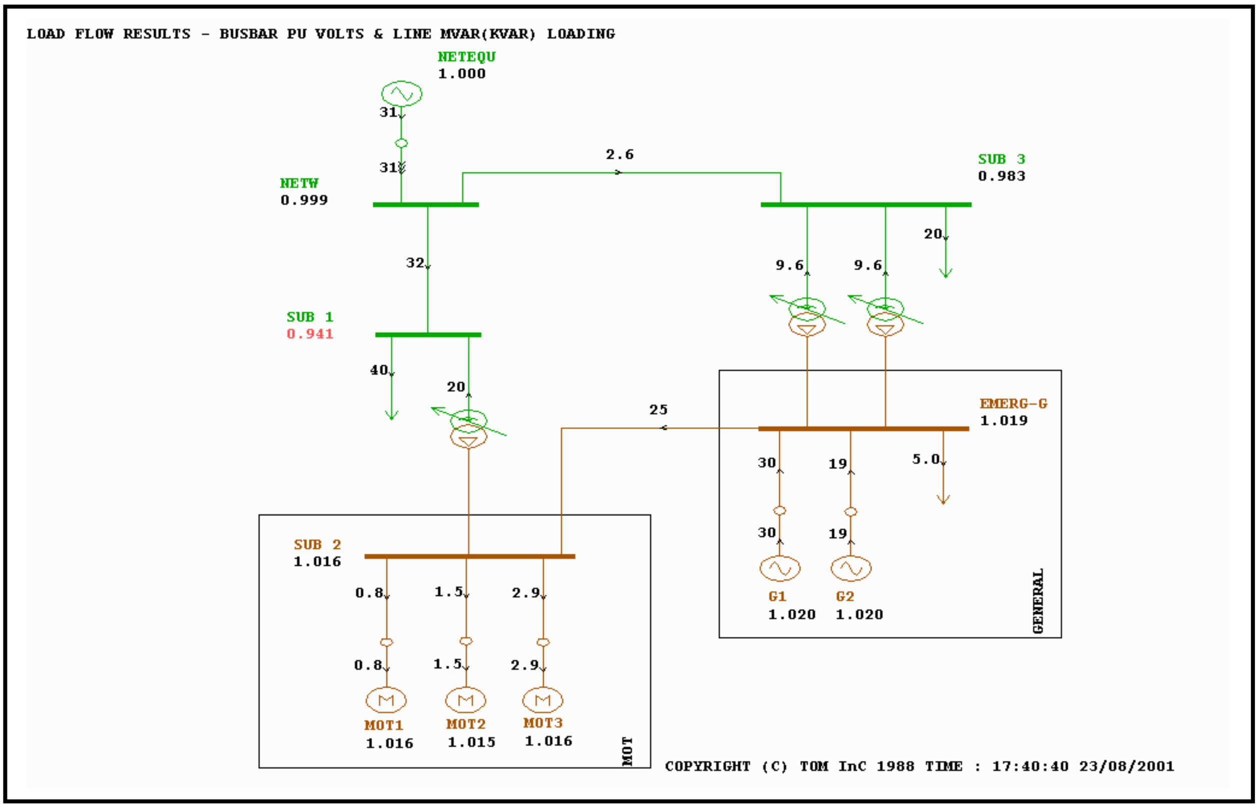


Figure 6.9

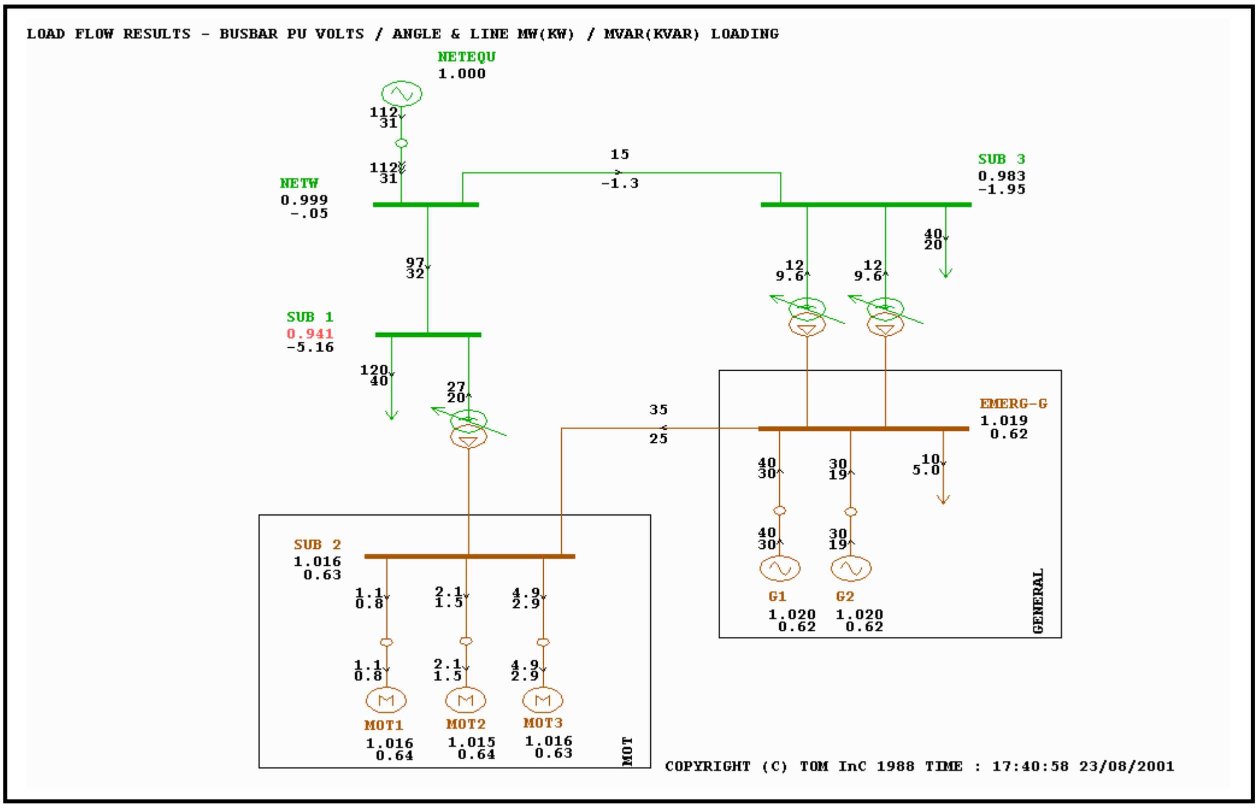


Figure 6.10

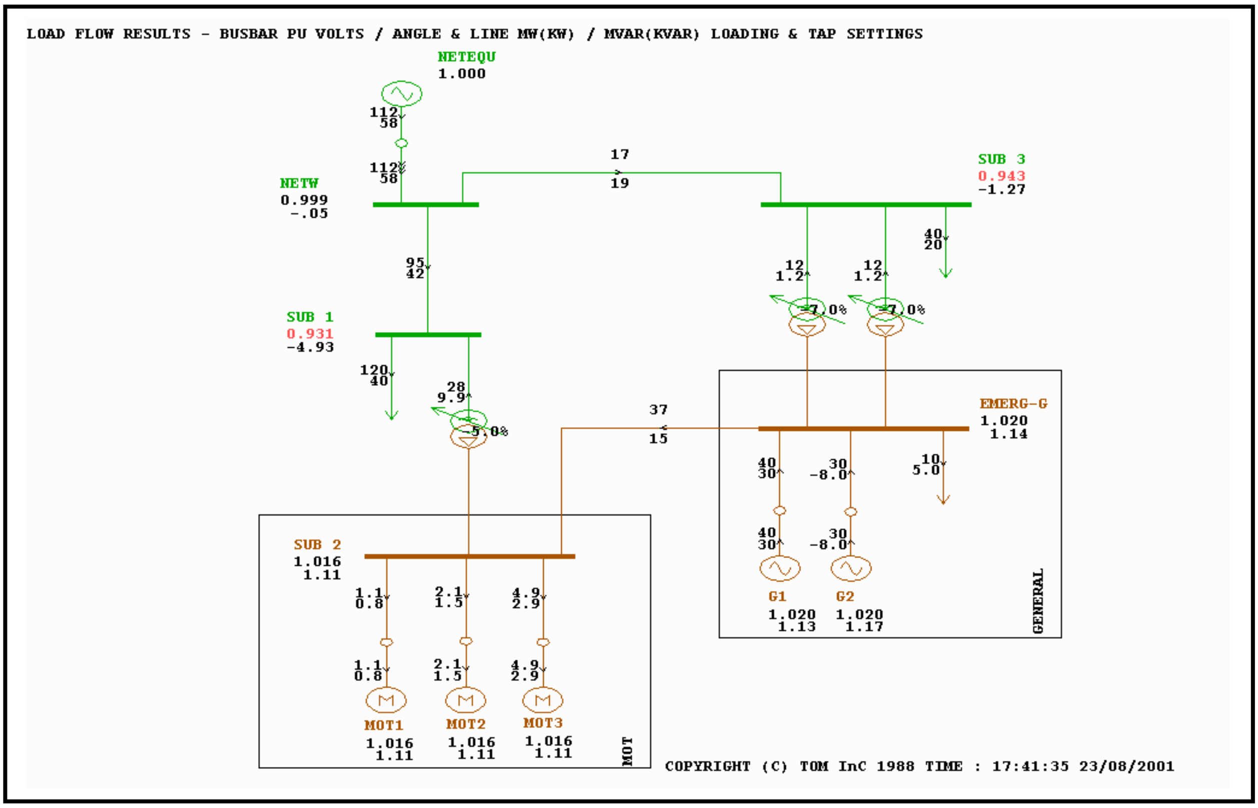


Figure 6.11

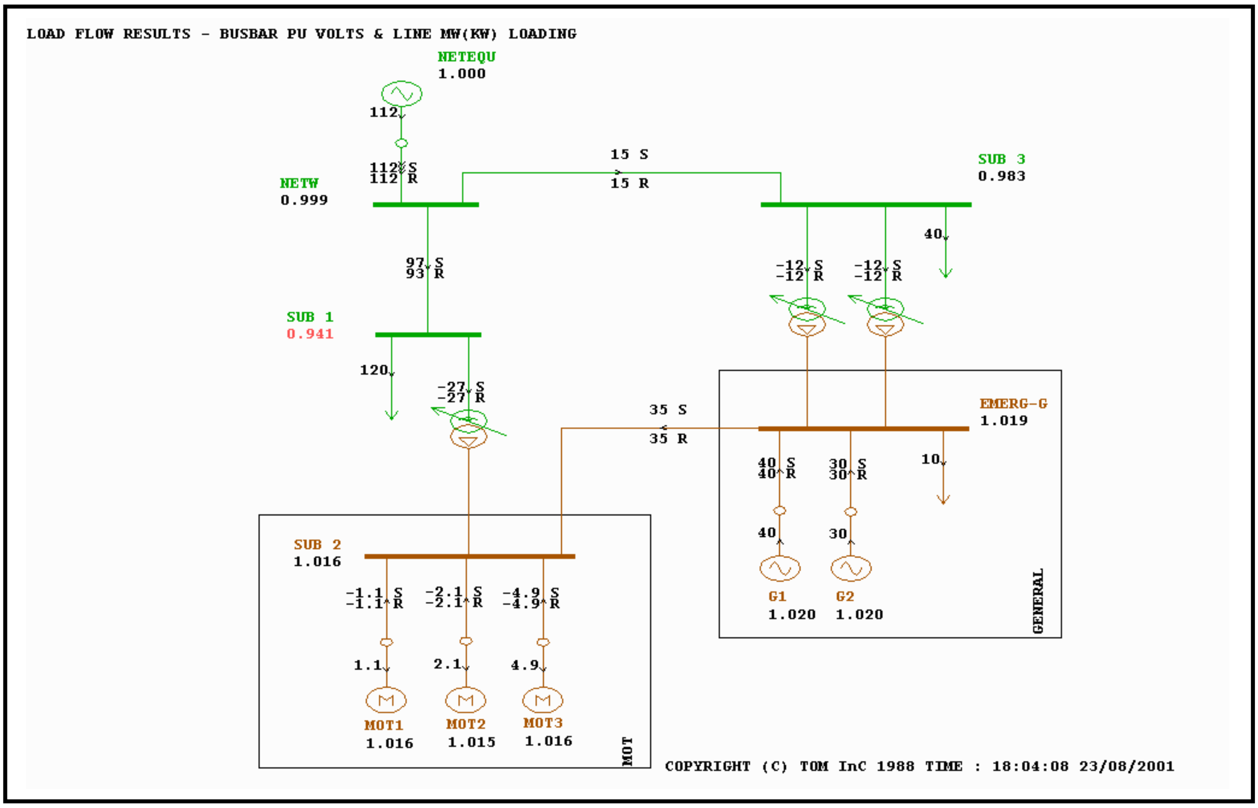


Figure 6.12

6.2.4[OUTAGES]

The outage section enables the user to temporarily disconnect any number of any type of system plant and then performs a loadflow on the reduced system. Therefore contingency analysis may be performed using this option. When the [OUTAGE] option is selected, any previous outages are restored. To select plant to be outaged the same deletion keys that exist in the drawing section are used (see 3.5.1). After selecting this option, you can just click on the required plants in order to select them for staying out of the study.

Figure 6.13 shows the results before selecting the [OUTAGE] option. To illustrate how the outage option works, let us say the user wishes to outage the circuit from **NETW** to **SUB 3**. To do this the cursor is positioned over the line and a click is pressed. The line is then shown as deleted, figure 6.14. You may use the <D> key while the cursor is on **NETW** and then move the cursor to **SUB 3** and press the <C> key as described in section 3.5.1.

