ATTACHMENT

Attachment 5-1 List of Existing 66 kV Transmission Line in the Study Area as of Dec. 1998

no.	name	name	Voltage (kV)	cct	Type	Size (mm2)	Length (km)	Note
1	Nabek	Kotaifa	66	1	OH	240	34.8	
2	Kotaifa	Sydanaya	66	1	OH	240	23.8	
3	Kotaifa	Adra 2	66	1	OH	240	19.2	
4	Sydanaya	Al Faihaa	66	1	OH	240	16.0	
5	Adra 2	Izaa	66	1	OH	240	5.0	
6	Adra 2	Izaa	66	2	OH	240	5.0	
7	Adra 2	Adra Cement	66	1	OH	240	5.0	
8	Adra Cement	Qaboon 2	66	1	OH	240	35.0	
9	Adra 2	Adra 1	66	1	OH	240	2.3	
10	Adra 1	Duma	66	1	OH	240	10.5	
11	Duma	Qaboon 2	66	1	OH	240	10.6	
12	Al Faihaa	Qaboon 2	66	1	OH	240	6.0	
13	Qaboon 2	Zamalka	66	1	OH	300	4.0	
14	Zamalka	Erbeen	66	1	UC	300	2.0	
15	Qaboon 2	Al Maarad	66	1	OH	95	23.0	
16	Al Maarad	Izaa	66	1	OH	240	30.0	
17	Izaa	Al Matar	66	1	OH	240	16.9	
18	Al Matar	Mutamarat Palace	66	1	OH	240	6.8	
19	Al Maarad	Mutamarat Palace	66	1	OH	240	2.5	
20	Mutamarat Palace	Kisweh	66	1	OH	240	23.0	
21	Qaboon 2	Bab Sharki	66	1	OH	240	9.0	
22	Bab Sharki	Dawar Al Matar	66	1	UC	300	1.2	
23	Bab Sharki	Dawar Al Matar	66	2	UC	300	1.2	
24	Qaboon 2	Al Thawra	66	1	UC	300	11.2	
25	Qaboon 2	Al Thawra	66	2	UC	300	11.2	
26	Al Thawra	Ersal	66	1	UC	300	1.3	
27	Qaboon 2	Mazzrha	66	1	UC	300	4.8	
28	Qaboon 2	Mazzrha	66	2	UC	300	4.8	
29	Mazzrha	Al Thawra	66	1	UC	300	3.0	
30	Mazzrha	Amaween	66	1	UC	300	3.9	
31	Mazzrha	Amaween	66	2	UC	300	3.9	
32	Amaween	Al Jamhaa	66	1	UC	300	2.5	
33	Amaween	Al Jamhaa	66	2	UC	300	2.5	
34	Amaween	Dummar	66	1	UC	300	3.5	
35	Amaween	Dummar	66	2	UC	300	3.5	
36	Dummar	Al Hameh	66	1	OH	240	5.0	
37	Dummar	Al Hameh	66	2	OH	240	5.0	
38	Al Jamhaa	Fursan	66	1	UC	300	15.0	
39	Al Jamhaa	Fursan	66	2	UC	300	15.0	
40	Ersal	Al Jamhaa	66	1	UC	300	6.0	
41	Al Jamhaa	Kafersuseh	66	1	UC	300	2.2	
42	Midan 1	Kafersuseh	66	1	UC	300	1.2	
43	Midan 2	Kafersuseh-Switch	66	1	OH	240	5.5	
44	Kafersuseh-Switch	Kafersuseh	66	1	UC	300	0.5	
45	Dawar Al Matar	Midan 1	66	1	UC	300	3.0	
46	Dawar Al Matar	Midan 2	66	1	UC	300	15.0	
47	Al Ashmar	Midan 2	66	1	UC	300	4.0	
48	Bab Sharki	Al Hajar Al Aswad	66	1	OH	240	6.0	
49	Al Hajar Al Aswad	Midan 2	66	1	OH	240	2.8	
50	Midan 2	Fursan	66	1	OH	240	10.5	
51	Al Hameh	Qasr Al Shab	66	1	OH	240	6.5	
52	Qasr Al Shab	Midan 2	66	1	OH	240	18.0	
53	Al Hameh	Mazzhe	66	1	OH	240	11.5	
54	Mazzhe	Fursan	66	1	OH	240	8.5	
55	Al Hameh	Kudseia	66	1	OH	240	4.0	
56	Al Hameh	Dimas	66	1	OH	240	15.0	
57	Kudseia	Dimas	66	1	OH	240	16.0	
58	Dimas	Zabadani	66	1	OH	240	20.0	
59	Zabadani	Switching Station	66	1	OH	240	10.0	
60	Dimas	Switching Station	66	1	OH	240	10.0	
61	Switching Station	Anjar (Lebanon)	66	1	OH	240	20.0	
62	Switching Station	Anjar (Lebanon)	66	2	OH	240	20.0	
63	Midan 2	Kisweh	66	1	OH	240	10.0	
64	Fursan	Kisweh	66	1	OH	240	18.0	

(note: OH: overhead line, UC: underground cable)

Attachment 5-2 List of 20 kV Feeder in the Study Area

Substation			Bank		Feeder			Remarks
Gov.	No.	Name	No.	Cap. (MVA)	Gov.	No.	Name	
City	101	Mazzrha	#1	20	City	101	Jameh	
City	101	Mazzrha	#1	20	City	102	Salhie 1	
City	101	Mazzrha	#1	20	City	103	Salhie 2	
City	101	Mazzrha	#1	20	City	104	Madrase	
City	101	Mazzrha	#1	20	City	105	Epn Nafis	
City	101	Mazzrha	#1	20	City	106	Safara	
City	101	Mazzrha	#2	20	City	201	Kikie	
City	101	Mazzrha	#2	20	City	202	Maysat	
City	101	Mazzrha	#2	20	City	203	Charkl	
City	101	Mazzrha	#2	20	City	204	Malaap	
City	101	Mazzrha	#2	20	City	205	Hayat	
City	101	Mazzrha	#2	20	City	206	Riadien	
City	101	Mazzrha	#3	20	City	301	Maspah	
City	101	Mazzrha	#3	20	City	302	Nasr	
City	101	Mazzrha	#3	20	City	303	Fayhaa	
City	101	Mazzrha	#3	20	City	304	Mouspk 1	
City	101	Mazzrha	#3	20	City	305	Mouspk 2	
City	101	Mazzrha	#3	20	City	306	Haffar	
City	101	Mazzrha	#3	20	City	307	Chamdin	
City	101	Mazzrha	#3	20	City	308	Serafi	
City	101	Mazzrha	#3	20	City	309	Hamofaila	
City	102	Amaween	#1	20	City	101	Malki	
City	102	Amaween	#1	20	City	102	Nadi	
City	102	Amaween	#1	20	City	103	Abdo	
City	102	Amaween	#1	20	City	104	Yousof	
City	102	Amaween	#1	20	City	105	Meridian	
City	102	Amaween	#1	20	City	106	Rawda	
City	102	Amaween	#1	20	City	107	Bazm	
City	102	Amaween	#2	20	City	201	Jamaa	
City	102	Amaween	#2	20	City	202	Wadi	
City	102	Amaween	#2	20	City	203	Jamarek	
City	102	Amaween	#2	20	City	204	Tahwilie	
City	102	Amaween	#2	20	City	205	Hachmi	
City	102	Amaween	#2	20	City	206	Al Dah	
City	102	Amaween	#3	20	City	301	Samah	
City	102	Amaween	#3	20	City	302	Cheraton	
City	102	Amaween	#3	20	City	303	Mouwasat	
City	102	Amaween	#3	20	City	304	Atfal	
City	102	Amaween	#3	20	City	305	Chami	
City	102	Amaween	#3	20	City	306	Maktabeh	
City	102	Amaween	#3	20	City	307	Hawakir	
City	102	Amaween	#3	20	City	308	Hadika	
City	102	Amaween	#3	20	City	309	K. Tichrin	
City	103	Mazzhe	#1	20	Rural	101	Al Ashbal	
City	103	Mazzhe	#1	20	City	102	Fath	
City	103	Mazzhe	#1	20	City	103	Rafei	
City	103	Mazzhe	#1	20	City	104	Al Tob	
City	103	Mazzhe	#1	20	City	105	Sahli	
City	103	Mazzhe	#1	20	City	106	Mazze 86	
City	103	Mazzhe	#2	20	City	201	Bahth 1	
City	103	Mazzhe	#2	20	City	202	Bahth 2	
City	103	Mazzhe	#2	20	City	203	Aotostrad	
City	103	Mazzhe	#2	20	City	204	Jameiya	
City	103	Mazzhe	#2	20	City	205	Hatef	
City	103	Mazzhe	#3	20	City	301	Horch	
City	103	Mazzhe	#3	20	City	302	Madaka	
City	103	Mazzhe	#3	20	City	303	Jabal	
City	103	Mazzhe	#3	20	City	304	Kasr	
City	103	Mazzhe	#3	20	City	305	Azhar	
City	103	Mazzhe	#3	20	City	306	Chafei	
City	103	Mazzhe	#3	20	City	307	Saraya	
City	103	Mazzhe	#3	20	City	308	Somarira	
City	103	Mazzhe	#3	20	City	309	Forsan	
City	103	Mazzhe	#3	20	City	310	Mazze 15	
City	104	Midan 1	#1	20	City	101	Moujtahede	
City	104	Midan 1	#1	20	City	102	Chakour	
City	104	Midan 1	#1	20	City	103	Komech	
City	104	Midan 1	#1	20	City	104	Nahr Echa	
City	104	Midan 1	#1	20	City	105	Kafr Sousa	
City	104	Midan 1	#1	20	City	106	Baramke	
City	104	Midan 1	#2	20	City	201	Bouktiar	
City	104	Midan 1	#2	20	City	202	Soheb	

