

## LOAD FLOW as requested

**CONTRACT NO. :**

**PROJECT : X DAM TO X WATER TRANSMISSION PIPELINE**

**COMPANY : X REGIONAL WATER AUTHORITY**

**SITE : `PUMPING STATIONS 1-2-3-4-5**

0	21/03/09	Issued for Approval	Dr.K	S.M.K.	A.D.	M.S.	
Rev.	Date	Description	ORIGI	PRPD	CHKD	APP'D	CONT. APPRD.
<b>X DAM TO X WATER TRANSMISSION PUMPING PIPELINE</b>							
<b>Project No. :</b>			<b>Doc. Class :</b>		<b>Scale : NTS</b>		
<b>LOAD FLOW as requested</b>							

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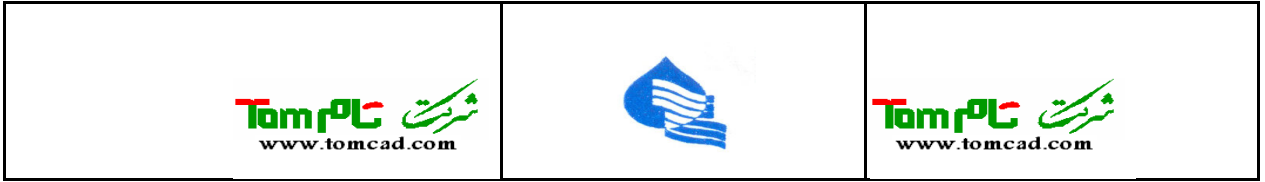
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## 1. INTRODUCTION

The five pumping stations located in Y of X transmit water from X dam to X city. The stations are supplied from 132KV lines part of X national grids. 132KV/6.64KV transformers are used to supply main 6.6KV busbars of the five pumping stations. Some small 400V loads are supplied from 6.6 KV busbars through 6.6/0.4 KV transformers in each pumping station.

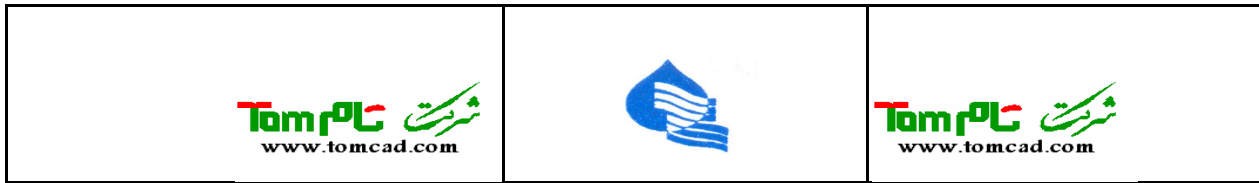
## 2. SCOPE

The objective of this document is to do load flow studies as it did in report GOZA8201 of (MONX), in order to further investigate the load flow situations as design discrepancy reasons requested in the M.O.V of 11 March 2009. However, the exact load flow study of the plant will be issued in another document latter on.

## 3. SYSTEM DESCRIPTION AND INPUT DATA

### 3.1. Reference Documents

GOZA8



### 3.2. System Analysis Software

PASHA (Power Apparatus and System Homological Analysis), Version 2008, was used for performing the studies. The software is product of TOM and serving the electrical utilities and the industries for twenty four years worldwide.

### 3.3. Electrical System Representation

#### 3.3.1. Network Topology

Single line diagram of the involving plants are used to produce the study power system. Figure 1 shows a view of the overall electrical network represented in the present studies inside the PASHA software.

The existence of the connection of the **pumping stations** to **X National GRID** is considered by introducing an equivalent representation of the grid. This is shown in Figure 1 in **GRID** area. The detailed representation of the X national power grid is already represented in PASHA software elsewhere. The 1390 deck of the 400KV, 230KV, and 132KV of the X network which includes the 63KV of the Esfahan is used to provide the equivalent of the power grid as represented in this report.

Figures 2,3,4,5,6 shows the detailed single line diagram of pumping stations as represented in PASHA software.

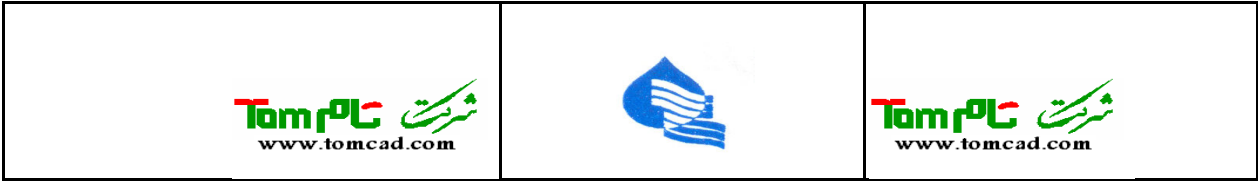
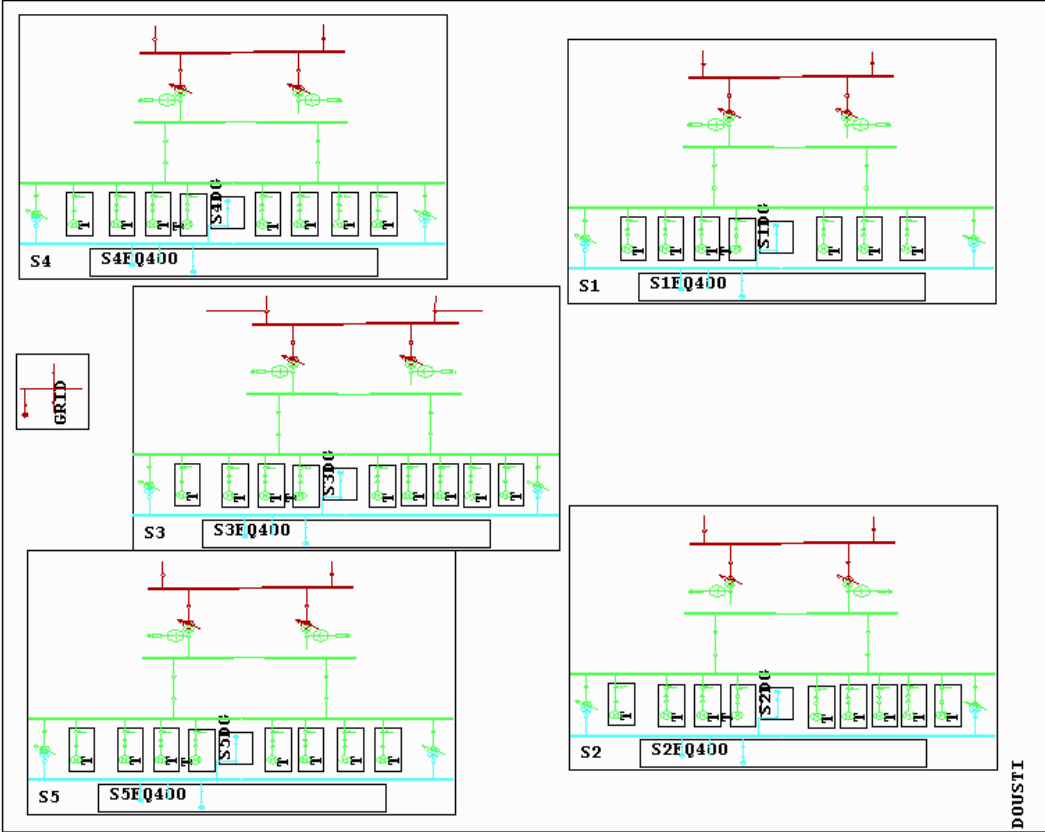