To commence a new loadflow calculation the <X> key is then pressed, this is shown in Figure 6.15. You can also use the mouse right click option for X. To view the new loadflow solution, the user then chooses a display option (i.e. [MVA DISP] or [DISP MODE]). On the new system diagram the outaged plant is shown by being drawn with dashed lines, this can be seen in figure 6.16.

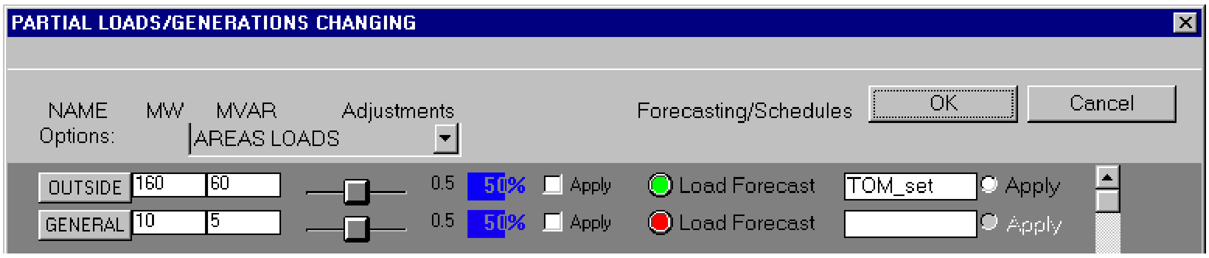
Any outages will be carried into the load change and fault options if these are selected next.

6.2.5 [LOAD CHNG]

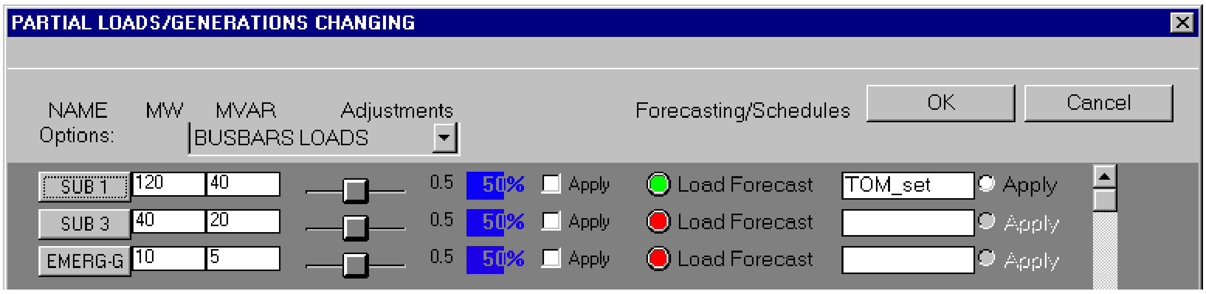
This has three options. The first one is the default and can also be select by pressing a click or any key except <G> and <P>. It allows a factor to be entered by which all loads are multiplied and a further loadflow is then performed. Figure 6.17 shows the load being changed by a factor of 1.5. The new load flow results can then viewed by selecting a display option. Figure 6.18 shows the new results. All the static loads have been multiplied by 1.5 this can be seen by comparing figure 6.18 with figure 6.10.

The second one is the same as the first one, except that the generation will also multiply by the user factor. This may be implemented by pressing <G>.