Attachment 5-2 List of 20 kV Feeder in the Study Area

Substation			Bank		Feeder			Remarks
Gov.	No.	Name	No.	Cap. (MVA)	Gov.	No.	Name	
City	104	Midan 1	#2	20	City	203	Mansour	
City	104	Midan 1	#2	20	City	204	Midan	
City	104	Midan 1	#2	20	City	205	Boustan	
City	104	Midan 1	#2	20	City	206	Hamadani	
City	104	Midan 1	#2	20	City	207	Srija	
City	104	Midan 1	#3	20	City	301	Atika	
City	104	Midan 1	#3	20	City	302	Al Tob	
City	104	Midan 1	#3	20	City	303	Walid	
City	104	Midan 1	#3	20	City	304	Fnoon	
City	104	Midan 1	#3	20	City	305	Halawi	
City	104	Midan 1	#3	20	City	306	Kaysari	
City	104	Midan 1	#3	20	City	307	Ersal A	
City	104	Midan 1	#3	20	City	308	Ersal B	
City	105	Midan 2	#1	20	Rural	101	Rasheed	
City	105	Midan 2	#1	20	Rural	102	Matahen 1	
City	105	Midan 2	#1	20	Rural	103	Daraya	
City	105	Midan 2	#1	20	Rural	104	Sbaina	
City	105	Midan 2	#1	20	Rural	105	Mokaylbia	
City	105	Midan 2	#1	20	Rural	106	Sawameh	
City	105	Midan 2	#1	20	Rural	107	Al Awaa	
City	105	Midan 2	#1	20	Rural	108	Sahnaia	
City	105	Midan 2	#1	20	Rural	109	Zogag 2	
City	105	Midan 2	#1	20	Rural	110	Debs 1	
City	105	Midan 2	#1	20	Rural	111	Al Sogaad	
City	105	Midan 2	#1	20	Rural	112	Cabel 2	
City	105	Midan 2	#2	30	Rural	201	Barada	
City	105	Midan 2	#2	30	Rural	202	Dair Ali	
City	105	Midan 2	#2	30	Rural	203	Khyata	
City	105	Midan 2	#2	30	Rural	204	Debs 2	
City	105	Midan 2	#2	30	Rural	205	Semex	
City	105	Midan 2	#2	30	Rural	206	Al Bourak	
City	105	Midan 2	#2	30	Rural	207	Zogag 1	
City	105	Midan 2	#2	30	Rural	208	Keswa	
City	105	Midan 2	#2	30	Rural	209	Bweda	
City	105	Midan 2	#2	30	Rural	210	Cablat 1	
City	105	Midan 2	#2	30	Rural	211	Seka	
City	105	Midan 2	#2	30	Rural	212	Matahen 2	
City	105	Midan 2	#3	30	City	301	Maaden	
City	105	Midan 2	#3	30	City	302	Achmar	
City	105	Midan 2	#3	30	City	303	Kaah	
City	105	Midan 2	#3	30	City	304	Hajar	
City	105	Midan 2	#3	30	City	305	Esali	
City	105	Midan 2	#3	30	City	306	Kadam	
City	105	Midan 2	#3	30	City	307	Bawabeh	
City	105	Midan 2	#3	30	City	308	Dahadille	
City	105	Midan 2	#3	30	City	309	Janoubi	
City	106	Al Ashmar	#1	20	City	101	Palastin	
City	106	Al Ashmar	#1	20	City	102	Klaydya	
City	106	Al Ashmar	#1	20	City	103	Tanzimiya	
City	106	Al Ashmar	#1	20	City	104	Esthlakiya	
City	106	Al Ashmar	#1	20	City	105	Zahira	
City	106	Al Ashmar	#1	20	City	106	Siada	
City	106	Al Ashmar	#1	20	City	107	Zftie	
City	106	Al Ashmar	#1	20	City	108	Dakak	
City	106	Al Ashmar	#1	20	City	109	Deryasin	
City	106	Al Ashmar	#2	20	City	201	Badileh	
City	106	Al Ashmar	#2	20	City	202	Sakp	
City	106	Al Ashmar	#2	20	City	203	Pattariat	
City	106	Al Ashmar	#2	20	City	204	Thoraya	
City	106	Al Ashmar	#2	20	City	205	Hozam	
City	106	Al Ashmar	#2	20	City	206	Yarmouk	
City	106	Al Ashmar	#2	20	City	207	Tadamon	
City	106	Al Ashmar	#2	20	City	208	Kwakbi	
City	107	Ersal	#1	20	City	101	Kolmeh	
City	107	Ersal	#1	20	City	102	Majles	
City	107	Ersal	#1	20	City	103	Baki	
City	107	Ersal	#1	20	City	104	Awkaf	
City	107	Ersal	#1	20	City	105	Asima	
City	107	Ersal	#1	20	City	106	Bondok	
City	107	Ersal	#1	20	City	107	Cham	
City	107	Ersal	#1	20	City	108	Dawli	
City	107	Ersal	#1	20	City	109	Yalboka	