Figure 1: The overall view of the study system

NETWORK DIAGRAM DRAWING - CLICK ICON FOR TOOLS

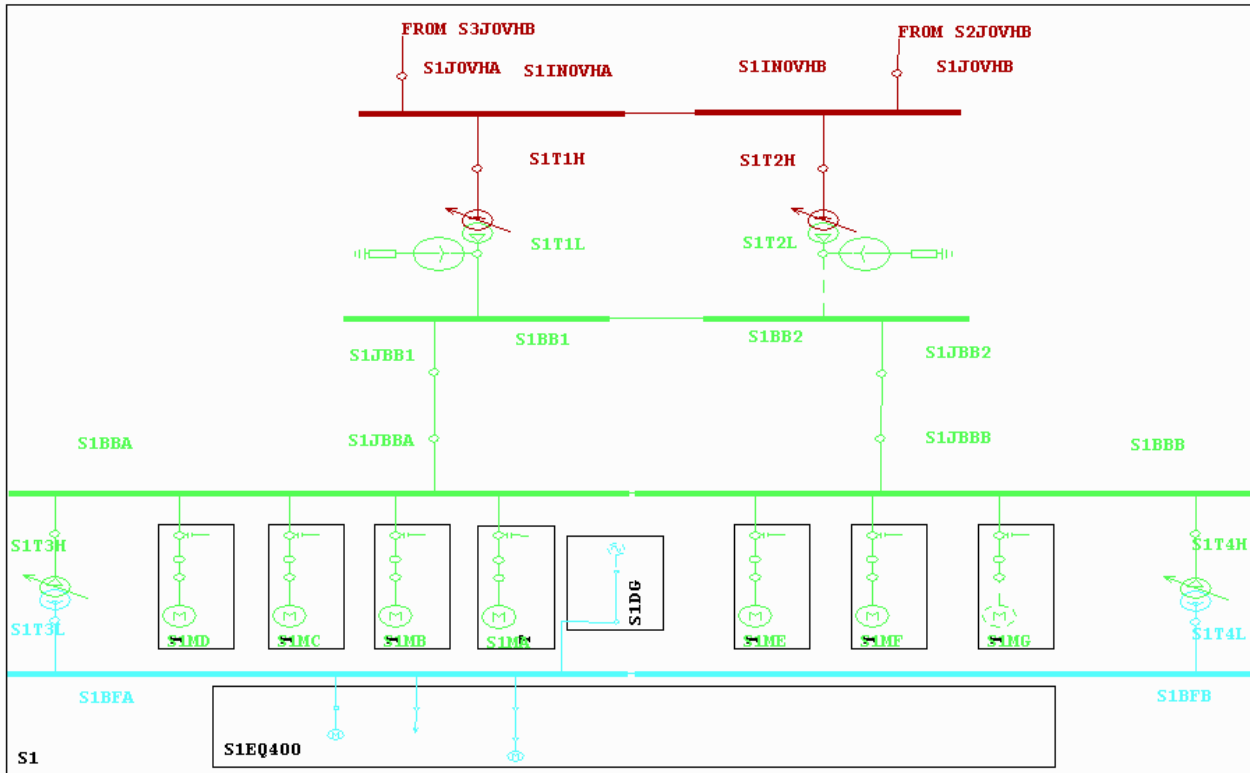


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Figure 2: Single line diagram of pumping station number 1

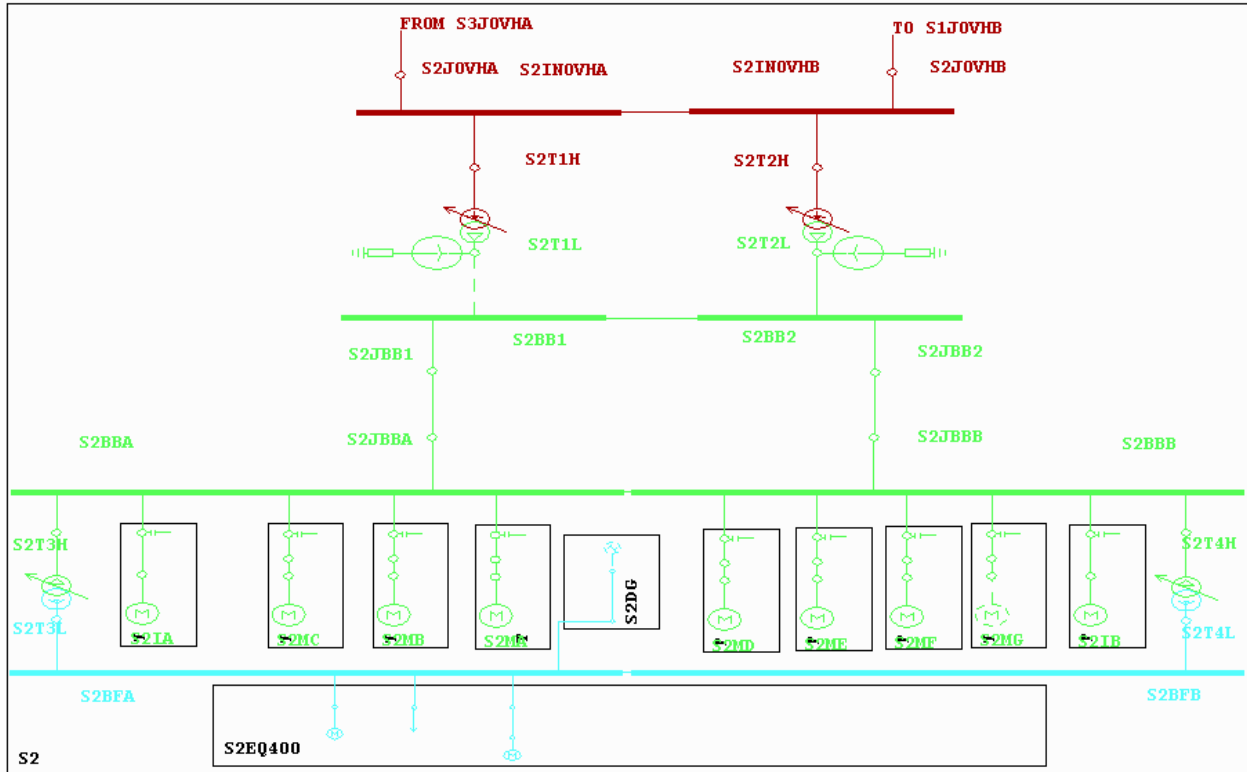
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Figure 3: Single line diagram of pumping station number 2

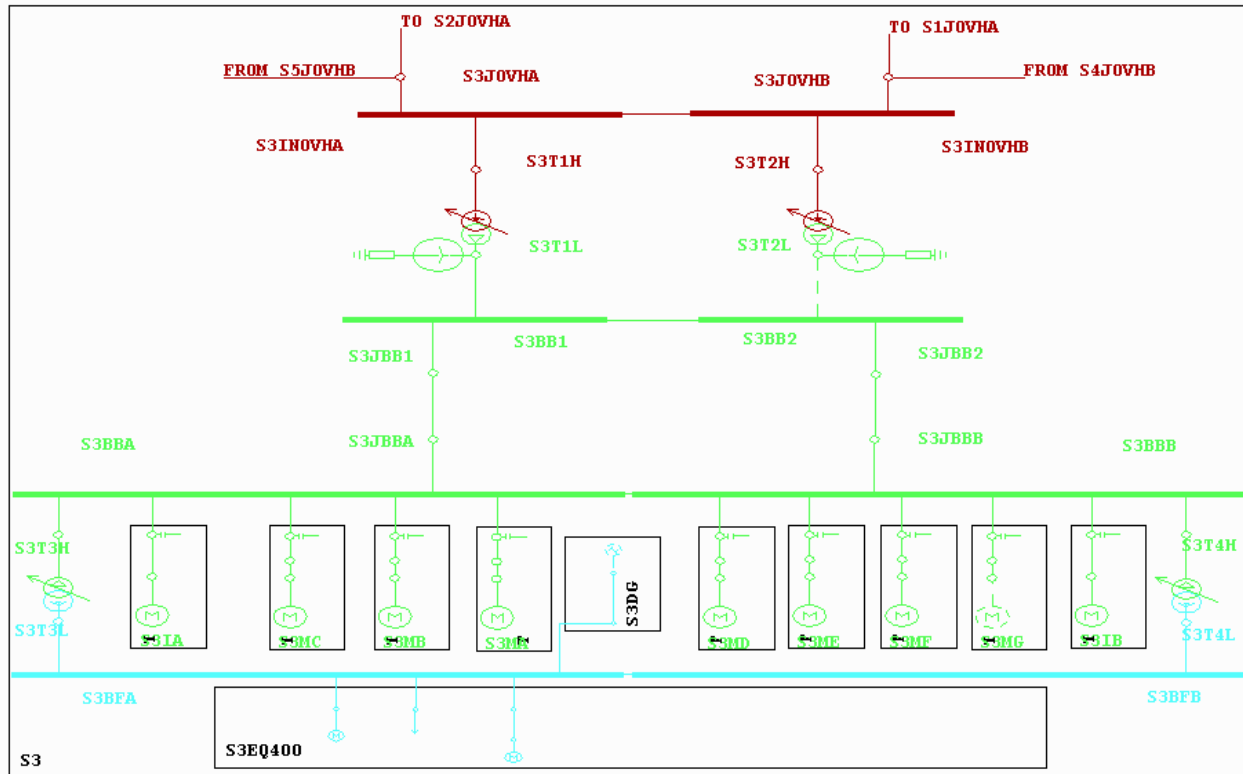
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Figure 4: Single line diagram of pumping station number 3