The third one is a partial load changing and it is more general. When selected a menu of the following figure will be appeared.



The user may select Area loads, Area generation, Busbars loads, Generation schedule, or individual voltage levels loads of his desired by changing the option menu and change the amount of static loads or the generations. In the above figure AREAS LOADS is selected. In this case, the computer shows the sum of the loads inside each area of the example system of this chapter. The area GENERAL has sum of 10MW active loads and the area MOT has no static load, i.e. the sum of the loads in this area is zero and that is why it is not shown. Instead the area OUTSIDE which is an indicator for the loads are not existed inside any area is shown separately. The user may change the amount of active and reactive loads either by typing his desired amount or by changing the percentage using the slider. In the last case, the amount of loads can be changed from 0 to 100%. Middle point i.e. 50% shows the amount of the actual loads when entered. The following figure shows the menu for the same example when BUSBARS LOADS option is selected. In this case, three busbars with the loads are listed. These are “SUB 1”, “SUB 3”, “EMERG-G”.



The load forecasting or generation schedule may also take place if appropriate load forecasting software included in the package. In this figure “SUB 1” has a forecasting program named “TOM_set” and the green light shows that the program is available. Please contact with TOM Industrial Consultant to configure your load forecasting or generation scheduling software with this last option.

In all the cases the “Apply” check mark must be set on in order to the changes take place in the next load flow study. After pressing OK button another load flow will be performed considering the new data set. The CANCEL button cancels all the changes. Closing the box also cancels all the changes.

Figure 6.19 shows the partial load-changing menu for a large-scale network consisting of many areas. If the number of the list is more than 60, the user must select Next or Previous page as will be appeared in the box.

It should be noted that in all the above cases the load and generation changes actually change the load data and generation data (if the option is in action) on the busbar data page in the edit section (4.5.1) or in generator data page in the edit section of (4.5.11).