Attachment 5-2 List of 20 kV Feeder in the Study Area

Substation			Bank		Feeder			Remarks
Gov.	No.	Name	No.	Cap. (MVA)	Gov.	No.	Name	
City	107	Ersal	#1	20	City	110	Siyaha	
City	107	Ersal	#1	20	City	111	Barid	
City	107	Ersal	#1	20	City	112	Mojamah	
City	107	Ersal	#1	20	City	113	Marad	
City	107	Ersal	#2	20	City	201	Miyah	
City	107	Ersal	#2	20	City	202	Horieh	
City	107	Ersal	#2	20	City	203	Modarjat	
City	107	Ersal	#2	20	City	204	Jabha	
City	107	Ersal	#2	20	City	205	Assasa	
City	107	Ersal	#2	20	City	206	Daman	
City	107	Ersal	#2	20	City	207	Noura	
City	107	Ersal	#2	20	City	208	Sepki	
City	107	Ersal	#2	20	City	209	Halboni	
City	107	Ersal	#2	20	City	210	Saha	
City	107	Ersal	#2	20	City	211	Habachi	
City	107	Ersal	#2	20	City	212	Hoja	
City	107	Ersal	#2	20	City	213	Rakim	
City	107	Ersal	#2	20	City	214	Samir	
City	107	Ersal	#2	20	City	215	Mouassas	
City	108	Bab Sharki	#1	20	Rural	101	Nokoosh	
City	108	Bab Sharki	#1	20	City	102	Kamsee	
City	108	Bab Sharki	#1	20	City	103	Mahao	
City	108	Bab Sharki	#1	20	City	104	Kebrit	
City	108	Bab Sharki	#1	20	City	105	Handasa	
City	108	Bab Sharki	#1	20	City	106	Boulos	
City	108	Bab Sharki	#1	20	City	107	Jallad	
City	108	Bab Sharki	#2	20	Rural	201	Younesiah	
City	108	Bab Sharki	#2	20	Rural	202	Hadeethah	
City	108	Bab Sharki	#2	20	Rural	203	Konserwah	
City	108	Bab Sharki	#2	20	City	204	Der	
City	108	Bab Sharki	#2	20	City	205	Dwelaa	
City	108	Bab Sharki	#3	20	Rural	301	Hashas	
City	108	Bab Sharki	#3	20	City	302	Bab Touma	
City	108	Bab Sharki	#3	20	City	303	Chark	
City	108	Bab Sharki	#3	20	City	304	Karamah	70% Rural
City	108	Bab Sharki	#3	20	City	305	Attaf	
City	108	Bab Sharki	#3	20	City	306	Nazihin	
City	108	Bab Sharki	#3	20	City	307	Zeuot	
City	108	Bab Sharki	#3	20	City	308	Maslar	
City	108	Bab Sharki	#3	20	City	309	Kabas	
City	109	Qasr Al Shab	#1	20	City	101	C1	
City	109	Qasr Al Shab	#1	20	City	102	C2	
City	109	Qasr Al Shab	#1	20	City	103	C3	
City	109	Qasr Al Shab	#1	20	City	104	C4	
City	109	Qasr Al Shab	#1	20	City	105	C5	
City	109	Qasr Al Shab	#1	20	City	106	C6	
City	109	Qasr Al Shab	#1	20	City	107	C7	
City	109	Qasr Al Shab	#1	20	City	108	C8	
City	109	Qasr Al Shab	#1	20	City	109	C9	
City	109	Qasr Al Shab	#1	20	City	110	C10	
City	109	Qasr Al Shab	#1	20	City	111	C11	
City	109	Qasr Al Shab	#1	20	City	112	C12	
City	109	Qasr Al Shab	#1	20	City	113	C13	
City	109	Qasr Al Shab	#1	20	City	114	C14	
City	109	Qasr Al Shab	#1	20	City	115	C15	
City	109	Qasr Al Shab	#1	20	City	116	C16	
City	109	Qasr Al Shab	#1	20	City	117	C17	
City	109	Qasr Al Shab	#1	20	City	118	C18	
City	110	Qaboon 1	-	-	City	001	Ersal 1	Line
City	110	Qaboon 1	-	-	City	002	Ersal 2	Line
City	110	Qaboon 1	#2	40	Rural	201	Dabagat	
City	110	Qaboon 1	#2	40	City	202	Mihani	
City	110	Qaboon 1	#2	40	City	203	Jobar	
City	110	Qaboon 1	#2	40	City	204	Barlaman	
City	110	Qaboon 1	#2	40	City	205	Mehdi	
City	110	Qaboon 1	#2	40	City	206	Machatel	
City	110	Qaboon 1	#2	40	City	207	Sironics	
City	110	Qaboon 1	#2	40	City	208	Acadimieh	
City	110	Qaboon 1	#2	40	City	209	Nahlawi	
City	110	Qaboon 1	#2	40	City	210	Moalimin	
City	110	Qaboon 1	#2	40	City	211	Emadieh	
City	110	Qaboon 1	#2	40	Rural	212	Hazza	

Attachment 5-2 List of 20 kV Feeder in the Study Area

Substation			Bank		Feeder			Remarks
Gov.	No.	Name	No.	Cap. (MVA)	Gov.	No.	Name	
City	110	Qaboon 1	#2	40	City	213	Kousour	
City	110	Qaboon 1	#2	40	City	214	Hindi	
City	110	Qaboon 1	#2	40	City	215	Koumasia	One customer
City	110	Qaboon 1	#2	40	City	216	Macazel 1	One customer
City	110	Qaboon 1	#2	40	City	217	Mokbar	One customer
City	110	Qaboon 1	#2	40	City	218	Zablatani	
City	110	Qaboon 1	#2	40	City	219	Abasien	
City	110	Qaboon 1	#2	40	City	220	Kwadri	
City	110	Qaboon 1	#2	40	City	221	Adawi	
City	110	Qaboon 1	#2	40	City	222	Tropikana	
City	110	Qaboon 1	#2	40	City	223	Barzeh	
City	110	Qaboon 1	#2	40	City	224	Techrin 3	One customer
City	110	Qaboon 1	#3	40	Rural	301	Reef	
City	110	Qaboon 1	#3	40	City	302	Macazel 2	One customer
City	110	Qaboon 1	#3	40	City	303	Tijara	
City	110	Qaboon 1	#3	40	City	304	Jandali	
City	110	Qaboon 1	#3	40	City	305	Maamel	
City	110	Qaboon 1	#3	40	City	306	Manara	
City	110	Qaboon 1	#3	40	City	307	Kourieh	
City	110	Qaboon 1	#3	40	City	308	Ferdoos	
City	110	Qaboon 1	#3	40	City	309	Kassaa	
City	110	Qaboon 1	#3	40	City	310	Bayrouni	
City	110	Qaboon 1	#3	40	City	311	Saha	
City	110	Qaboon 1	#3	40	City	312	Kouzbari	
City	110	Qaboon 1	#3	40	City	313	Tahrir	
City	110	Qaboon 1	#3	40	City	314	Faris	
City	111	Qaboon 2	#1	30	City	101	Jaber	
City	111	Qaboon 2	#1	30	City	102	Tansik	
City	111	Qaboon 2	#1	30	City	103	Talim	
City	111	Qaboon 2	#1	30	City	104	Komasie	
City	111	Qaboon 2	#1	30	City	105	Warwar	
City	111	Qaboon 2	#1	30	City	106	Tchrin 1	
City	111	Qaboon 2	#1	30	City	107	Tchrin 2	
City	111	Qaboon 2	#1	30	City	108	Kasem	
City	111	Qaboon 2	#1	30	City	109	Hamich	
City	111	Qaboon 2	#1	30	City	110	Ziraa	
City	111	Qaboon 2	#1	30	City	111	Charaf	
City	111	Qaboon 2	#1	30	City	112	Hafiriya	
City	111	Qaboon 2	#1	30	City	113	Ansar	
City	111	Qaboon 2	#2	20	Rural	201	Erbeen	
City	111	Qaboon 2	#2	20	Rural	202	Al Foren	
City	111	Qaboon 2	#2	20	Rural	203	Baladee	
City	111	Qaboon 2	#2	20	Rural	204	Panorama	
City	111	Qaboon 2	#2	20	Rural	205	Hellal	
City	111	Qaboon 2	#2	20	Rural	206	Entag	
City	112	Al Jamhaa	#1	20	City	101	Talim	
City	112	Al Jamhaa	#1	20	City	102	Kiwan	
City	112	Al Jamhaa	#1	20	City	103	Fattaleh	
City	112	Al Jamhaa	#1	20	City	104	Amawieen	
City	112	Al Jamhaa	#1	20	City	105	Kadaa	
City	112	Al Jamhaa	#1	20	City	106	Bakoura	
City	112	Al Jamhaa	#1	20	City	107	Tamrid	
City	112	Al Jamhaa	#1	30	City	108	Nisan	
City	112	Al Jamhaa	#1	30	City	109	Shiha	
City	112	Al Jamhaa	#1	30	City	110	Tanzim	
City	112	Al Jamhaa	#1	30	City	111	Mazaz	
City	113	Al Thawra	-	-	City	001	Mazraa	Line
City	113	Al Thawra	-	-	City	002	Ersal 1	Line
City	113	Al Thawra	-	-	City	003	Ersal 2	Line
City	113	Al Thawra	#1	30	City	101	Amara	
City	113	Al Thawra	#1	30	City	102	Dar Al Salam	
City	113	Al Thawra	#1	30	City	103	Marje	
City	113	Al Thawra	#1	30	City	104	Rokiya	
City	113	Al Thawra	#1	30	City	105	Asrouniya	
City	113	Al Thawra	#1	30	City	106	Hamidiya	
City	113	Al Thawra	#1	30	City	107	Harika	
City	113	Al Thawra	#2	30	City	201	Tabo	
City	113	Al Thawra	#2	30	City	202	Kanawat	
City	113	Al Thawra	#2	30	City	203	Souk Al Hall	
City	113	Al Thawra	#2	30	City	204	Abdin	
City	113	Al Thawra	#2	30	City	205	Epn Al Amid	
City	113	Al Thawra	#2	30	City	206	Enn Al Korch	