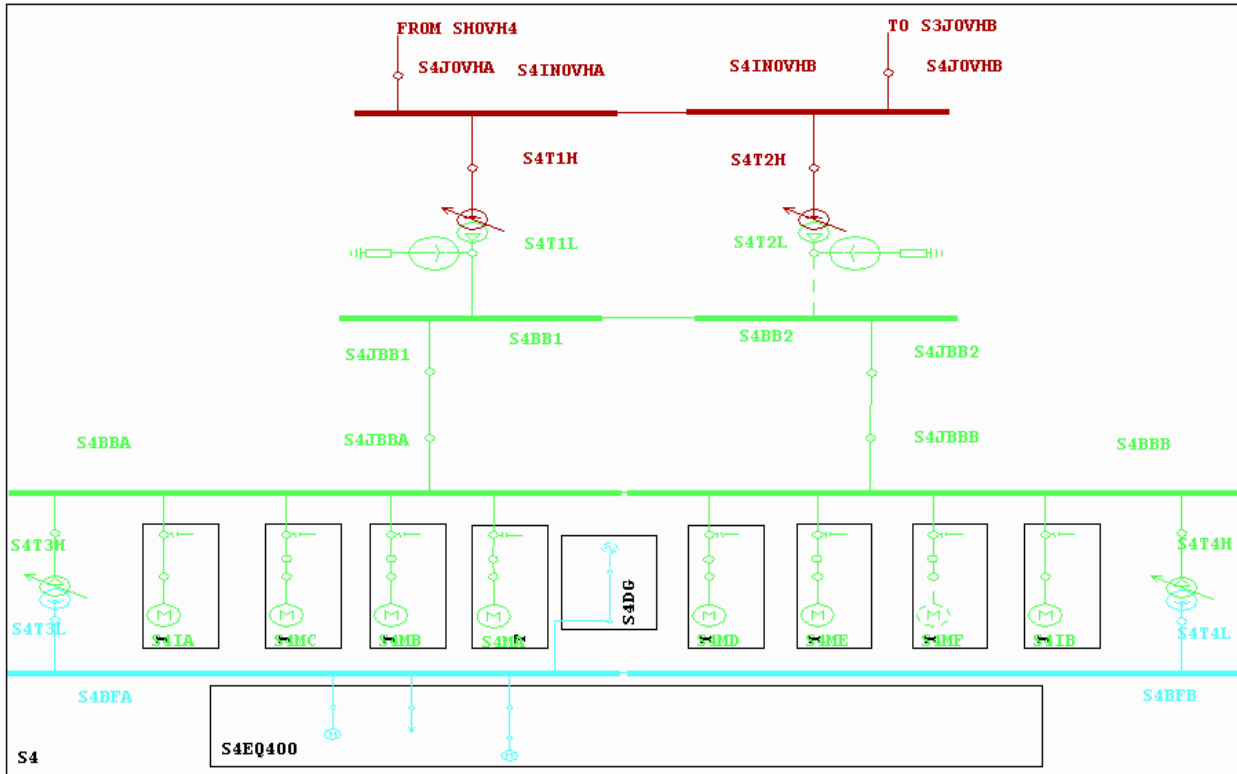
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Figure 5: Single line diagram of pumping station number 4

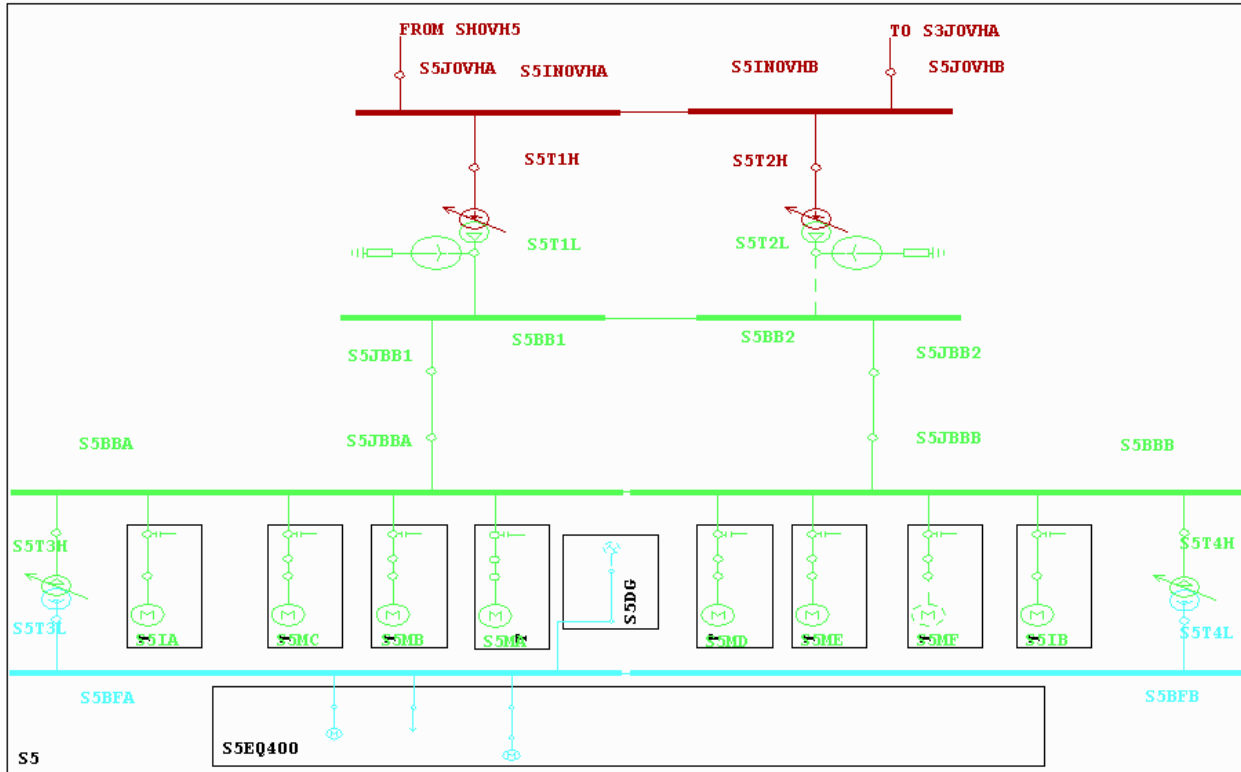
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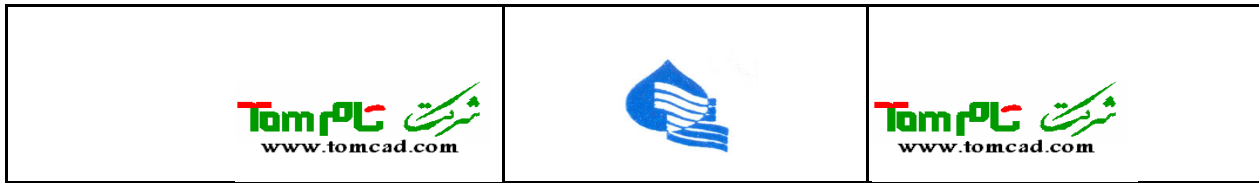
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Figure 6: Single line diagram of pumping station number 5

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### 3.3.2. Network Parameters and Data

The data are provided in two groups. One is from PASHA data bases which contains the fundamental data of equipment, usually based on the equipment ratings. The second one is according to PASHA edit pages which includes the drawn equipment data on system base. This is selected to be 10MVA.

The overall network data are not represented in this document for the sake of simplicity, but they will be provided in our next documents. In here just the 132KV network are represented as shown in figure 7 and the input data are listed in Table 1.

### 3.3.3. Operating Mode of the Electrical Network

In all the stations it is assumed that the 400V bus ties are just closed in case one of the incomings is out. Automatic bus transfer scheme is employed in 400V ties.

In all the stations it is assumed that the 6.6KV bus ties are just closed in case one of the incomings is out. Automatic bus transfer scheme is employed in 6.6KV ties.

In the present study the 132KV lines are assumed to be constructed in single circuit configuration. This is mutual among the circuits are not considered. The consideration of mutual is however important for the distance relays coordination and setting studies which is out of the scope of our reports.

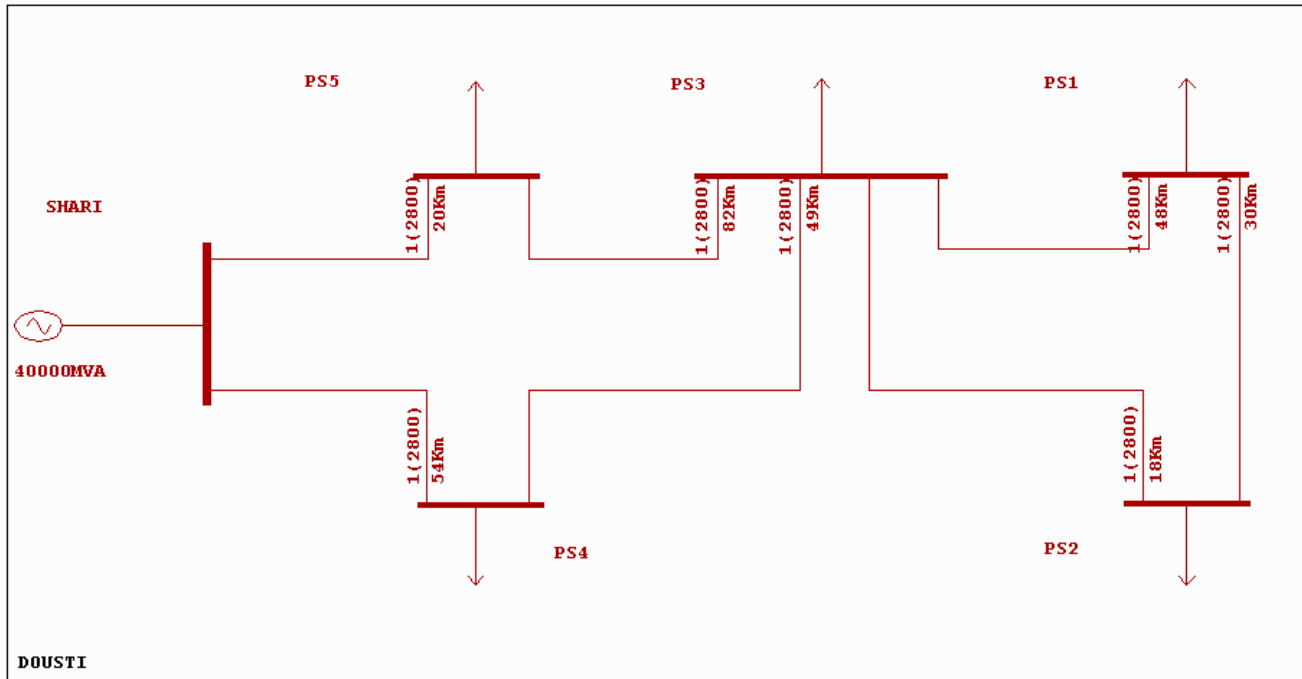
In the present normal operation, the 132KV ties are opened in station three and in station one, as drawn in Figure one. Therefore, the 132KV ring transmission lines are assumed to be operated radially in normal operation mode.