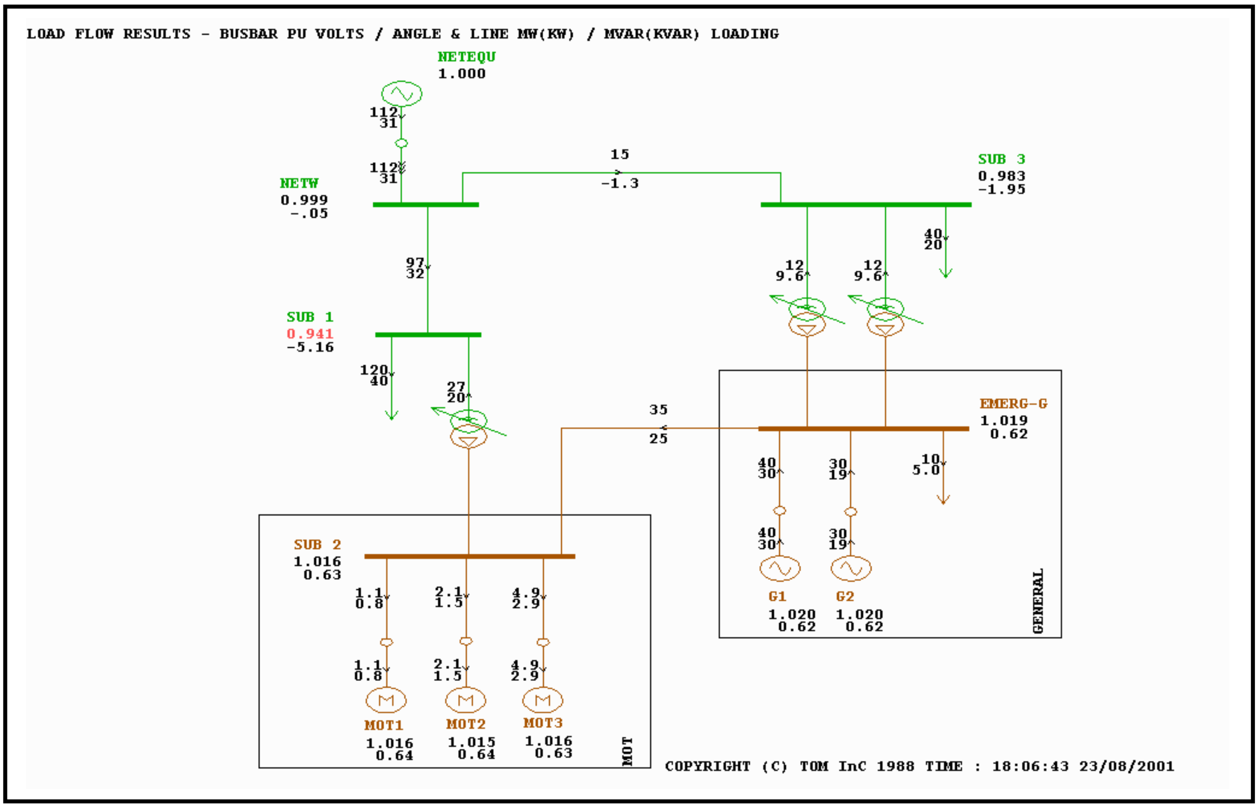


Figure 6.13

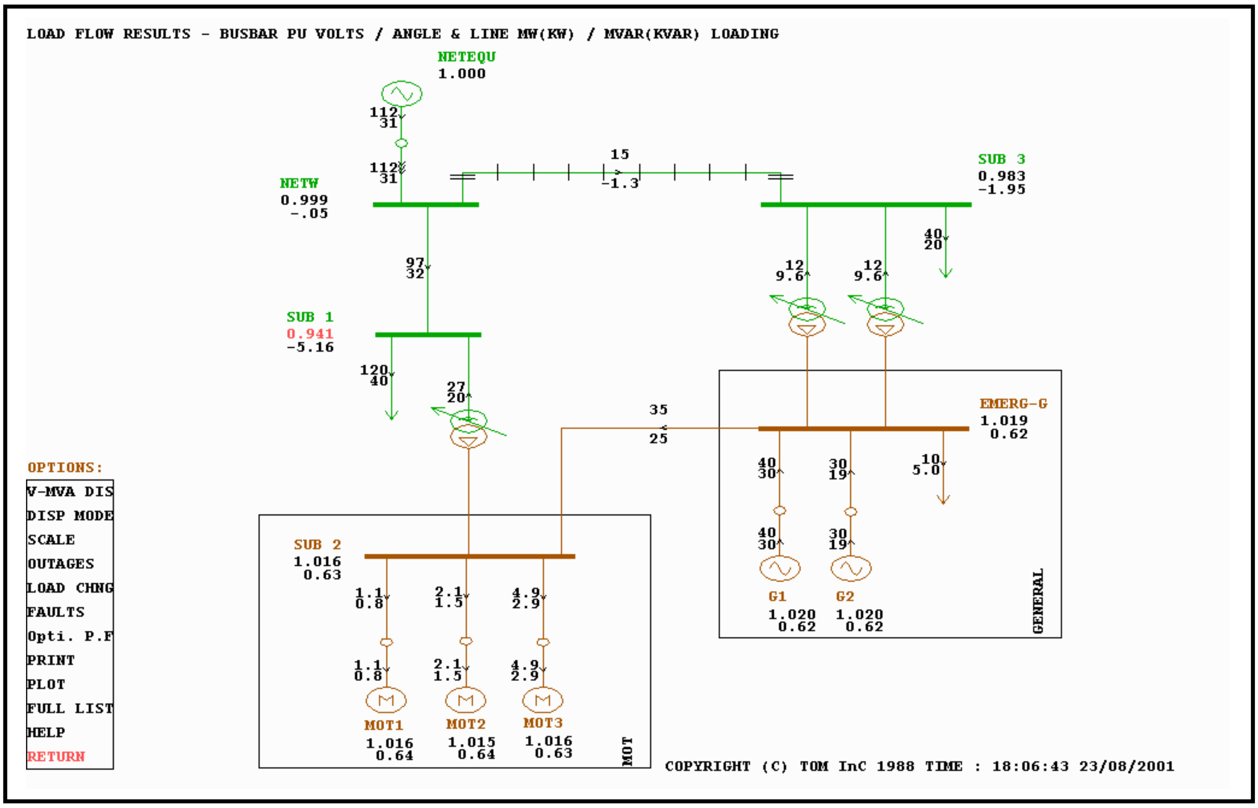


Figure 6.14

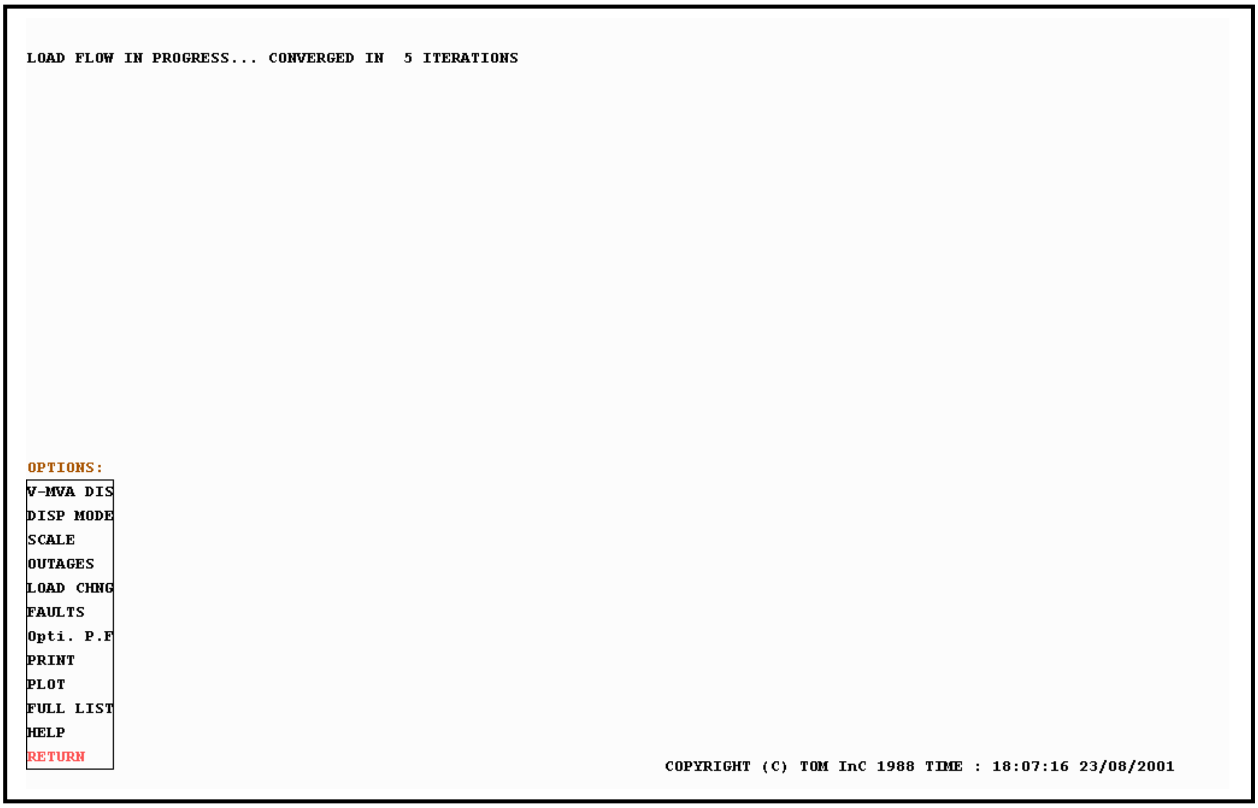


Figure 6.15

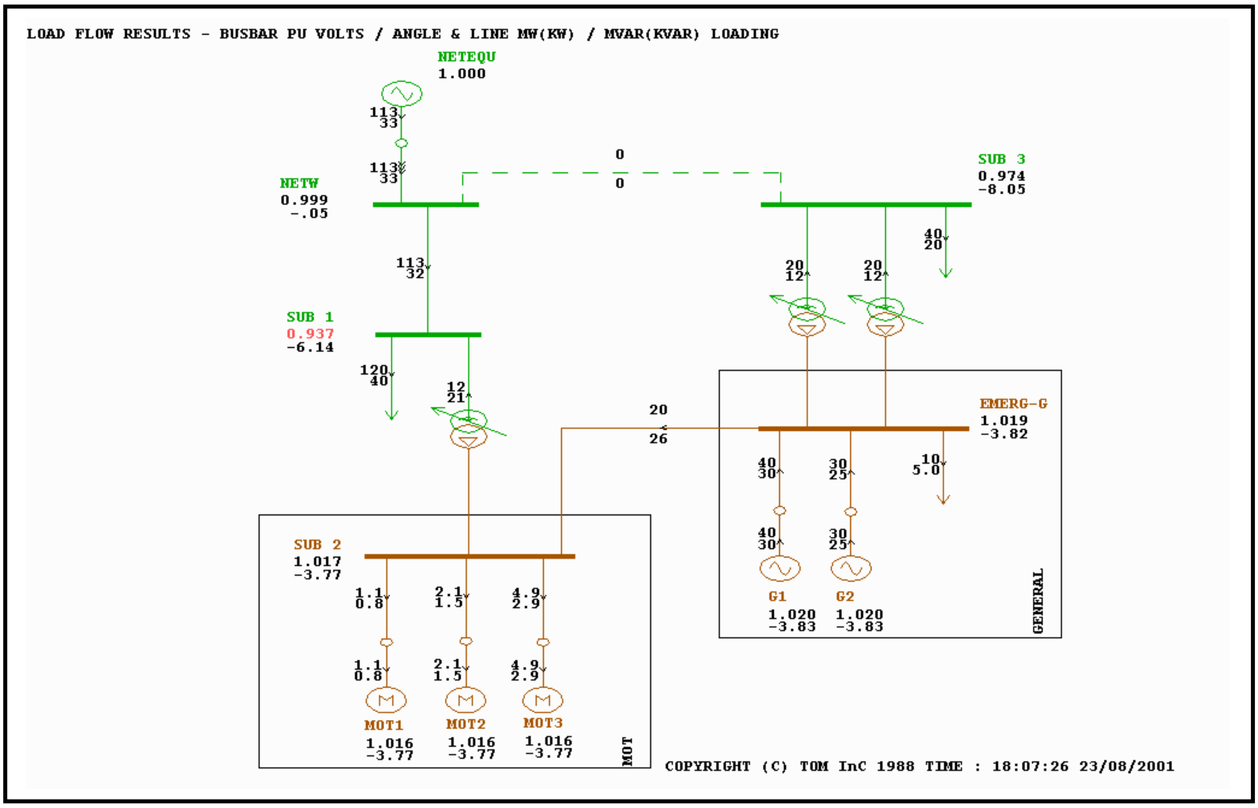


Figure 6.16

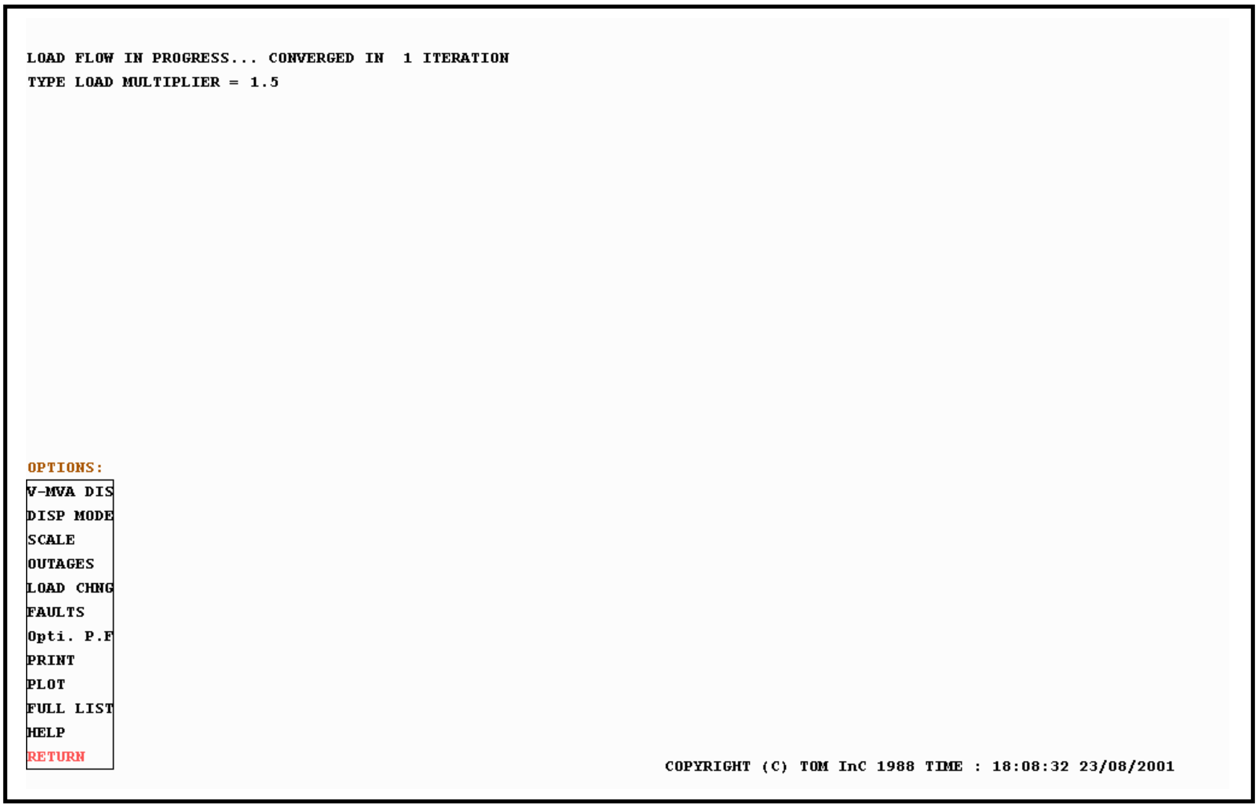


Figure 6.17

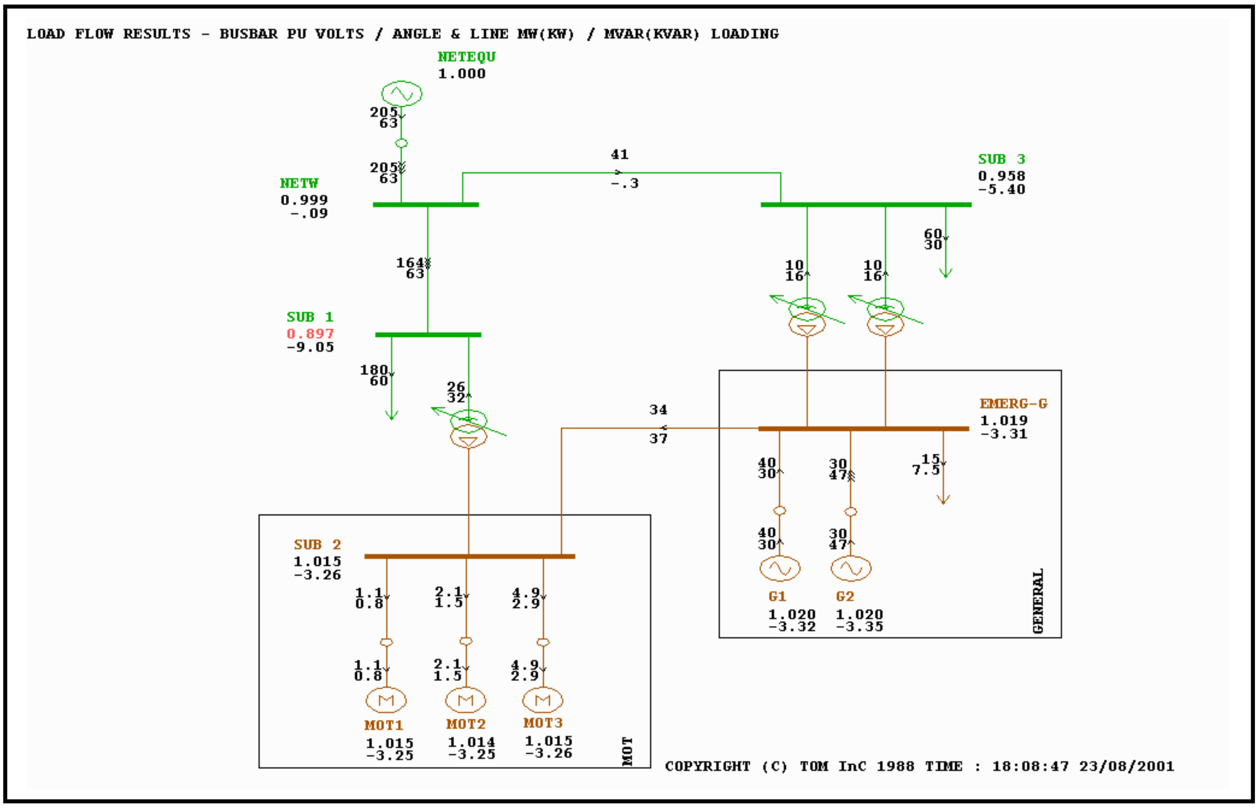


Figure 6.18

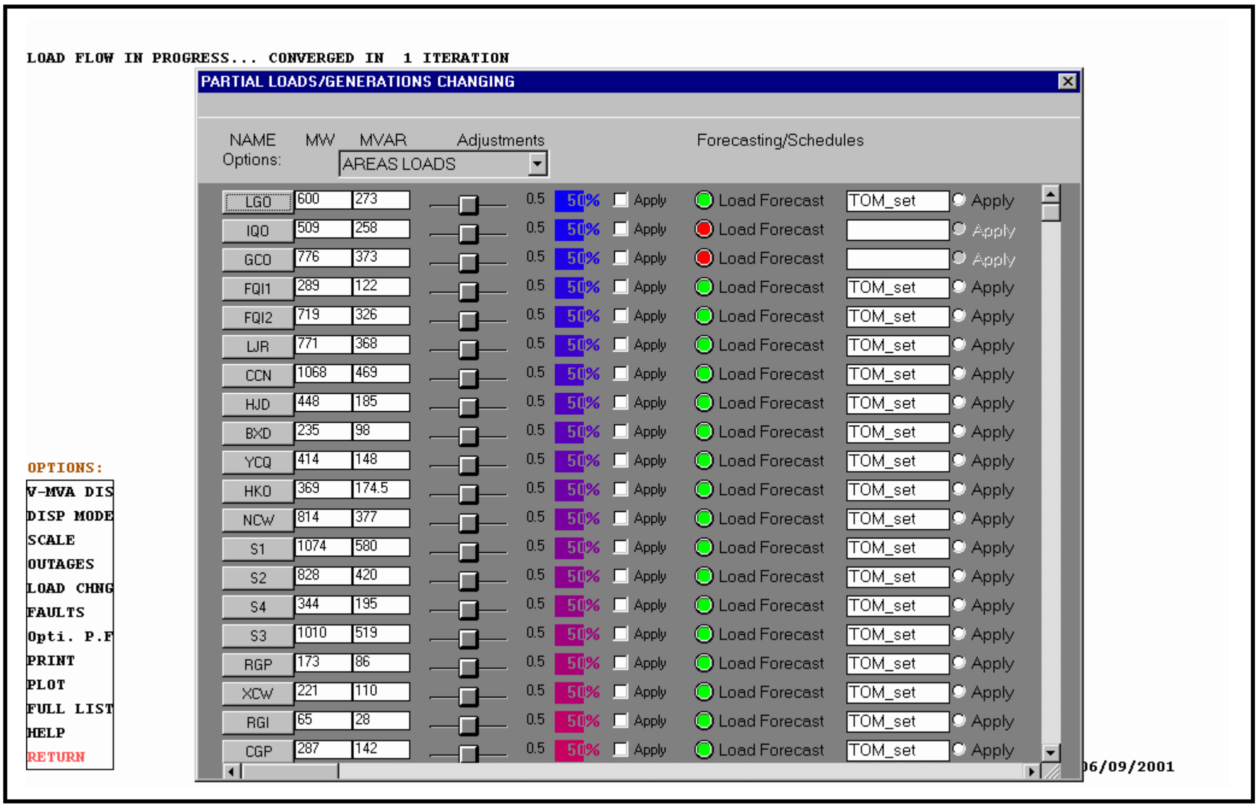

LOAD FLOW IN PROGRESS... CONVERGED IN 1 ITERATION
PARTIAL LOADS/GENERATIONS CHANGING
NAME MW MVAR Adjustments
Forecasting/Schedules
Options:
AREAS LOADS
LGO 600 273
IQO 509 258
GCO 776 373
FQI1 289 122
FQI2 719 326
LJR 771 368
CCN 1068 469
HJD 448 185
BXD 235 98
YCQ 414 148
HKO 369 174.5
NCW 814 377
S1 1074 580
S2 828 420
S4 344 195
S3 1010 519
RGP 173 86
XCW 221 110
RGI 65 28
CGP 287 142
0.5
50%
Apply
Load Forecast
TOM_set
Apply
OPTIONS:
V-MVA DIS
DISP MODE
SCALE
OUTAGES
LOAD CHNG
FAULTS
Opti. P.F
PRINT
PLOT
FULL LIST
HELP
RETURN
06/09/2001

Figure 6.19

6.2.6 [FAULTS]

Enters the fault level section (see chapter 7) with the system in its current form (with load flow result have been previously obtained) which will include any outages or load changes introduced.