Attachment 5-2 List of 20 kV Feeder in the Study Area

Substation			Bank		Feeder			Remarks
Gov.	No.	Name	No.	Cap. (MVA)	Gov.	No.	Name	
City	113	Al Thawra	#2	30	City	207	7 Bahrat	
City	113	Al Thawra	#3	30	City	301	Sadat	
City	113	Al Thawra	#3	30	City	302	Al Ward	
City	113	Al Thawra	#3	30	City	303	Hamra	
City	113	Al Thawra	#3	30	City	304	Tamin	
City	113	Al Thawra	#3	30	City	305	Iwan	
City	113	Al Thawra	#3	30	City	306	Difaa	
City	113	Al Thawra	#3	30	City	307	Akariya	
City	114	Dawar Al Matar	#1	20	Rural	101	Kazzaaz	
City	114	Dawar Al Matar	#1	20	City	102	Nidal	
City	114	Dawar Al Matar	#1	20	City	103	Fom	
City	114	Dawar Al Matar	#2	20	City	201	Chouhada	
City	114	Dawar Al Matar	#2	20	City	202	Boustan Al Door	
City	114	Dawar Al Matar	#2	20	City	203	Al Sinaya	
City	114	Dawar Al Matar	#2	20	City	204	Bab Charki	
City	114	Dawar Al Matar	#2	20	City	205	Al Jamal	
City	114	Dawar Al Matar	#2	20	City	206	Amawi	
City	114	Dawar Al Matar	#2	20	City	207	Kouatli	
City	115	Dummar	#1	20	Rural	101	Kassarah	
City	115	Dummar	#1	20	City	102	Al Chab	
City	115	Dummar	#1	20	City	103	Masaken	
City	115	Dummar	#1	20	City	104	Gazieh	
City	115	Dummar	#1	20	City	105	Kasion	
City	115	Dummar	#1	20	City	106	Haras	
City	115	Dummar	#1	20	City	107	Charkiya	
City	115	Dummar	#1	20	City	108	Ayach	
City	115	Dummar	#1	20	City	109	Mostawsaf	
City	115	Dummar	#1	20	City	110	Sakani	
City	115	Dummar	#2	20	City	201	Bohooth	
City	115	Dummar	#2	20	City	202	Techrin	
City	115	Dummar	#2	20	City	203	Dahiya	
City	115	Dummar	#2	20	City	204	Abrage	
City	115	Dummar	#2	20	City	205	Hawach	
City	115	Dummar	#2	20	City	206	Arin	
City	115	Dummar	#2	20	City	207	Kasr Al Azm	
City	115	Dummar	#2	20	City	208	Al Jondi	
City	115	Dummar	#2	20	City	209	Chamsiya	
City	115	Dummar	#2	20	City	210	Mohajrin	
City	141	Kafersuseh						
City	161	Barzhe						
City	162	Zablatani						
City	163	Harash						
City	164	Jalaa						
City	165	Hosh Blas						
City	166	Shekh Hassan						
City	167	Qsoor						
Rural	201	Duma	#1	30	Rural	101	Douma	
Rural	201	Duma	#1	30	Rural	102	Eben Seena	
Rural	201	Duma	#1	30	Rural	103	Morakabat	
Rural	201	Duma	#1	30	Rural	104	Anaater	
Rural	201	Duma	#1	30	Rural	105	Al Hossen	
Rural	201	Duma	#1	30	Rural	106	Al Jallaa	
Rural	201	Duma	#1	30	Rural	107	Eskan	
Rural	201	Duma	#1	30	Rural	108	Segen	
Rural	201	Duma	#2	20	Rural	201	Hajariah	
Rural	201	Duma	#2	20	Rural	202	Harasta	
Rural	201	Duma	#2	20	Rural	203	Mesraba	
Rural	201	Duma	#2	20	Rural	204	Betwanah	
Rural	201	Duma	#2	20	Rural	205	Abiniah	
Rural	202	Adra 1	#1	20	Rural	101	Nashef	
Rural	202	Adra 1	#1	20	Rural	102	Ethaaha	
Rural	202	Adra 1	#1	20	Rural	103	Mounshaha	
Rural	202	Adra 1	#1	20	Rural	104	Soukhnah	
Rural	202	Adra 1	#1	20	Rural	105	Torouk	
Rural	202	Adra 1	#1	20	Rural	106	Makhbar	
Rural	202	Adra 1	#1	20	Rural	107	Madanaiah 3	
Rural	202	Adra 1	#1	20	Rural	108	Madanaiah 8	
Rural	202	Adra 1	#2	10	Rural	201	Omaliah	
Rural	202	Adra 1	#2	10	Rural	202	Naft	
Rural	202	Adra 1	#2	10	Rural	203	Al Tall	
Rural	202	Adra 1	#2	10	Rural	204	Sarfi Seheie	
Rural	203	Adra 2	#1	20	Rural	101	Harra 1	