One 132KV/6.6KV 20 MVA transformer is assumed to be in use in each station.



Figure 7: Single line diagram of the network analyzed in the present document  
TAVANIR REPRESENTATION

NETWORK DIAGRAM DRAWING - H FOR HELP -X TO EXIT



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Table 1 Data base for system equipment

**CABLES AND LINES DATA BASE**

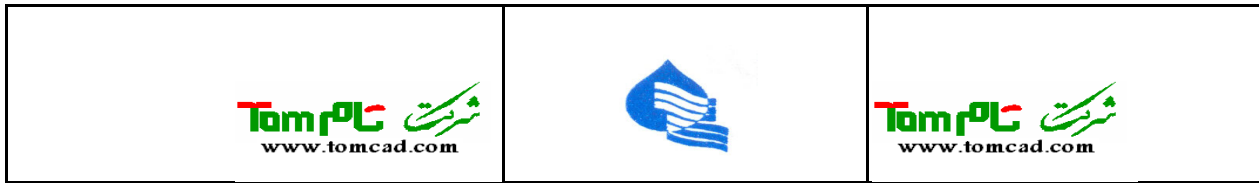
CABLE SIZE	Type MANUFACT.	PASHA LIB.	RATING MVA	RATING KV	RESISTANCE PU/KM	REACTANCE PU/KM	SUSEPTANCE PU/KM	ZERO SEQUENCE RESISTANCE- PU/KM	ZERO SEQUENCE REACTANCE- PU/KM
1(280)	gantry	32180000	150.9	132	0.00116	0.00367	0.00035	0.00392	0.01025
1(280)	lines	32280000	150.9	132	0.00116	0.00367	0.00035	0.00392	0.01025
1(500)	Alborz	6150000	8.5	6	0.01314	0.01565	0.00093	0.02767	0.02253
1(240)	Alborz	6124001	5.49	6	0.01311	0.01757	0.00091	0.02347	0.00967
1(150)	Alborz	1115000	0.47	0.6	0.14865	0.12623	0.00005	0.41621	0.07574
1(95)	Alborz	1109500	0.27	0.6	0.13123	0.14317	0.00006	0.36745	0.0859
Used for Tie connections and those not known	FICT	132	100	132		0.0001			0.0003
	FICT	6	5	6.6		0.0001			0.0003
	FICT	400	2	.4		0.0001			0.0003

Note : RATING MVA IS OBTAINED FROM CABLE CURRENT CAPACITY, RATINGS ARE THE PU BASES

**CAPACITOR BANKS DATA BASE**

CABLE SIZE	Type MANUFACT.	PASHA LIB.	RATING MVA	RATING KV	RESISTANCE PU/KM	REACTANCE PU	SUSEPTANCE PU	ZERO SEQUENCE RESISTANCE- PU	ZERO SEQUENCE REACTANCE- PU
700	CAPACITOR	700	0.7	6.6	0	-1	0	0	0
150	CAPACITOR	150	0.15	6.6	0	-1	0	0	0
850	CAPACITOR	850	0.85	6.6	0	-1	0	0	0
800	CAPACITOR	800	0.8	6.6	0	-1	0	0	0

Note : RATING MVA ARE THE PU BASES

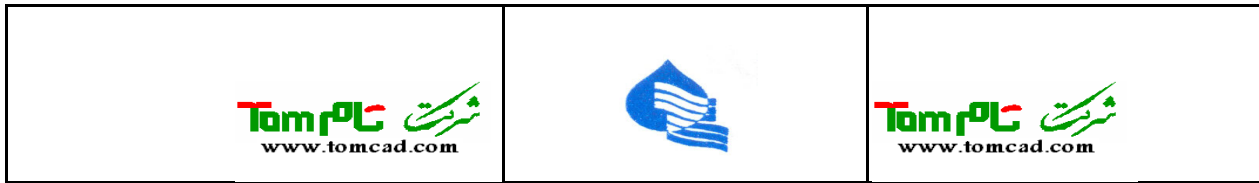


**TRANSFORMERS DATA BASE**

RATING (BASE) MVA	U1/U2 KV/KV	CONNECTION TYPE **	PASHA LIB.	RESISTANCE PU	REACTANCE PU	ZERO SEQUENCE		MIN. TAP	TAP STEP	MAX. TAP	RATIO DV	Type or MANUFACT.
						RESISTANCE PU*	REACTANCE PU					
INCOMING Transformer												
20	132/6.64	XD11	20	0.06	0.124	0.06	0.115	-15	1.67	15	-0.01	IRTR
.4	6.6/.4	DX1	400	0.0109	0.0434	0.0109	0.0434	-5	2.5	5		IRTR
Earthing Transformer												
4	6.6	zigzag	2000	0	9999	0.625*	0.014					IRTR

\*2000A grounding resistor considered,

\*\*X means Yn and from simulation point of view DY11 is equal to DY5, and DY1 is equal to DY7,



**MOTORS DATA BASE**

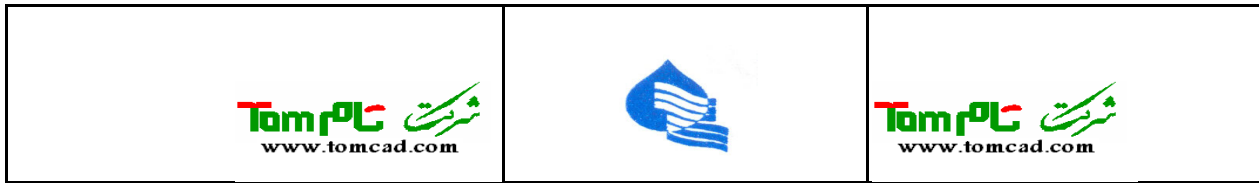
RATED	PASHA	VOLTAGE	BASE	MAGNETIZING	STATOR		ROTOR		OTHERS		
					RESIST.-PU	REACT.-PU	RESIST.-PU	REACT.-PU	Type or Manufac turer	H (Sec.) (total) (driven)	Driven TYPE*
KW	LIB.	KV	MVA	REAC T.-PU	RESIST.-PU	REACT.-PU	RESIST.-PU	REACT.-PU	Type or Manufac turer	H (Sec.) (total) (driven)	Driven TYPE*
2800	9280000	6.6	3.575	1.951	0.0204	0.0948	0.0083	0.0632	ABB	0.1989	0,0,1
2500	9250000	6.6	3.031	2.115	0.0297	0.0569	0.0069	0.038	ABB	0.1841	0,0,1
2350	9235000	6.6	3.041	1.843	0.0218	0.0862	0.0074	0.0575	ABB	0.0834	0,0,1
600	9060000	6.6	0.741	2.305	0.065	0.0749	0.0064	0.0499	ABB	1.0607	0,0,1
37.5	37	0.4	0.047	2.067	0.053	0.0801	0.0166	0.0534	ABB	0.1	1,0,0

\*Driven Type: Mechanical Torque Formula= $(A+B(1-s)+C(1-s)^2)T_{mo}$  where  $A+B+C=1$ , B and C is written and s is slip.

For centrifuisual pump  $A=0, B=0, C=1$

\*\*Starting resistor: 1 P.U. on 10 MVA on rotor base for 2800, 2500, 2350 KW motors.

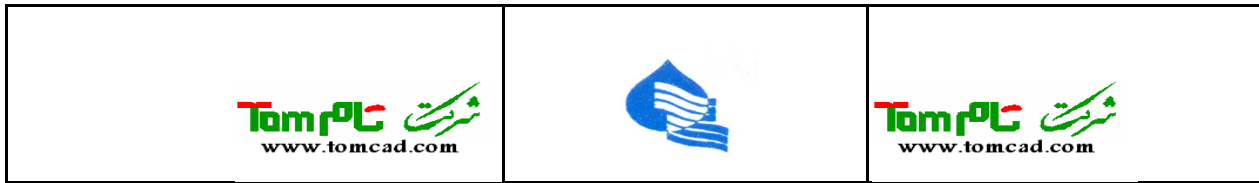
Starting time of resistor 12 sec in 8 steps assumed analogue. Refer to GINO ESE data sheet.



LUMPED LOADS DATA BASE

RATED	PASHA	VOLTAGE	BASE	MAGNETIZING	STATOR		ROTOR		OTHERS		
					RESIST.-PU	REACT-PU	RESIST.-PU	REACT.-PU	% STATIC Load	H (Sec.) (total) (driven)	Driven TYPE*
MVA	LIB.	KV	MVA	REAC T.-PU	RESIST.-PU	REACT-PU	RESIST.-PU	REACT.-PU	% STATIC Load	H (Sec.) (total) (driven)	Driven TYPE*
0.375	7times37	.4	10	62.8	1.61	2.43	0.504	1.61	20	0.00329	0,0,1

\*Driven Type: Mechanical Torque Formula= $(A+B(1-s)+C(1-s)^2)T_{mo}$  where  $A+B+C=1$ , B and C is written and s is slip.