6.2.7 [Opti. P.F.]

Performs optimal power flow on the existing system. Economic dispatch, Reactive optimal power flow may be selected separately too, by pressing <A> or <R> on this option. The default considers both optimizations. For further information on this option, please refer to Chapter 14.

6.2.8 [PRINT]

Sends the results of the last loadflow to a line printer file (PRINTER.92). The listing contains system and study titles and details on :

(1) Line power flows,
(2) Overloaded circuits, including voltage violation, and turbine maximum check
(3) Busbars,
(4) Area details,
(5) Controls,
(6) Induction motors
(7) Transformer tap-changes.

These options may be selected from in-line green box menu bars too.

6.2.9 [FULL LIST]

Initiates the display, on the terminal, of the results of the last loadflow calculation. Selecting this option by pressing the <SP> key or a click gives the full listing. Pressing keys <1> to <7> starts the display at one of the main sections as listed above (see PRINT above).

Figures 6.20, 6.21 and 6.22 show the output generated for the example system used throughout this manual. The <S> key on the bottom of the map is provided for searching.

6.2.10 [PLOT]

Sends the entire diagram (on the screen and out of the screen) together with the latest loadflow result to a plotting file. The plotting diagrams can then be plotted on a plotter device by running PLOT.EXE (See Chapter 20) under the DOS command or its counterpart in Windows or Linux.

6.2.11 [HELP]

Displays the on-line HELP information on the terminal.

```
FAST DECOUPLED LOAD FLOW          OUTPUT OF RESULTS
===================================================

SYSTEM TITLE: PASHA MANUAL 2000 WITH DATA WITH AREA

STUDY TITLE:

LINE POWER FLOWS
----------------

-----BUSBARS-----   -------SENDING END-------   ------RECEIVING END------   ----LINE LOSS---- --AREA-TO-AREA--
FROM      TO            MW      MVAR     MVA         MW      MVAR     MVA        MW      MVAR
NETW      SUB 1      96.660   32.063  101.839     93.440   23.886   96.445     3.220    8.178
SUB 1     SUB 2     -26.560  -16.115   31.067    -26.764  -20.201   33.532     0.204    4.086        MOT
NETW      SUB 3      15.369   -1.274   15.421     15.134    2.627   15.360     0.235   -3.901
SUB 3     EMERG-G   -12.433   -8.687   15.167    -12.478   -9.580   15.732     0.045    0.893        GEN
SUB 3     EMERG-G   -12.433   -8.687   15.167    -12.478   -9.580   15.732     0.045    0.893        GEN
EMERG-G   SUB 2      34.986   25.040   43.023     34.865   25.370   43.118     0.121   -0.330   GEN  MOT
NETEQU    NETW      112.064   30.871  116.239    112.028   30.789  116.182     0.036    0.082
MOT1      SUB 2      -1.061   -0.754    1.301     -1.061   -0.748    1.299     0.000   -0.005   MOT  MOT
MOT2      SUB 2      -2.122   -1.508    2.603     -2.123   -1.503    2.601     0.001   -0.005   MOT  MOT
MOT3      SUB 2      -4.917   -2.939    5.728     -4.918   -2.919    5.719     0.002   -0.020   MOT  MOT
G1        EMERG-G    40.001   30.001   50.001     39.969   30.062   50.012     0.032   -0.061   GEN  GEN
G2        EMERG-G    29.993   19.098   35.557     29.969   19.137   35.558     0.025   -0.039   GEN  GEN
                                                                            -------- --------
                                                                               3.965    9.772
                                                                            -------- --------

OVERLOADED CIRCUIT SUMMARY
--------------------------

-----BUSBARS-----    RATING   ----LOADING----- --AREA-TO-AREA--
FROM      TO          MVA       MVA    PER CENT

NETEQU    NETW      100.000  116.239     116.

VOLTAGE VIOLATION SUMMARY (0.95> >1.05)

Continue listing? (Y or N or S)  Yes
                                 No
                                 Search

                                          COPYRIGHT (C) TOM InC 1988 TIME : 18:11:05 23/08/2001
```

Figure 6.20

```
------------------------

BUSBAR    AREA      ----VOLTAGE----

SUB 1                  0.9412

OUT OF TURBINE RANGE
------------------------

GENERATOR      MW     TURBINE.MW   AREA


BUSBAR DETAILS
--------------

BUSBAR    AREA    TYPE    ----VOLTAGE----   ---GENERATION----   ------LOAD-------   ----MISMATCH-----
                            MAG    ANGLE    ACTIVE  REACTIVE    ACTIVE  REACTIVE    ACTIVE  REACTIVE
                            P.U     DEG       MW      MVAR        MW      MVAR        MW      MVAR

NETW               PQ    0.9994   -0.050     0.000    0.000      0.000    0.000      0.000    0.000
SUB 1              PQ    0.9412   -5.163     0.000    0.000    120.000   40.000      0.000    0.001
SUB 2      MOT     PQ    1.0158    0.635     0.000    0.000      0.000    0.000     -0.002   -0.001
SUB 3              PQ    0.9826   -1.955     0.000    0.000     40.000   20.000      0.000    0.001
EMERG-G    GEN     PQ    1.0192    0.621     0.000    0.000     10.000    5.000     -0.004   -0.002

NETEQU            SLK    1.0000    0.000   112.064   30.871      0.000    0.000
MOT1       MOT     PQ    1.0155    0.636     0.000    0.000      1.061    0.754      0.000    0.000
MOT2       MOT     PQ    1.0152    0.637     0.000    0.000      2.122    1.508      0.000    0.000
MOT3       MOT     PQ    1.0155    0.635     0.000    0.000      4.916    2.939      0.000    0.000
G1         GEN     PQ    1.0199    0.616    40.000   30.000      0.000    0.000     -0.001   -0.001

G2         GEN     PV    1.0200    0.620    30.000   19.098      0.000    0.000      0.007
                                         -------- --------   -------- --------   -------- --------
                                          182.064   79.969    178.099   70.200      0.000   -0.004
                                         -------- --------   -------- --------   -------- --------
                                         -------- --------
GENERATORS                                182.064   79.969
                                         -------- --------
                                         -------- --------   -------- --------

Continue listing? (Y or N or S)  Yes
                                 No
                                 Search

                                          COPYRIGHT (C) TOM InC 1988 TIME : 18:11:12 23/08/2001
```