Attachment 5-2 List of 20 kV Feeder in the Study Area

Substation			Bank		Feeder			Remarks
Gov.	No.	Name	No.	Cap. (MVA)	Gov.	No.	Name	
Rural	203	Adra 2	#1	20	Rural	102	Harra 2	
Rural	203	Adra 2	#1	20	Rural	103	Gazal	
Rural	203	Adra 2	#1	20	Rural	104	Al Domair	
Rural	203	Adra 2	#1	20	Rural	105	Makhbar	
Rural	203	Adra 2	#1	20	Rural	106	Al Sekeh	
Rural	203	Adra 2	#1	20	Rural	107	Ramadan	
Rural	203	Adra 2	#1	20	Rural	108	Ethaaha	
Rural	204	Kotaifa	#1	10	Rural	101	Eskan	
Rural	204	Kotaifa	#1	10	Rural	102	Kotaifa	
Rural	204	Kotaifa	#1	10	Rural	103	Hela	
Rural	204	Kotaifa	#1	10	Rural	104	Adra	
Rural	204	Kotaifa	#1	10	Rural	105	Moadamia	
Rural	204	Kotaifa	#1	10	Rural	106	Rhaiba	
Rural	204	Kotaifa	#1	10	Rural	107	Lewaa	
Rural	204	Kotaifa	#1	10	Rural	108	Madjana	
Rural	205	Nabek	#1	20	Rural	101	Nasreia	
Rural	205	Nabek	#1	20	Rural	102	Mahloola	
Rural	205	Nabek	#1	20	Rural	103	Yabroud 2	
Rural	205	Nabek	#1	20	Rural	104	Ahtheia	
Rural	205	Nabek	#1	20	Rural	105	Jaboor	
Rural	205	Nabek	#1	20	Rural	106	Dair Atia	
Rural	205	Nabek	#2	20	Rural	201	Kara	
Rural	205	Nabek	#2	20	Rural	202	Nabak	
Rural	205	Nabek	#2	20	Rural	203	Garbeia	
Rural	205	Nabek	#2	20	Rural	204	Sharkia	
Rural	205	Nabek	#2	20	Rural	205	Yabroud 1	
Rural	206	Al Hameh	#1	20	Rural	101	Water 1	
Rural	206	Al Hameh	#1	20	Rural	102	Water 2	
Rural	206	Al Hameh	#1	20	Rural	103	Saboura	
Rural	206	Al Hameh	#1	20	Rural	104	Esmant	
Rural	206	Al Hameh	#1	20	Rural	105	Al Khadra	
Rural	206	Al Hameh	#1	20	Rural	106	Bohooth	
Rural	206	Al Hameh	#2	20	Rural	201	Beera	
Rural	206	Al Hameh	#2	20	Rural	202	Deemas	
Rural	206	Al Hameh	#2	20	Rural	203	Kodsaia	
Rural	206	Al Hameh	#2	20	Rural	204	Al Bojaa	
Rural	206	Al Hameh	#2	20	Rural	205	Jamraia	
Rural	207	Sydanaya	#1	20	Rural	101	Rankous	
Rural	207	Sydanaya	#1	20	Rural	102	Zaitoun	
Rural	207	Sydanaya	#1	20	Rural	103	Kotaifah 2	
Rural	207	Sydanaya	#2	20	Rural	201	Saidnaia	
Rural	207	Sydanaya	#2	20	Rural	202	Akmar	
Rural	207	Sydanaya	#2	20	Rural	203	Mneen	
Rural	207	Sydanaya	#2	20	Rural	204	Halboun	
Rural	207	Sydanaya	#2	20	Rural	205	Kotaifah 1	
Rural	208	Zabadani	#1	20	Rural	101	Rawdah	
Rural	208	Zabadani	#1	20	Rural	102	Madaia	
Rural	208	Zabadani	#1	20	Rural	103	Bloudan	
Rural	208	Zabadani	#2	20	Rural	201	Sarf Sehee	
Rural	208	Zabadani	#2	20	Rural	202	Barada	
Rural	208	Zabadani	#2	20	Rural	203	Souk	Hama1&2, Al Feejee
Rural	208	Zabadani	#2	20	Rural	204	Zabadanee	
Rural	209	Fursan	#1	30	Rural	101	Kaokab	
Rural	209	Fursan	#1	30	Rural	102	Serah	
Rural	209	Fursan	#1	30	Rural	103	Moadamiah	
Rural	209	Fursan	#1	30	Rural	104	Khaleeg	
Rural	209	Fursan	#1	30	Rural	105	Thawrah	
Rural	209	Fursan	#1	30	City	106	Mouhallak	
Rural	209	Fursan	#1	30	City	107	Marwahiat	
Rural	209	Fursan	#1	30	City	108	Mazze	
Rural	209	Fursan	#1	30	City	109	Afrad	
Rural	209	Fursan	#2	20	Rural	201	Al Fadel	
Rural	209	Fursan	#2	20	Rural	202	Katana	
Rural	209	Fursan	#2	20	Rural	203	Mostawdahat	
Rural	209	Fursan	#2	20	Rural	204	Esteshaar	
Rural	209	Fursan	#2	20	Rural	205	Rokham	
Rural	210	Al Matar	#1	5M*2	Rural	101	Matar 1	Feeds airport only
Rural	210	Al Matar	#1	5M*2	Rural	102	Matar 2	Feeds airport only
Rural	210	Al Matar	#1	5M*2	Rural	103	Esharah 1	Feeds airport only
Rural	210	Al Matar	#1	5M*2	Rural	104	Esharah 2	Feeds airport only
Rural	210	Al Matar	#1	5M*2	Rural	105	Mantikah Horah	Feeds airport only
Rural	210	Al Matar	#1	5M*2	Rural	106	Syrian	Feeds airport only

Attachment 5-2 List of 20 kV Feeder in the Study Area

Substation			Bank		Feeder			Remarks
Gov.	No.	Name	No.	Cap. (MVA)	Gov.	No.	Name	
Rural	210	Al Matar	#1	5M*2	Rural	107	Matar 3	Feeds airport only
Rural	210	Al Matar	#1	5M*2	Rural	108	Matar 4	Feeds airport only
Rural	210	Al Matar	#2	20	Rural	201	Wedian Al Rabeeh	
Rural	210	Al Matar	#2	20	Rural	202	Ghassoula	
Rural	210	Al Matar	#2	20	Rural	203	Khameera	
Rural	210	Al Matar	#2	20	Rural	204	Afrad	
Rural	210	Al Matar	#2	20	Rural	205	Tareek Al Matar	
Rural	210	Al Matar	#2	20	Rural	206	Komama	
Rural	210	Al Matar	#2	20	Rural	207	Akraba	
Rural	210	Al Matar	#2	20	Rural	208	Garamana	
Rural	210	Al Matar	#2	20	Rural	209	Gazlania	
Rural	211	Izaa	#1	20	Rural	101	Hazrama	
Rural	211	Izaa	#1	20	Rural	102	Nashabeiah	
Rural	211	Izaa	#1	20	Rural	103	Bath 1	
Rural	211	Izaa	#1	20	Rural	104	Ramadan	
Rural	211	Izaa	#1	20	Rural	105	Tahweel 1	
Rural	211	Izaa	#1	20	Rural	106	Tahweel 2	
Rural	211	Izaa	#1	20	Rural	107	Harariah 1	
Rural	211	Izaa	#2	20	Rural	201	Harariah 2	
Rural	211	Izaa	#2	20	Rural	202	Bath 2	
Rural	212	Mutamarat Palace	#1	10	Rural	101		Private Substation
Rural	212	Mutamarat Palace	#2	10	Rural	201		Private Substation
Rural	213	Adra Cement	#1	20	Rural	101		Private Substation
Rural	213	Adra Cement	#2	20	Rural	201		Private Substation
Rural	213	Adra Cement	#3	20	Rural	301		Private Substation
Rural	214	Kisweh	#1	20	Rural	101	Dair Hajer	
Rural	214	Kisweh	#1	20	Rural	102	Sham	
Rural	214	Kisweh	#1	20	Rural	103	Sengab	
Rural	214	Kisweh	#1	20	Rural	104	Auotostrad	
Rural	214	Kisweh	#2	20	Rural	201	Houboob	
Rural	214	Kisweh	#2	20	Rural	202	Majedia	
Rural	214	Kisweh	#2	20	Rural	203	Horjole	
Rural	214	Kisweh	#2	20	Rural	204	Tayaba	
Rural	214	Kisweh	#2	20	Rural	205	Thahaleb	
Rural	214	Kisweh	#2	20	Rural	206	Sharakes	
Rural	215	Al Maarad	#1	20	Rural	101	Bait Sahem	
Rural	215	Al Maarad	#1	20	Rural	102	Shabha	
Rural	215	Al Maarad	#1	20	Rural	103	Makam	
Rural	215	Al Maarad	#1	20	Rural	104	Dyabia	
Rural	215	Al Maarad	#2	20	Rural	201	Faress	
Rural	215	Al Maarad	#2	20	Rural	202	Al Nour	
Rural	215	Al Maarad	#2	20	Rural	203	Al Baidar	
Rural	215	Al Maarad	#2	20	Rural	204	Al Rawda	
Rural	215	Al Maarad	#2	20	Rural	205	Happy Land	
Rural	215	Al Maarad	#2	20	Rural	206	Khyata	
Rural	216	Dimas	#1	20	Rural	101	Mazareh Yafour	
Rural	216	Dimas	#1	20	Rural	102	Tabreed	
Rural	216	Dimas	#1	20	Rural	103	Korah Al Assad	
Rural	216	Dimas	#1	20	Rural	104	Nohman	
Rural	216	Dimas	#1	20	Rural	105	Abar	
Rural	217	Nasrieh	#1	40	Rural	101	Mazareh	
Rural	217	Nasrieh	#1	40	Rural	102	Nasreiah	
Rural	217	Nasrieh	#1	40	Rural	103	Jairoud	
Rural	217	Nasrieh	#1	40	Rural	104	Matthana	
Rural	218	Kudseia	#1	20	Rural	101	Jamheiat	
Rural	218	Kudseia	#1	20	Rural	102	Ethaha	
Rural	219	Erbeen	#1	20	Rural	101	Askalanee	
Rural	219	Erbeen	#1	20	Rural	102	Tasabehjee	
Rural	219	Erbeen	#1	20	Rural	103	Zamalka	
Rural	219	Erbeen	#1	20	Rural	104	Madares	
Rural	219	Erbeen	#2	20	Rural	201	Ain Tarma	
Rural	219	Erbeen	#2	20	Rural	202	Kafar Batna	
Rural	219	Erbeen	#2	20	Rural	203	Taweel	
Rural	219	Erbeen	#2	20	Rural	204	Hamooria	
Rural	220	Al Faihaa	#1	20	Rural	101	Fayaha 6A	
Rural	220	Al Faihaa	#1	20	Rural	102	Fayaha 6B	
Rural	220	Al Faihaa	#1	20	Rural	103	Fayaha 10	
Rural	220	Al Faihaa	#1	20	Rural	104	Fayaha 7	
Rural	220	Al Faihaa	#2	20	Rural	201	Bostan	
Rural	220	Al Faihaa	#2	20	Rural	202	Mashfa	
Rural	220	Al Faihaa	#2	20	Rural	203	Thanaweia	
Rural	220	Al Faihaa	#2	20	Rural	204	Sallimah	