**GENERATOR DATA BASE**

RATED POWER MVA	TYPE	RATED VOLTAGE KV	PASHA LIB.	RESISTANCE PU	REACTANCE PU	ZERO SEQUENCE		H (SEC)
						RESISTANCE- PU	REACTANCE- PU	
.25		0.46	200	0.0179	1.497	0.018	0.07	2.0
40000	GRID	132	40000	0	10	0.64	5.08	Inf

PASHA LIB.	DIRECT AXIS				QUADRATURE AXES				
	X'd	$\tau'$ d	X''d	$\tau''$ d	Xq	X'q	$\tau'$ q	X''q	$\tau''$ q
200	0.317	1.23	0.196	0.2604	0.949	0.949	0	0.217	0.0085
40000	8	10	6.4						

Table 2: List of DATA which are represented in PASHA software

## INPUT DATA

=====

O SYSTEM TITLE: TAVANIR REPRESENTATION  
 O STUDY TITLE:

SYSTEM MVA BASE = 100.000

PASHA ACTUAL DYNAMIC FAULT IS ACTIVE

### B U S B A R   D A T A   I N P U T

#### S Y N C H R O N O U S   G E N E R A T O R S

BUSBAR NAME	GENERATION		RES R	GENERATOR IMPEDANCES PU			O-C TIME CONST		AREA
	P (MW)	Q (MVAR)		SYN-X XD	DA-TR-X XD'	DA-ST-X XD''	TDO' (MSEC)	TDO'' (MSEC)	

WARNING - TDO'' OF FOLLOWING MACHINE MISSING

SHARI	68.24	19.83	0.0000	0.0250	0.0200	0.0160	10000.00	0.00	DOUSTI
-------	-------	-------	--------	--------	--------	--------	----------	------	--------

END OF SYNCHRONOUS MACHINE DATA

### S T A T I C   L O A D S

BUSBAR NAME	LOAD		INITIAL VOLTAGES			AREA
	P (MW)	Q (MVAR)	MAG (PU)	ANG (DEG)	VNOM. (KV)	
SHARI	0.00	0.00	1.0000	0.000	132.000	DOUSTI
PS4	13.20	6.39	1.0000	0.000	132.000	DOUSTI
PS5	11.60	5.62	1.0000	0.000	132.000	DOUSTI
PS3	14.50	7.02	1.0000	0.000	132.000	DOUSTI
PS1	14.50	7.02	1.0000	0.000	132.000	DOUSTI
PS2	13.20	6.39	1.0000	0.000	132.000	DOUSTI

END OF STATIC LOAD DATA

### I N D U C T I O N   M O T O R S

BUSBAR NAME	LOAD PASHA	LOAD		MOTOR IMPEDANCES PU						MAGNETISING REACT	AREA
		P (MW)	Q (MVAR)	STATOR RES	STATOR REACT	ROTOR 1 RES	ROTOR 1 REACT	ROTOR 2 RES	ROTOR 2 REACT		

END OF INDUCTION MACHINE DATA

END OF BUSBAR DATA

BRANCH DATA INPUT

---

BUSBAR		BRANCH IMPEDANCES (PU)					TRANSFORMER	AREA-TO-AREA	PASHA TYPE
FROM	TO	PPS AND NPS		ZPS		SUSC	TAP WINDING		
		R	X	R	X	B	(%)	CODE	
SHARI	PS4	0.0411	0.1301	0.1390	0.3634	0.0283		DOUSTI DOUSTI 32280000.	
SHARI	PS5	0.0154	0.0486	0.0520	0.1359	0.0106		DOUSTI DOUSTI 32280000.	
PS5	PS3	0.0632	0.1999	0.2135	0.5584	0.0434		DOUSTI DOUSTI 32280000.	
PS4	PS3	0.0374	0.1184	0.1265	0.3308	0.0257		DOUSTI DOUSTI 32280000.	
PS3	PS2	0.0139	0.0440	0.0470	0.1230	0.0096		DOUSTI DOUSTI 32280000.	
PS3	PS1	0.0367	0.1163	0.1242	0.3247	0.0252		DOUSTI DOUSTI 32280000.	
PS2	PS1	0.0228	0.0722	0.0772	0.2018	0.0157		DOUSTI DOUSTI 32280000.	

END OF BRANCH DATA



#### 4. LIMITS CONSIDERED

During the course of load flow studies the following limits and tolerances are usually considered:

- (1) Device overloads capabilities, according to manufacturer documents.
- (2) Generator MW-MVAR capability curves, according to manufacturer documents.
- (3) Maximum – Minimum tap settings for transformers.
- (4) Steady state voltage tolerance limits according to IEC standard in each voltage level.
- (5) Power frequency over voltage limits (for load rejections and single phase short circuit) according to IEC standard or manufacturer data. It is assumed that single phase fault will be cleared as rapidly as possible below 1min.

#### 5. LOAD REQUIREMENTS AND CHARACTERISTICS

The following items define the various load requirements that are considered in load flow studies:

- (1) load consideration
  - a) MONX load considered.
  - b) The peak worst condition load come from load flow of the actual plant.
  - c) The minimum load requirement of the pumping stations 0MW-0MVAR i.e., the plant is not connected to the network
- (2) Others

#### 6. LOAD FLOW CASES

The following diagram (Figure 8) shows the result of load flow study for a basic case. This is the case as considered in MONX report. Shariati voltage is assumed 1.05 P.U.

Figures 9 -14 show the other cases with some realistic consideration.

Figure 15 shows X grid load flow, showing the SHAR1 (shariate) busbar voltage in peak situation.

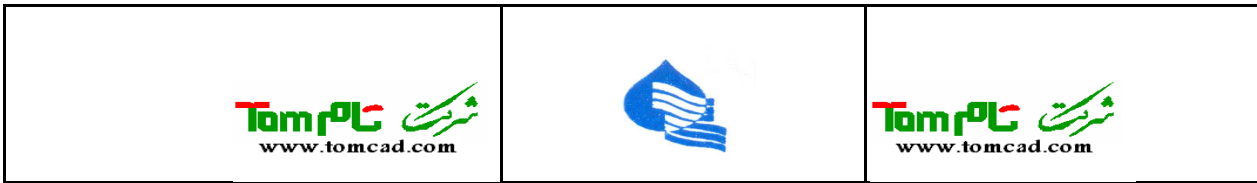
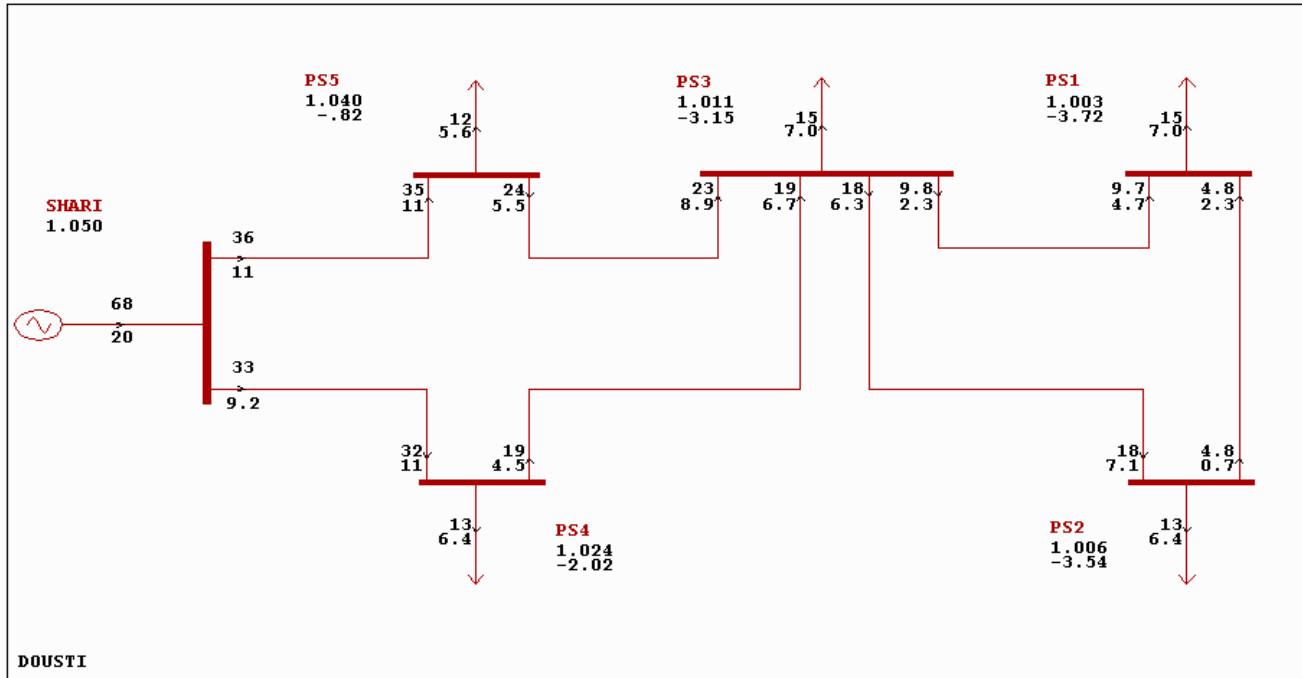