Figure 6.21

```
MOTOR LOADS                               0.000     0.000       8.099     5.200
                                       -------- --------    -------- --------

MAXIMUM MISMATCH =    0.007 MW    0.002 MVAR

AREA   DETAILS
--------------

AREA       ---GENERATION---   ------LOAD------   -----SHUNTS-----   ----INCOMING----   ----OUTGOING---- ---LINE LOSS---
           ACTIVE  REACTIVE   ACTIVE  REACTIVE   ACTIVE  REACTIVE   ACTIVE  REACTIVE   ACTIVE  REACTIVE ACTIVE  REACTIVE
             MW      MVAR       MW      MVAR       MW      MVAR       MW      MVAR       MW      MVAR     MW      MVAR

           112.064   30.871   160.000   60.000     0.000    0.000    86.705   64.402    34.865   25.370    3.9       9.9
GENERAL     70.000   49.098    10.000    5.000     0.000    0.000     0.000    0.000    59.941   44.201    0.1      -0.1
MOT          0.000    0.000     8.099    5.200     0.000    0.000    34.865   25.370    26.764   20.201    0.0       0.0

*TOTAL*    182.064   79.969   178.099   70.200     0.000    0.000   121.570   89.773   121.570   89.773    4.0       9.8

CONTROLED BUSBAR SUMMARY
------------------------

BUSBAR   AREA   CONTROL?

INDUCTION MOTOR DETAILS
-----------------------

BUSBAR   ID    MECHANICAL   -ELECTRICAL LOAD-    SLIP   AREA
                LOAD MW         MW        MVAR                     EFF%      PF

MOT1              1.000       1.061     0.754  0.018    MOT       94.26     0.815
MOT2              2.000       2.122     1.508  0.018    MOT       94.26     0.815
MOT3              4.800       4.916     2.939  0.010    MOT       97.63     0.858



Continue listing? (Y or N or S)  Yes
                                 No
                                 Search
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```

Figure 6.22

6.2.12 [RETURN]

Exits from the loadflow section to the Main PASHA menu.

6.3 Failure of the initial calculation.

When either the network diagram or some network data is invalid, it is possible for the initial load flow calculation to fail. If this occurs the user is immediately informed, with a message saying where the erroneous system parameters are at fault.

6.3.1 Data errors

Two error messages are caused by data errors. The first is shown in figure 6.23, and caused by failing to specify the line impedance. Since the loadflow calculation has failed, when the load flow menu is enabled, only the [HELP] and [RETURN] options are displayed.

The second error message is caused when the solution is found to be diverging rather than converging as shown in figure 6.24. This can be caused by excessive loading of the system, or by an incorrect physical situation. As the load flow calculation has failed only a limited number of options are provided: [HELP], [RETURN] and [LOAD CHNG]. The load change option is included to allow the user to adjust the loading if this is what has caused the divergence.