Attachment 5-2 List of 20 kV Feeder in the Study Area

Substation			Bank		Feeder			Remarks
Gov.	No.	Name	No.	Cap. (MVA)	Gov.	No.	Name	
Rural	220	Al Faihaa	#2	20	Rural	205	Afraah	
Rural	220	Al Faihaa	#2	20	Rural	206	Rahmah	
Rural	220	Al Faihaa	#2	20	Rural	207		U/C for "Police Hospital"?
Rural	221	Al Hajar Al Aswad	#?				Police Hospital	Bank unknown
Rural	221	Al Hajar Al Aswad	#1	30	Rural	101	Gawalan	
Rural	221	Al Hajar Al Aswad	#1	30	Rural	102	Mahattah	
Rural	221	Al Hajar Al Aswad	#1	30	Rural	103	Khaleel	
Rural	221	Al Hajar Al Aswad	#1	30	Rural	104	Yalda	
Rural	221	Al Hajar Al Aswad	#1	30	Rural	105	Baladiah	
Rural	221	Al Hajar Al Aswad	#1	30	Rural	106	Dah Yormouk	
Rural	221	Al Hajar Al Aswad	#2	30	City	107	Ahli	
Rural	221	Al Hajar Al Aswad	#2	30	City	108	Talaeh	
Rural	221	Al Hajar Al Aswad	#2	30	City	201	Takadom	
Rural	221	Al Hajar Al Aswad	#2	30	City	202	Madina	
Rural	221	Al Hajar Al Aswad	#2	30	City	203	Kalsa	
Rural	221	Al Hajar Al Aswad	#2	30	City	204	Baskwit	
Rural	221	Al Hajar Al Aswad	#2	30	City	205	Loubieh	
Rural	221	Al Hajar Al Aswad	#2	30	City	206	Arouba	
Rural	221	Al Hajar Al Aswad	#2	30	City	207	Mashmamer	
Rural	241	Khan Al Sheeh						
Rural	261	Al Tal						
Rural	262	Yabroud						
Rural	263	Harasta						
Rural	264	Nashabieh						
Rural	265	Al Miliha						
Rural	266	Saledeh Zinab						
Rural	267	Kudseia 1						
Rural	268	Kudseia 2						
Rural	269	Darya						
Other	301	Auyoba	#1	10	Rural	101	Sahsah	
Other	301	Auyoba	#1	10	Rural	102	Haramoun	
Other	301	Auyoba	#2	10	Rural	201	Hamreet	

Attachment 5-3 Transformer Field Survey Data (1/6)

Date Nov. 23rd, 1998

Substation : BAB SHARKI (108)
Feeder : Younesiah (201)

Transformer	No./Name		Tr.1/Younsieh 2		
	Type		Tower Mounted		
	Capacity		400 kVA		
Primary (MV)Side	20kV Feeder		Cable (Over-head)	Al	120 mm^2
	Drop Line	Line	Wire	Al	70 mm^2
		DS	Exist		
		Fuse	Exist		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	500 mm^2
		C.B.	O.C. Breaker		800 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	400,400,400	Al	120 mm^2
		Feeder 2	400,400,400	Al	120 mm^2
		Feeder 3	400,400,400	Al	120 mm^2
		Feeder 4	---	Al/Cu	mm^2
		Feeder 5	---	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 2	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 3	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
Remarks	Lightning arresters are installed.				

Date Nov. 23rd, 1998

Substation : BAB SHARKI (108)
Feeder : Younesiah (201)

Transformer	No./Name		Tr.14/Nahda 4		
	Type		Ground Mounted		
	Capacity		1,600 kVA		
Primary (MV)Side	20kV Feeder		Cable/Wire	Cu/Al	mm^2
	Drop Line	Line	Cable/Wire/Bus-Bar	Cu/Al	mm^2
		DS			
		Fuse			
Secondary (LV)Side	Circuit 1	Conductor	Cable/Bus-Bar	Al/Cu	mm^2
		C.B.	O.C. Breaker		1,250 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	355A,355A,315A	Al/Cu	mm^2
		Feeder 2	100A,100A,100A	Al/Cu	mm^2
		Feeder 3		Al/Cu	mm^2
		Feeder 4		Al/Cu	mm^2
		Feeder 5		Al/Cu	mm^2
		Feeder 6		Al/Cu	mm^2
	Circuit 2	Conductor	Cable/Bus-Bar	Al/Cu	mm^2
		C.B.	O.C. Breaker		800 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	355A;315A;355A	Al/Cu	mm^2
		Feeder 2	315A;315A;355A	Al/Cu	mm^2
		Feeder 3	315A;315A;315A	Al/Cu	mm^2
		Feeder 4		Al/Cu	mm^2
		Feeder 5		Al/Cu	mm^2
		Feeder 6		Al/Cu	mm^2
	Circuit 3	Conductor	Cable/Bus-Bar	Al/Cu	mm^2
		C.B.	O.C. Breaker		1,250 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	400+200;315*2;400+200	Al/Cu	mm^2
		Feeder 2	160+160;160+315;200*2	Al/Cu	mm^2
		Feeder 3	500;500;500	Al/Cu	mm^2
		Feeder 4	100;200;100	Al/Cu	mm^2
		Feeder 5		Al/Cu	mm^2
		Feeder 6		Al/Cu	mm^2
Remarks					

Date Nov. 24th, 1998

Substation : NABEK (205)
Feeder : Dair Atia (105)

Transformer	No./Name		Tr.1/Nanshieh		
	Type		Ground Mounted		
	Capacity		630 kVA		
Primary (MV)Side	20kV Feeder		Cable	Al	120 mm^2
	Drop Line	Line	Cable/Wire/Bus-Bar	Cu/Al	mm^2
		DS	Exist		
		Fuse	None		
Secondary (LV)Side	Circuit 1	Conductor	Cable/Bus-Bar	Al/Cu	mm^2
		C.B.	O.C. Breaker		1,000 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	315;200;315	Al	120 mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	200;315;315	Al	120 mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	100;100;100	Cu	25 mm^2
	Circuit 2	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 3	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
Remarks					

Date Nov. 24th, 1998

Substation : NABEK (205)
Feeder : Dair Atia (105)

Transformer	No./Name		Tr.2/Bahrat		
	Type		Tower Mounted		
	Capacity		200 kVA		
Primary (MV)Side	20kV Feeder		Wire	Al	50/8 mm^2
	Drop Line	Line	Wire	Al	50/8 mm^2
		DS	None		
		Fuse	None		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Al/Cu	mm^2
		C.B.	Manual Breaker		400 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	100;355;400	Al	120 mm^2
		Feeder 2	?,100,100	Cu	50 mm^2
		Feeder 3	250;355;400	Al	120 mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 2	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 3	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
Remarks	Lightning arresters are installed.				