Figure 8: Load flow study of the base case MONX representation, for exact load magnitude please refer to Table 1 input data

**LOAD FLOW RESULTS - BUSBAR PU VOLTS / ANGLE & LINE MW(KW) / MVAR(KVAR) LOADING**

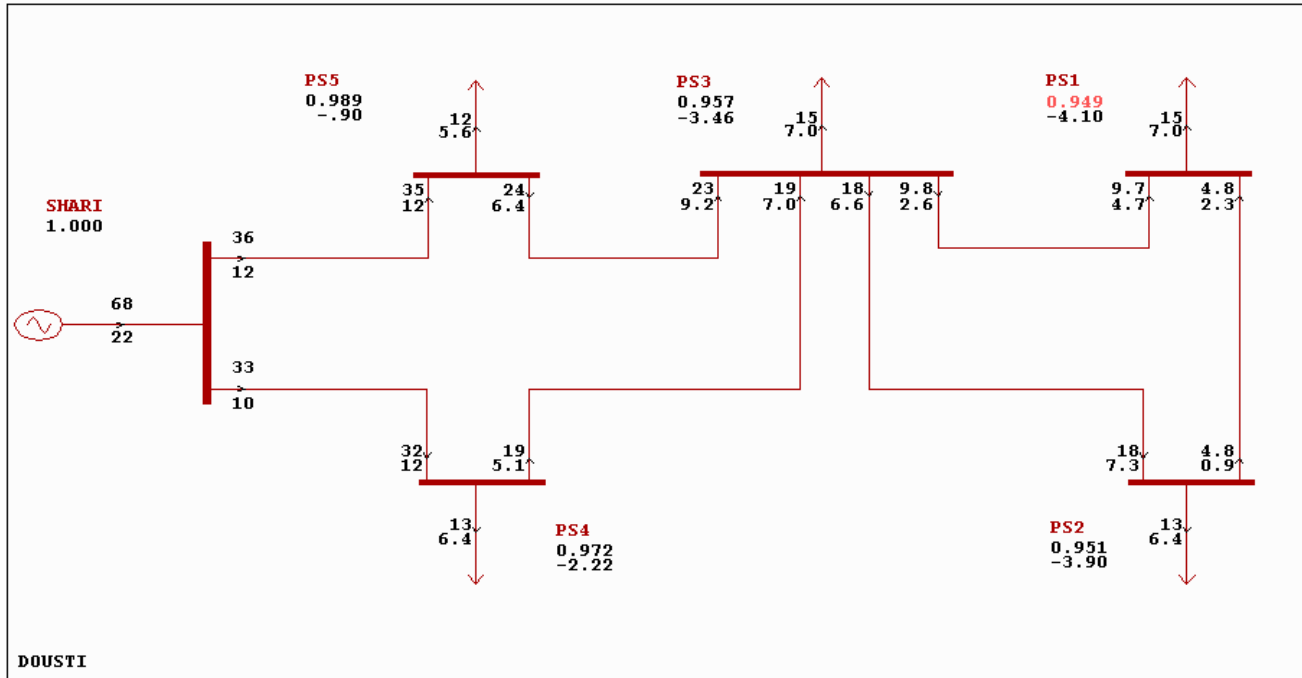


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Figure 9: Load flow study of the base case 1 P.U. voltage is considered, for exact load magnitude please refer to Table 1 input data

**LOAD FLOW RESULTS - BUSBAR PU VOLTS / ANGLE & LINE MW(KW) / MVAR(KVAR) LOADING**



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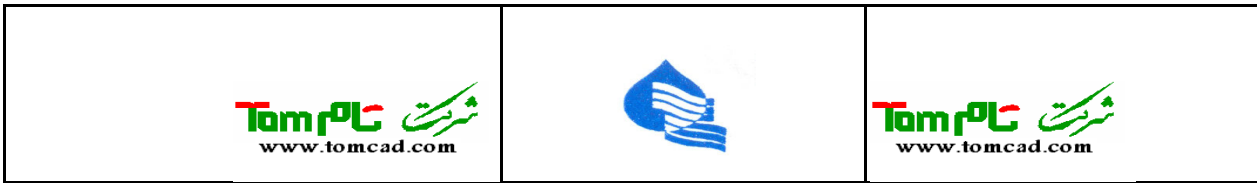
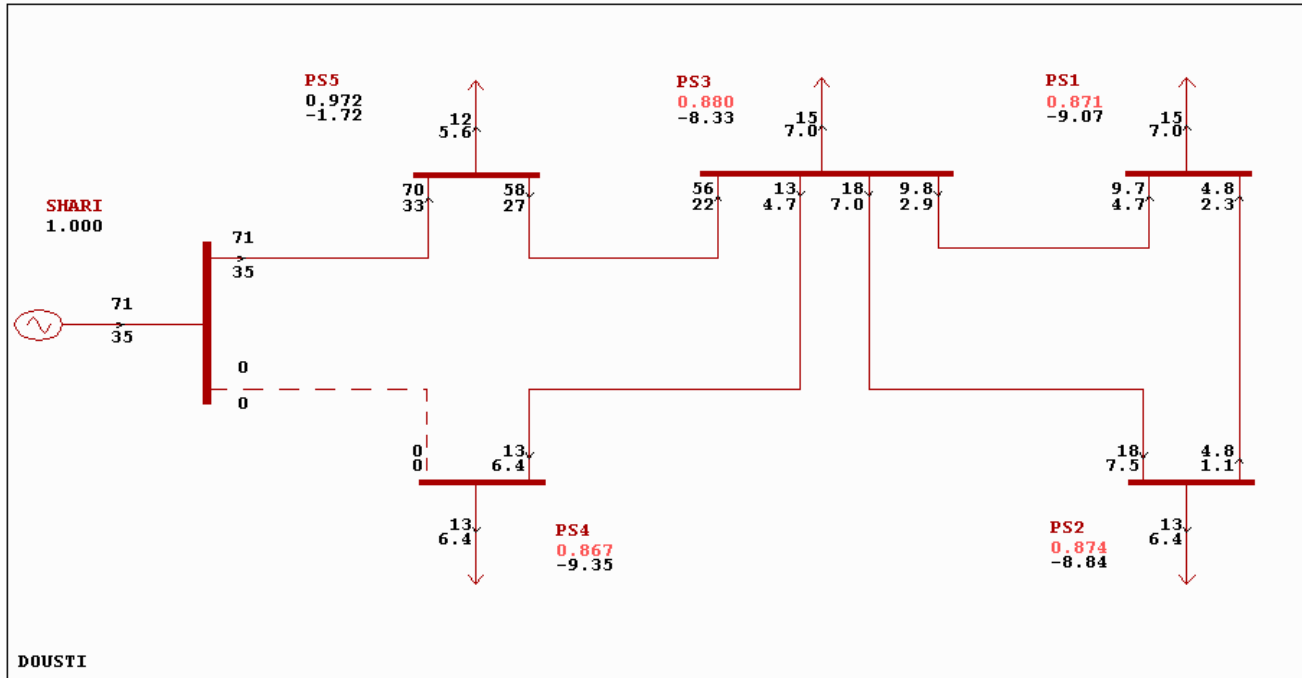


Figure 10: Load flow study of the base case 1P.U. voltage in contingency situation , for exact load magnitude please refer to Table 1 input data