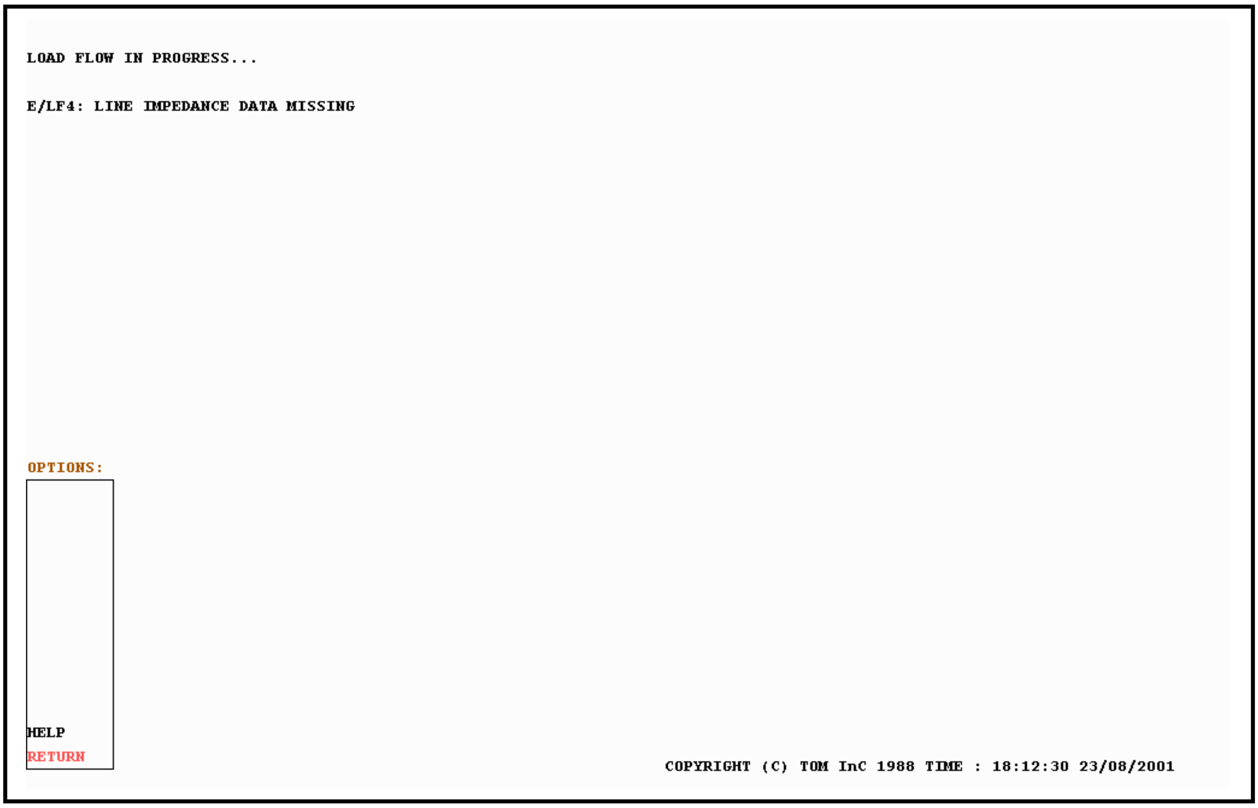


Figure 6.23

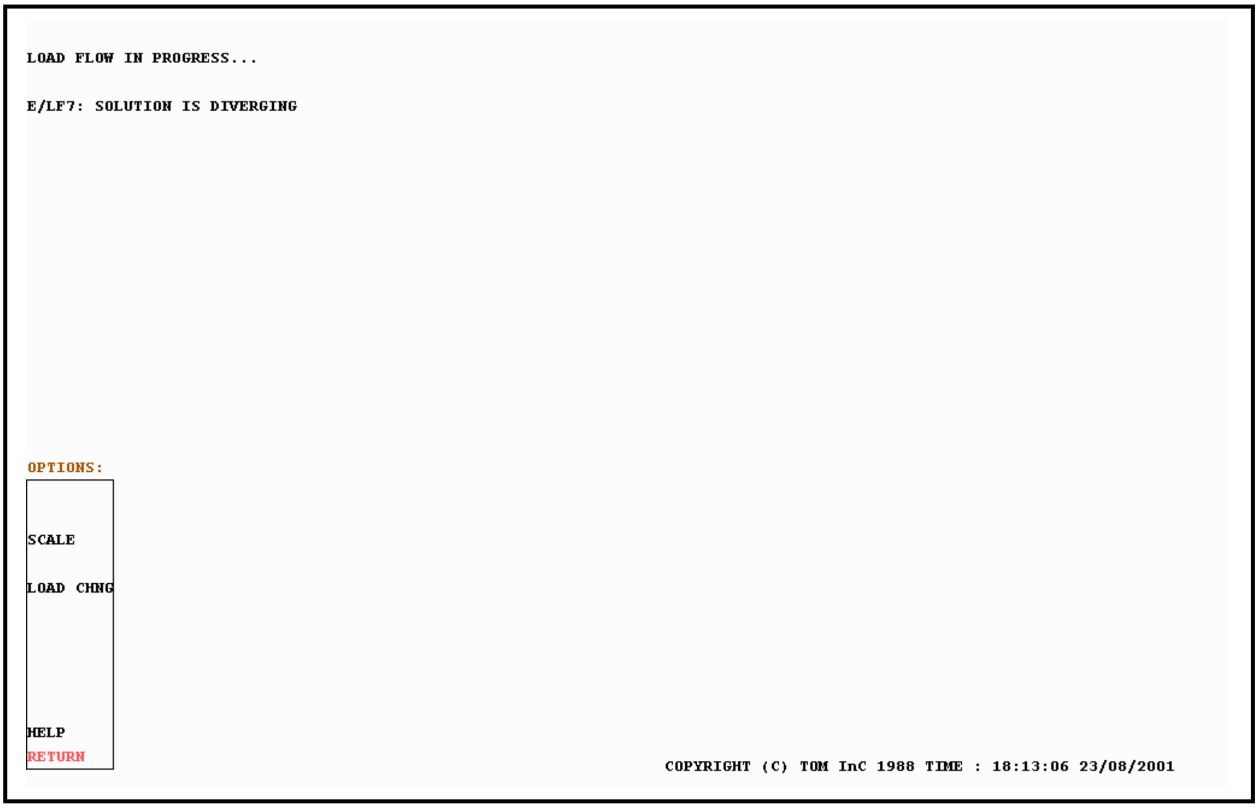


Figure 6.24

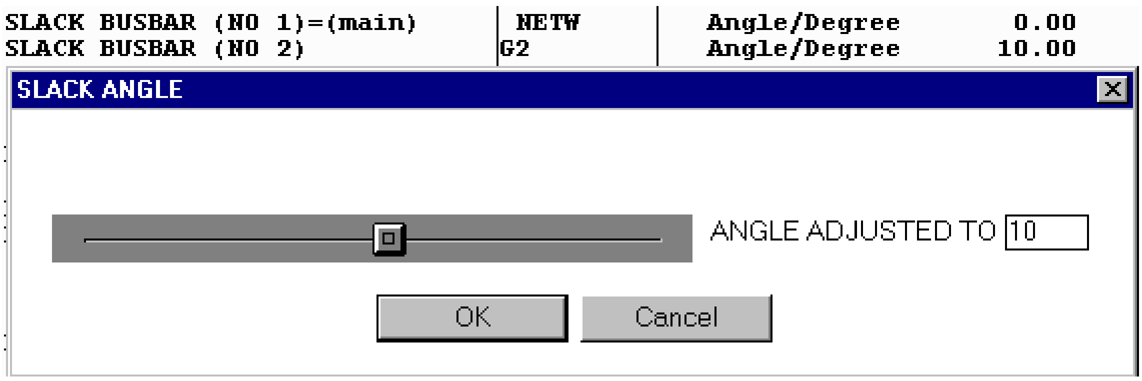
6.3.2 Split networks

It is usually accepted that a load flow study must only function with completely connected systems (please see the next paragraph), i.e. those in which no busbar or group of busbars were completely isolated from the rest of the system. When this was detected an error message specifying a 'split' network is displayed in PASHA, as shown in figure 6.25. The reason that it is claimed the load flow must not be solved for split networks is that a split network is in reality two or more systems and as such each section should be modeled separately.

But there are situations that the isolated networks must be solved, as stated in section 6.1.1. PASHA solves split networks by introducing more slack busbars that can be specified in the ANALYSIS PARAMETERS 1 edit page. The SLACK NO 1(main) is selected by the program or user as described in section 6.1.1. The others slack busbars must be specified by the user at least one for each part of the split networks.

The result of load flow for a split network is shown in figure 6.26 while NETEQU is the main slack and G2 is slack no 2 with 10 degree angle adjusted for it. Any switching action can take place between two separated networks in transient stability simulation. For other options available under this topic please refer to section 6.1.1.

Each slack busbar may be specified with an angle. The following figure shows a menu that must be set by the user whenever he inputs a slack busbar in the ANALYSIS PARAMETER 1 data page.



Setting the angle of each slack busbar affects on the angles of the all busbars exist in the area connected to that slack busbar.

In fault studies if these two sections are connected through a line and the line is in outage then it is possible to put a fault in one of the sections so that the other section will not be affected by the fault.

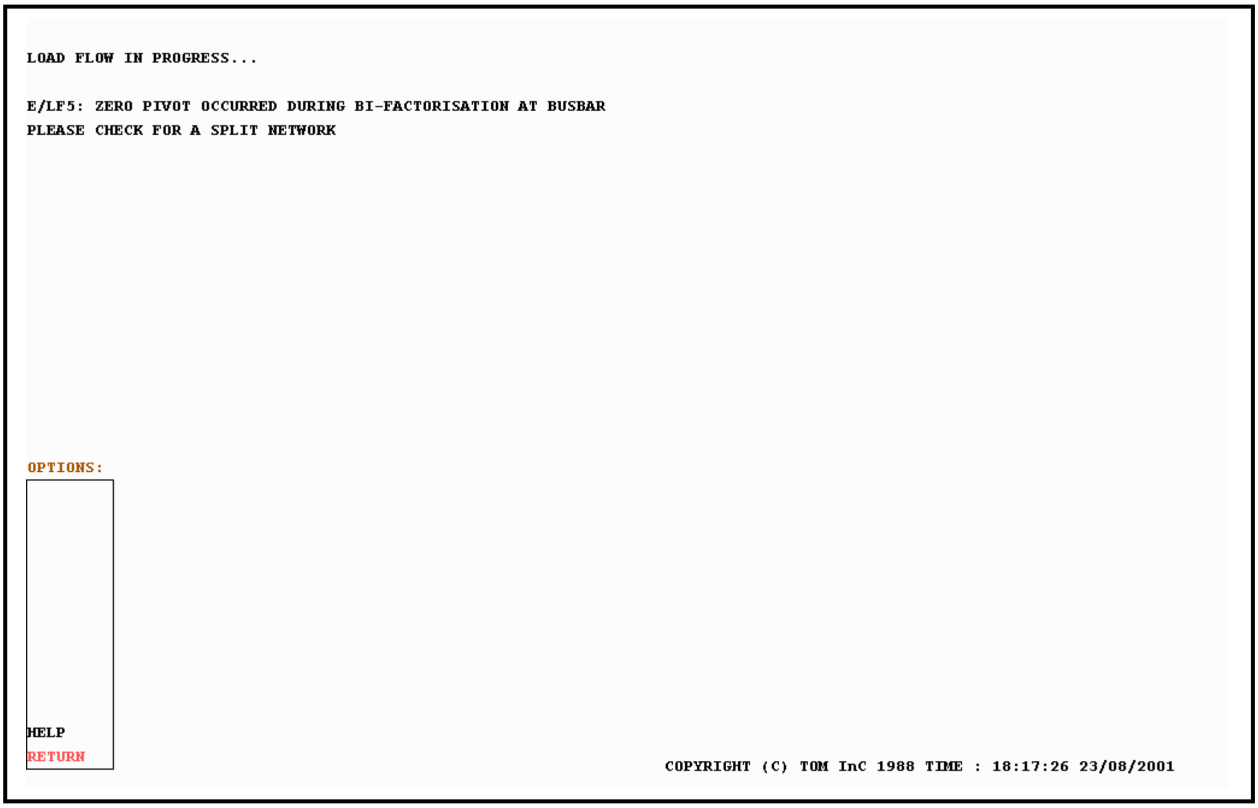


Figure 6.25

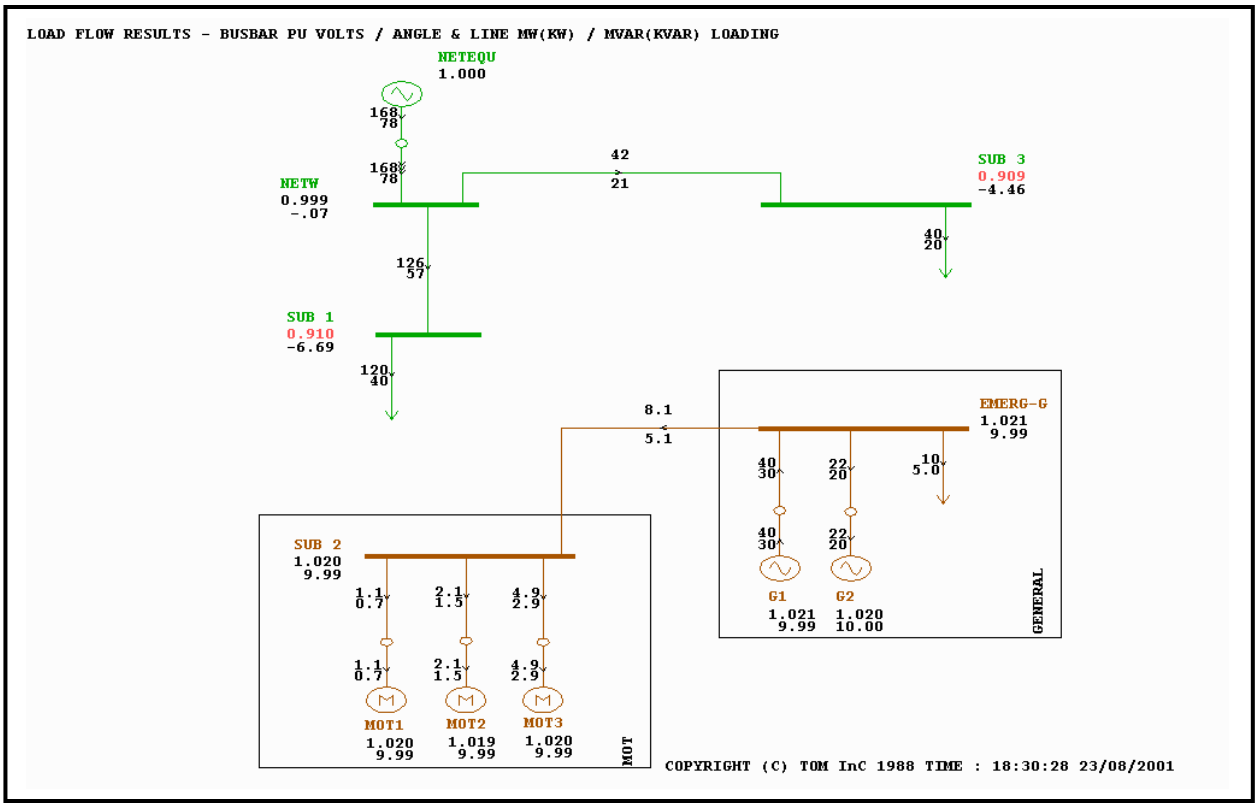


Figure 6.26

6.4 Summary

The load flow section of PASHA provides a fast and reliable algorithm to determine power flows, busbar voltages and angles. All of the study results can be easily displayed on the network diagram or listed in a tabular form to the terminal or sent to a line printer or plotting file for later printing or plotting.

The load flow section also provides a powerful method of interactively creating temporary outages for contingency analysis and load changes, which can be carried through to fault level studies.

Multi slacks with different angles can be introduced and the initial condition for many studies like transient stability, motor starting, frequency dynamics, out of phase switching, etc. are prepared.