Attachment 5-3 Transformer Field Survey Data (2/6)

Date Nov. 24th, 1998

Substation : NABEK (205)
Feeder : Dair Alia (105)

Transformer	No./Name		Tr.3/Roherti		
	Type		Ground Mounted Slim		
	Capacity		400 kVA		
Primary (MV)Side	20kV Feeder		Wire	Al	70 mm^2
	Drop Line	Line	Bus-Bar	Al	mm^2
		DS	Exist		
		Fuse	Exist (Electrical wires are connected together)		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	300 mm^2
		C.B.	O.C. Breaker		1,000 A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	250;250;250	Cu	120 mm^2
		Feeder 3	250;250;250	Cu	120 mm^2
		Feeder 4	300;400;355	Cu	120 mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	355;300;300	Cu	120 mm^2
	Circuit 2	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 3	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
Remarks					

Date Nov. 25th, 1998

Substation : MIDAN 2 (105)
Feeder : Barada (201)

Transformer	No./Name		Tr.2/Aam		
	Type		Tower Mounted		
	Capacity		630 kVA		
Primary (MV)Side	20kV Feeder		Wire	Cu	35 mm^2
	Drop Line	Line	Wire	Cu	35 mm^2
		DS	Exist		
		Fuse	Exist (25A)		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	300 mm^2
		C.B.	O.C. Breaker		1,000 A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	400;400;400	Cu	120 mm^2
		Feeder 2	355;355;400	Cu	120 mm^2
		Feeder 3	400;400;400	Cu	120 mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 2	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 3	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
Remarks					

Date Nov. 25th, 1998

Substation : MIDAN 2 (105)
Feeder : Barada (201)

Transformer	No./Name		Tr.3a/Refrigerator Factory Private		
	Type		Ground Mounted		
	Capacity		630 kVA		
Primary (MV)Side	20kV Feeder		Cable (Oil)	Al	120 mm^2
	Drop Line	Line	Bus-Bar	Cu	50 mm^2
		DS	Exist (On Load DS)		
		Fuse	Exist (40A)		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	500 mm^2
		C.B.	O.C. Breaker		1,000 A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	500*2;500*2;500*2	Cu	300 mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 2	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 3	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
Remarks	Two feeders (In-coming and Out-going) and two transformers are connected the bus-bar through disconectors. These disconnectors are on load disconnector exept one which is connected to the in-coming feeder. ~~240kVA Capacitor is installed at each transformer.~~				

Date Nov. 25th, 1998

Substation : MIDAN 2 (105)
Feeder : Barada (201)

Transformer	No./Name		Tr.3b/Refrigerator Factory Private		
	Type		Ground Mounted		
	Capacity		630 kVA		
Primary (MV)Side	20kV Feeder		Cable (Oil)	Al	120 mm^2
	Drop Line	Line	Bus-Bar	Cu	50 mm^2
		DS	Exist (On Load DS)		
		Fuse	Exist (40A)		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	500 mm^2
		C.B.	O.C. Breaker		1,000 A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	630*2;630*2;630*2	Cu	300 mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 2	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 3	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
Remarks	Two feeders (In-coming and Out-going) and two transformers are connected the bus-bar through disconectors. These disconnectors are on load disconnector exept one which is connected to the in-coming feeder. ~~240kVA Capacitor is installed at each transformer.~~				

Attachment 5-3 Transformer Field Survey Data (3/6)

Date Nov 26th, 1998

Substation : SYDNAYA (207)
Feeder : Kotaifah 1 (205)

Transformer	No./Name		Tr.1/Al Ice Kherela (Private Tr. for the farm)		
	Type		Twoer Mounted		
	Capacity		50 kVA		
Primary (MV)Side	20kV Feeder		Wire	Al	50 mm²
	Drop Line	Line	Wire	Al	50 mm²
		DS	Exist		
		Fuse	None		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	50 mm²
		C.B.	Manual Breaker		600 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	315;160;80	Cu	50 mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 2	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 3	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
Remarks	Lightning arresters are installed.				

Date Nov 26th, 1998

Substation : SYDNAYA (207)
Feeder : Kotaifah 1 (205)

Transformer	No./Name		Tr.2/Bada		
	Type		Tower Mounted		
	Capacity		200 kVA		
Primary (MV)Side	20kV Feeder		Wire	Al	50 mm²
	Drop Line	Line	Wire	Al	50 mm²
		DS	Exist		
		Fuse	Exist (10A)		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Al	120 mm²
		C.B.	O.C. Breaker		160/400 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	200;200;200	Al	90 mm²
		Feeder 2	200;200;200	Al	90 mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 2	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 3	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
Remarks	Lightning arresters are installed.				

Date Nov 26th, 1998

Substation : SYDNAYA (207)
Feeder : Kotaifah 1 (205)

Transformer	No./Name		Tr.3/Hafir Al Foka		
	Type		Ground Mounted Slim		
	Capacity		200 kVA		
Primary (MV)Side	20kV Feeder		Wire	Al	120 mm²
	Drop Line	Line	Bus-Bar	Al	mm²
		DS	Exist		
		Fuse	Exist		
Secondary (LV)Side	Circuit 1	Conductor	Bus-Bar	Al	mm²
		C.B.	Manual Breaker		600 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	?;?;?	Al	120 mm²
		Feeder 2	?;?;?	Al	120 mm²
		Feeder 3	?;?;?	Al	120 mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 2	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 3	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
Remarks					

Date Nov 26th, 1998

Substation : SYDNAYA (207)
Feeder : Kotaifah 1 (205)

Transformer	No./Name		Tr.4/Al Hatef		
	Type		Tower Mounted		
	Capacity		200 kVA		
Primary (MV)Side	20kV Feeder		Wire	Al	50 mm²
	Drop Line	Line	Wire	Al	50 mm²
		DS	Exist		
		Fuse	16A (Wires are installed instead of cut out fuse		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	70 mm²
		C.B.	O.C. Breaker		160 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	160;160;160	Cu	50 mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 2	Conductor	Cable	Cu	70 mm²
		C.B.	O.C. Breaker		160 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	160;160;160	Cu	50 mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 3	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
Remarks					

Attachment 5-3 Transformer Field Survey Data (4/6)

Date Nov 28, 1998

Substation : ZABADANI (208)
Feeder : Zabadanee (204)

Transformer	No./Name		Tr.1/Khan Al Fondok		
	Type		Ground Mounted Prefabricated		
	Capacity		400 kVA		
Primary (MV)Side	20kV Feeder		Wire	Al	120 mm^2
	Drop Line	Line	Cable	Al	120 mm^2
		DS	None		
		Fuse	Exist (16A)		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	500 mm^2
		C.B.	O.C. Breaker		800 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	400;400;400	Cu	95 mm^2
		Feeder 2	355;400;400	Cu	95 mm^2
		Feeder 3	400;400;355	Cu	95 mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 2	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 3	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
Remarks					

Date Nov 28, 1998

Substation : ZABADANI (208)
Feeder : Zabadanee (204)

Transformer	No./Name		Tr 2/Diab Diab		
	Type		Ground Mounted Prefabricated		
	Capacity		400 kVA		
Primary (MV)Side	20kV Feeder		Wire	Cu	50 mm^2
	Drop Line	Line	Cable	Al	120 mm^2
		DS	Exist (Circuit Breakers)		
		Fuse	None (Wire is installed instead)		
Secondary (LV)Side	Circuit 1	Conductor	Bus-Bar	Al	mm^2
		C.B.	None		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	500,630,400	Cu	70 mm^2 * 2
		Feeder 2	630,630,500	Cu	70 mm^2 * 2
		Feeder 3	500,500,315	Cu	185 mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 2	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 3	Conductor	—	Al/Cu	mm^2
		C.B.	—		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm^2
		Feeder 2	—	Al/Cu	mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
Remarks					

Date Nov 29th, 1998

Substation : AMAWEEN (102)
Feeder : Malki (101)