**LOAD FLOW RESULTS - BUSBAR PU VOLTS / ANGLE & LINE MW(KW) / MVAR(KVAR) LOADING**

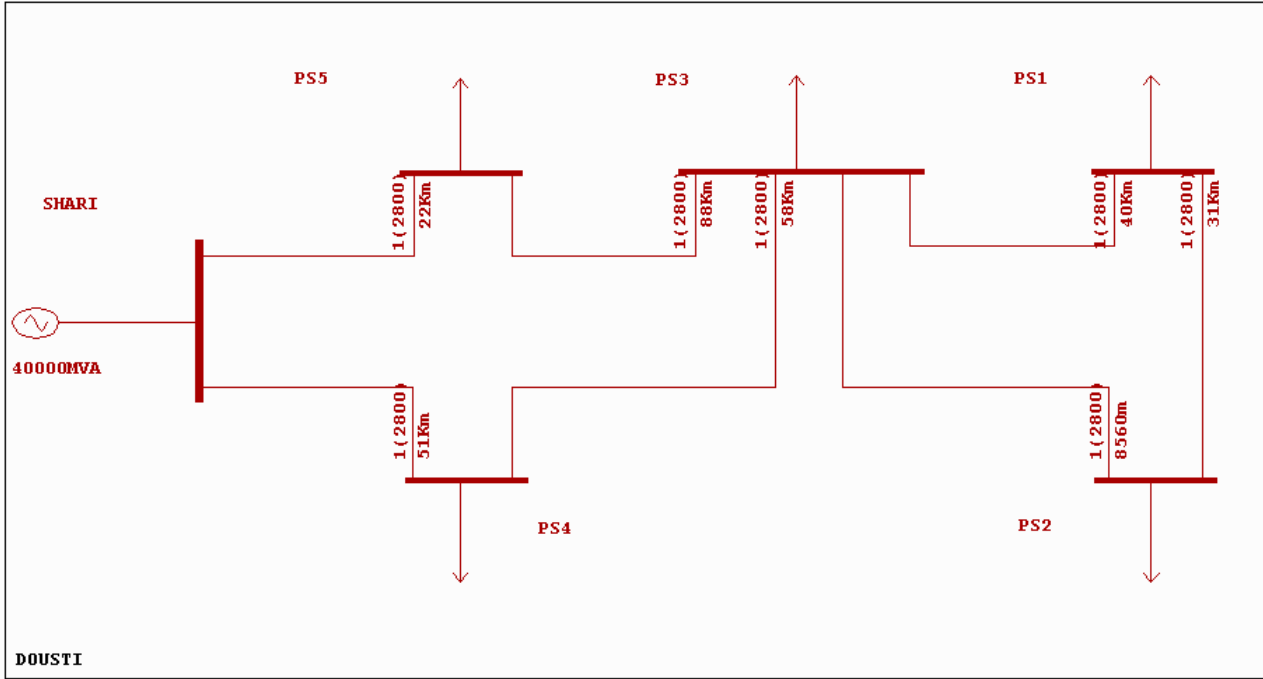


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Figure 11(a): Actual distance of substation after construction, the distance are rounded up in the figure.

NETWORK DIAGRAM DRAWING - CLICK ICON FOR TOOLS

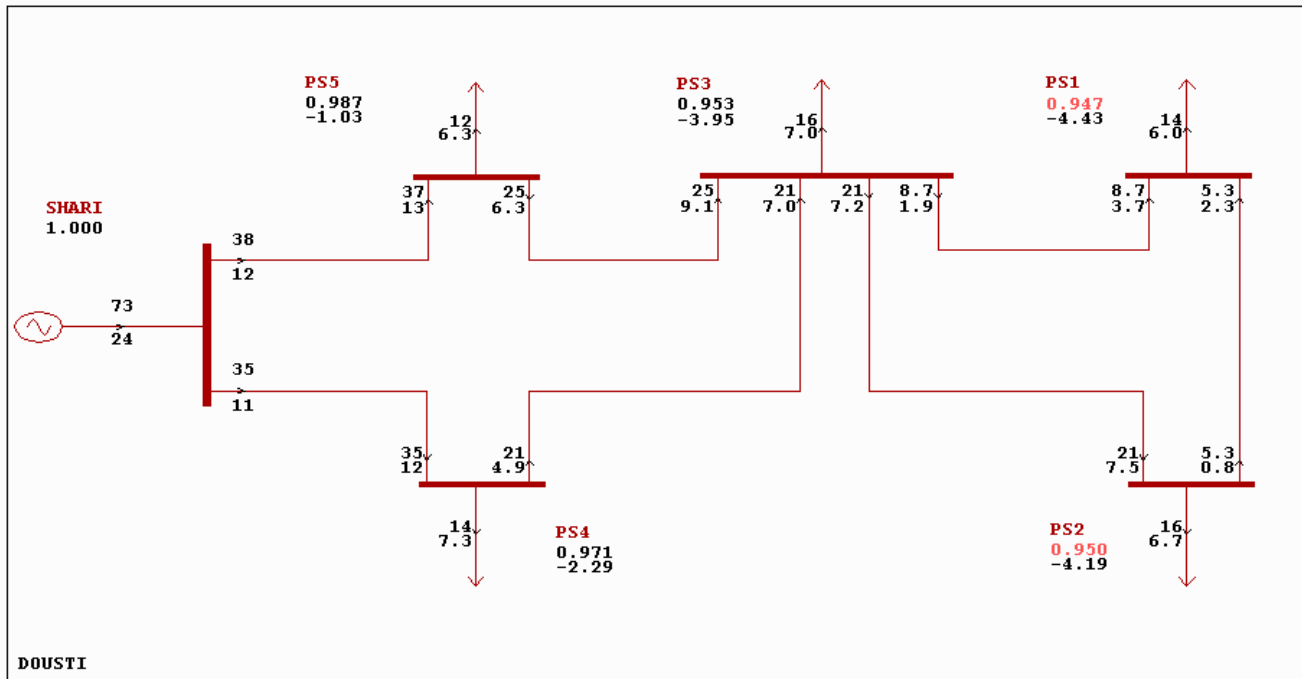


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Figure 11(b): Load flow study of the base case 1P.U. voltage for actual loads and actual distance.

LOAD FLOW RESULTS - BUSBAR PU VOLTS / ANGLE & LINE MW(KW) / MVAR(KVAR) LOADING



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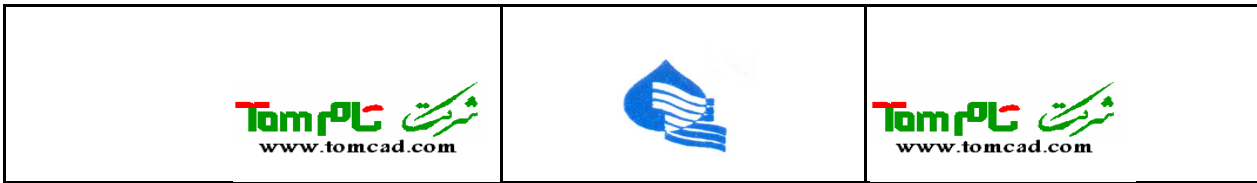
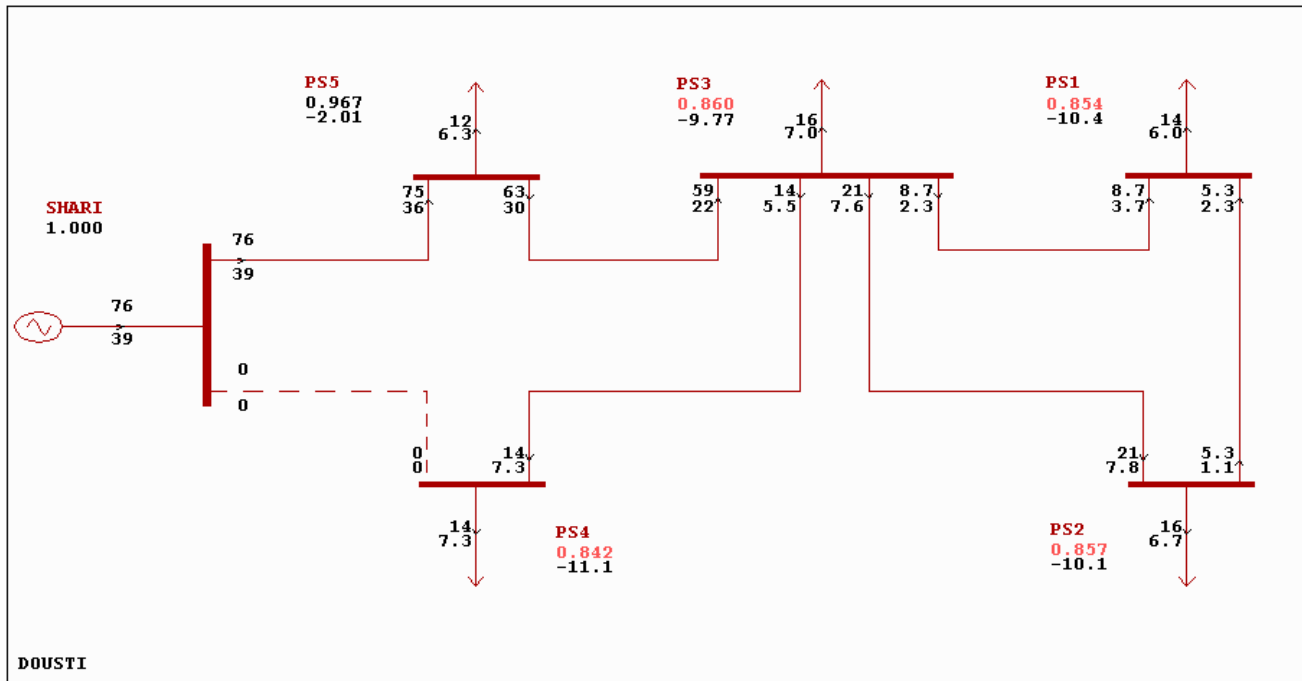


Figure 12: Load flow study of the base case 1P.U. voltage for actual loads , contingency situation.

LOAD FLOW RESULTS - BUSBAR PU VOLTS / ANGLE & LINE MW(KW) / MVAR(KVAR) LOADING



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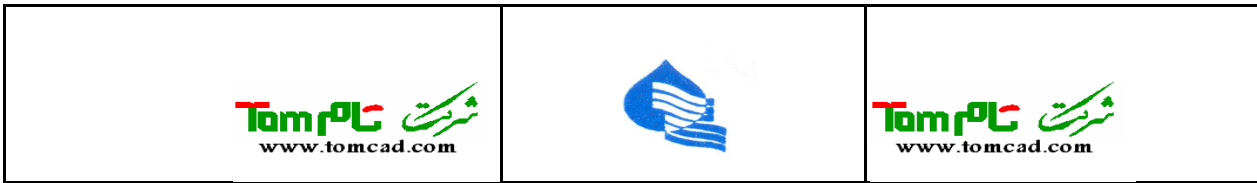
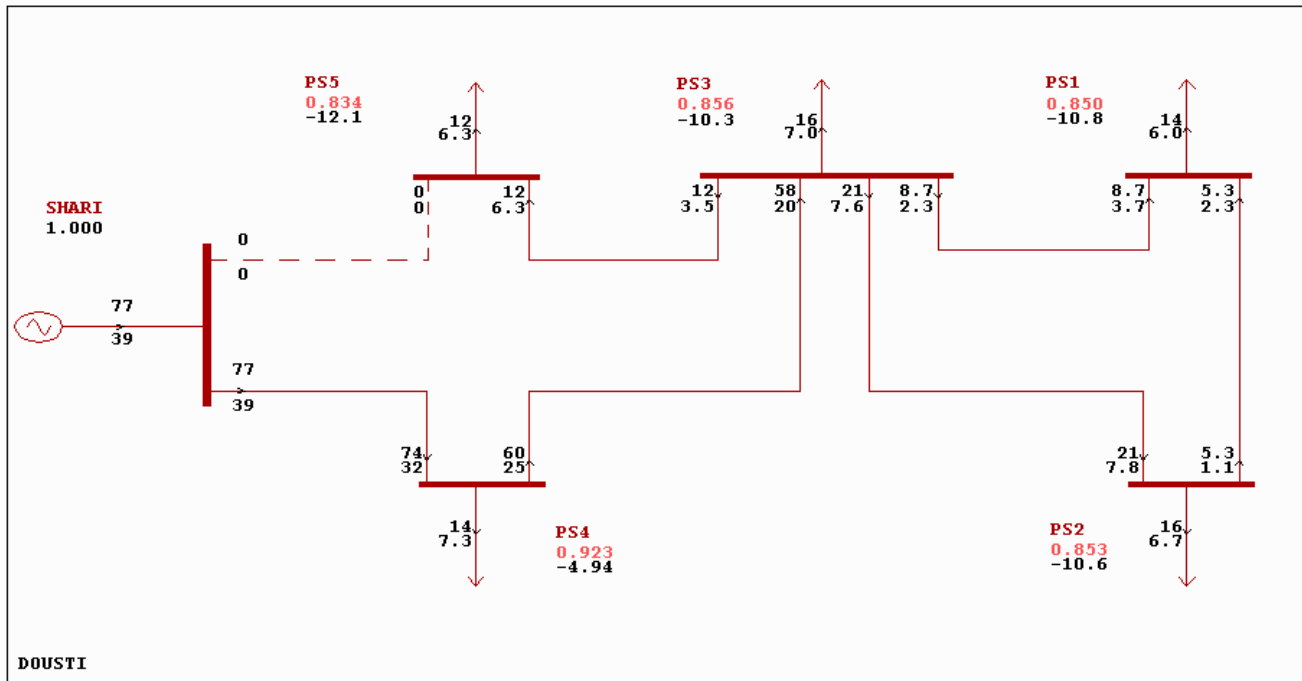


Figure 13: Load flow study of the base case 1P.U. voltage for actual loads and distance, another contingency situation.

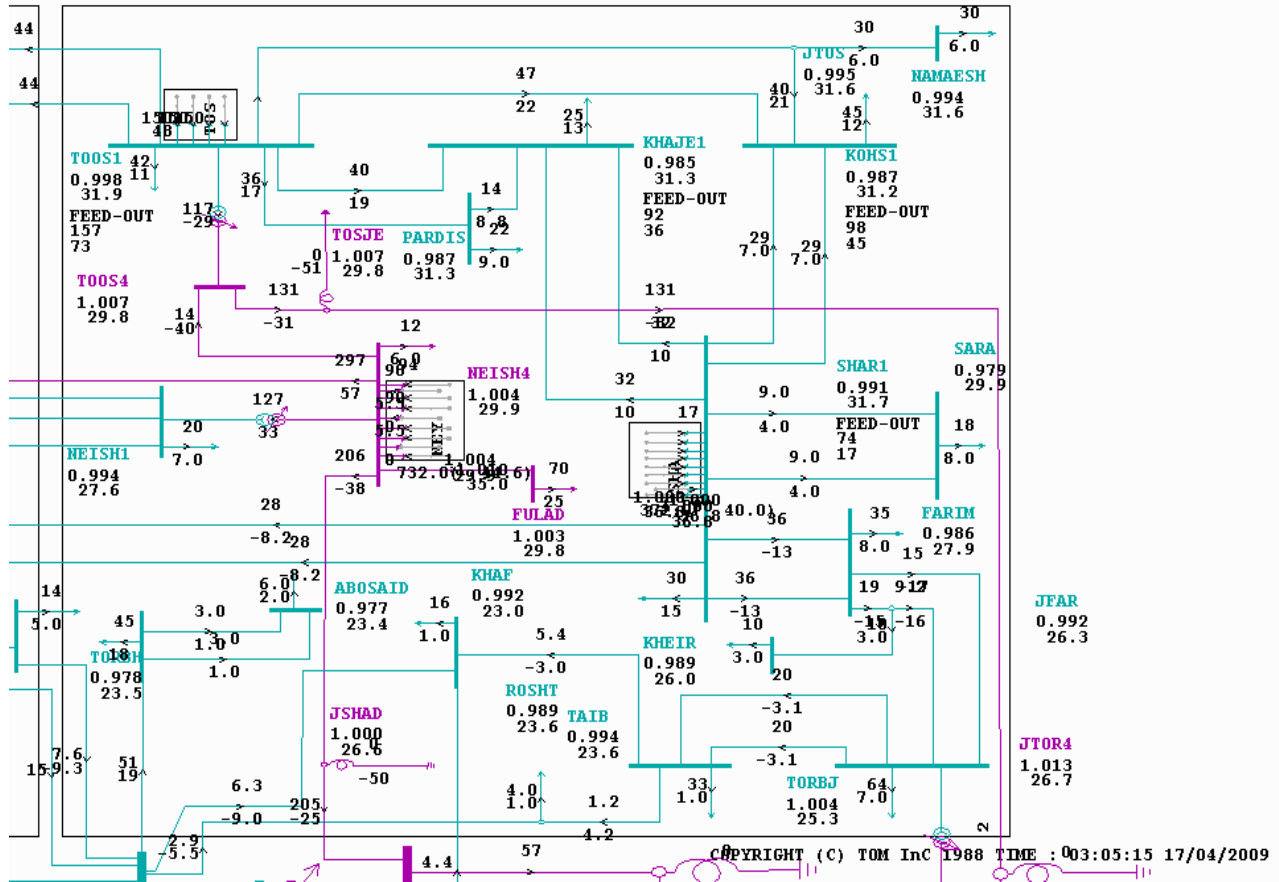
LOAD FLOW RESULTS - BUSBAR PU VOLTS / ANGLE & LINE MW(KW) / MVAR(KVAR) LOADING

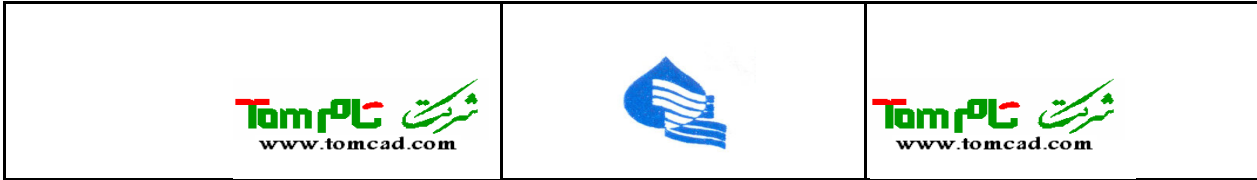


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Figure 14: Load flow study of the X grid 1387 (1385 Y) showing Shariate busbar (SHAR1) voltage in peak situation.

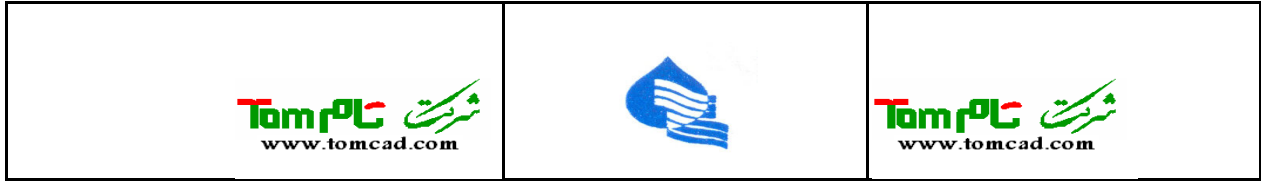
LOAD FLOW RESULTS - BUSBAR PU VOLTS / ANGLE & LINE MW(KW) / MVAR(KVAR) LOADING





## 7. CONTINGENCIES

During the course of the study (section 6 studies) the contingency situations are reported in figures 10,12, and 13.



## 8. CALCULATION RESULTS

The following results are reported

(1) Load flow result of base case

(2) Load flow result of contingency case

## 9. CONCLUSION

The system does not treat as it is considered in the planning stage by MONX. The lack of voltage is obvious in many situation considered, although the 132KV supplying network is operating in loop condition

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