Transformer	No./Name		Tr.1/The Arabic Language Committee (Private)		
	Type		In Building Type		
	Capacity		200 kVA		
Primary (MV)Side	20kV Feeder		Cable	Al	185 mm^2
	Drop Line	Line	Bus-Bar	Al	mm^2
		DS			
		Fuse			
Secondary (LV)Side	Circuit 1	Conductor	Cable/Bus-Bar	Al/Cu	mm^2
		C.B.	O.C. Breaker		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1		Al/Cu	mm^2
		Feeder 2		Al/Cu	mm^2
		Feeder 3		Al/Cu	mm^2
		Feeder 4		Al/Cu	mm^2
		Feeder 5		Al/Cu	mm^2
		Feeder 6		Al/Cu	mm^2
	Circuit 2	Conductor	Cable/Bus-Bar	Al/Cu	mm^2
		C.B.	O.C./Manual Breaker		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1		Al/Cu	mm^2
		Feeder 2		Al/Cu	mm^2
		Feeder 3		Al/Cu	mm^2
		Feeder 4		Al/Cu	mm^2
		Feeder 5		Al/Cu	mm^2
		Feeder 6		Al/Cu	mm^2
	Circuit 3	Conductor	Cable/Bus-Bar	Al/Cu	mm^2
		C.B.	O.C./Manual Breaker		A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1		Al/Cu	mm^2
		Feeder 2		Al/Cu	mm^2
		Feeder 3		Al/Cu	mm^2
		Feeder 4		Al/Cu	mm^2
		Feeder 5		Al/Cu	mm^2
		Feeder 6		Al/Cu	mm^2
Remarks	No light is installed. Gave up survey because of darkness.				

Date Nov 29th, 1998

Substation : AMAWEEN (102)
Feeder : Malki (101)

Transformer	No./Name		Tr.2/Garbi Malki 1		
	Type		Ground Mounted		
	Capacity		1,600 kVA		
Primary (MV)Side	20kV Feeder		Cable	Al	185 mm^2 (Oil)
	Drop Line	Line	Bus-Bar	Cu	50 mm^2
		DS	Exist (On Load Type)		
		Fuse	Exist (40A)		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	300 mm^2
		C.B.	O.C. Breaker		1,250 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	315;315;315	Al	70 mm^2
		Feeder 2	315;400;250	Al	120 mm^2
		Feeder 3	315;400;400	Al	185 mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 2	Conductor	Cable	Cu	500 mm^2
		C.B.	O.C. Breaker		1,250 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	400;400;400	Al	50 mm^2
		Feeder 2	630;400;315	Al	185 mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
	Circuit 3	Conductor	Cable	Al/Cu	mm^2
		C.B.	O.C. Breaker		800 A
		Branch	Fuse (R,S,T) (A)	Cable	
		Feeder 1	315;355;355	Al	120 mm^2
		Feeder 2	355;315;500	Al	120 mm^2
		Feeder 3	—	Al/Cu	mm^2
		Feeder 4	—	Al/Cu	mm^2
		Feeder 5	—	Al/Cu	mm^2
		Feeder 6	—	Al/Cu	mm^2
Remarks					

Attachment 5-3 Transformer Field Survey Data (5/6)

Date Nov 29th, 1998

Substation : AMAWEEN (102)
Feeder : Malki (101)

Transformer	No./Name		Tr.5/Korshied		
	Type		In Building Type		
	Capacity		630 kVA		
Primary (MV)Side	20kV Feeder		Cable	Al/Cu	mm²
	Drop Line	Line	Bus-Bar	Cu	mm²
		DS			
		Fuse			
Secondary (LV)Side	Circuit 1	Conductor	Cable	Al	500 mm²
		C.B.	O.C./Manual Breaker		1,250 A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	315;400;315	Cu	95 mm²
		Feeder 2	250;250;250	Cu	95 mm²
		Feeder 3	400;250;250	Cu	95 mm²
		Feeder 4	250;Wire;250	Cu	95 mm²
		Feeder 5	250;250;250	Cu	95 mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 2	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 3	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
Remarks					

Date Nov 29th, 1998

Substation : MAZZHE (103)
Feeder : Al Tob (104)

Transformer	No./Name		Tr.1/April 17th sq		
	Type		Ground Mounted		
	Capacity		630 kVA		
Primary (MV)Side	20kV Feeder		Cable	Al	185 mm²
	Drop Line	Line	Bus-Bar	Al	mm²
		DS	Exist		
		Fuse	Exist		
Secondary (LV)Side	Circuit 1	Conductor	Bus-Bar	Al	mm²
		C.B.	O.C. Breaker		1,000 A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	400;400;160	Cu	70 mm²
		Feeder 2	100;160;160	Cu	16 mm²
		Feeder 3	? ; ? ;160	Cu	16 mm²
		Feeder 4	200;400;400	Cu	25 mm²
		Feeder 5	400;355;400	Cu	95 mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 2	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 3	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
Remarks					

Date Nov 29th, 1998

Substation : MAZZHE (103)
Feeder : Al Tob (104)

Transformer	No./Name		Tr.2/Damashq Al Jadidha		
	Type		Ground Mounted		
	Capacity		630 kVA		
Primary (MV)Side	20kV Feeder		Cable	Al/Cu	mm²
	Drop Line	Line	Bus-Bar	Al/Cu	mm²
		DS	Exist		
		Fuse	Exist		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	500 mm²
		C.B.	O.C. Breaker		1,000 A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	350;400;400	Al	185 mm²
		Feeder 2	400;250;250	Cu	120 mm²
		Feeder 3	400;315;400	Al	185 mm²
		Feeder 4	? ;315;315	Al	120 mm²
		Feeder 5	200;315;200	Al	120 mm²
		Feeder 6	630;630;315	Cu	300 mm²
	Circuit 2	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 3	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
Remarks					

Date Nov 30th, 1998

Substation : ERSAL (107)
Feeder : Mojamah (112)

Transformer	No./Name		Tr.1/Astihlakieh		
	Type		Ground Mounted (Underground)		
	Capacity		630 kVA		
Primary (MV)Side	20kV Feeder		Cable	Al	185 mm²
	Drop Line	Line	Bus-Bar	Cu	mm²
		DS	Exist (On Load Type)		
		Fuse	Exist		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	500 mm²
		C.B.	O.C. Breaker		1,250 A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	315;400;400	Al	120 mm²
		Feeder 2	400;315;400	Al	185 mm²
		Feeder 3	315;315;315	Al	95 mm²
		Feeder 4	400;315;400	Cu	50 mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	355;200; ?	Cu	50 mm²
	Circuit 2	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 3	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
Remarks					

Attachment 5-3 Transformer Field Survey Data (6/6)

Date Nov 30th, 1998

Substation : ERSAL (107)
Feeder : Mojamah (112)

Transformer	No./Name		Tr.2/Al Salhieh		
	Type		Ground Mounted (Underground)		
	Capacity		630 kVA		
Primary (MV)Side	20kV Feeder		Cable	Al	185 mm²
	Drop Line	Line	Bus-Bar	Al/Cu	mm²
		DS	Exist (On Load Type)		
		Fuse	Exist		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	300 mm²
		C.B.	Manual Breaker		1,000 A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	400;400;400	Al	185 mm²
		Feeder 2	400;400;355	Al	185 mm²
		Feeder 3	315;355;400	Al	185 mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	- ;400;400	Cu	50 mm²
		Feeder 6	400; - ; -	Cu	25 mm²
	Circuit 2	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 3	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
Remarks					

Date Nov 30th, 1998

Substation : QABOON 1 (110)
Feeder : Abasien (219)

Transformer	No./Name		Tr.3/Khudar		
	Type		Ground Mounted		
	Capacity		630 kVA		
Primary (MV)Side	20kV Feeder		Cable	Al	185 mm²
	Drop Line	Line	Bus-Bar	Cu	mm²
		DS	Exist (On Load Type)		
		Fuse	Exist		
Secondary (LV)Side	Circuit 1	Conductor	Cable	Cu	300 mm²
		C.B.	O.C. Breaker		800 A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	315;315;315	Cu	50 mm²
		Feeder 2	160;160;160	Cu	35 mm²
		Feeder 3	250;315;400	Cu	50 mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 2	Conductor	Cable	Cu	300 mm²
		C.B.	O.C. Breaker		800 A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	355;355;355	Cu	50 mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
	Circuit 3	Conductor	—	Al/Cu	mm²
		C.B.	—		A
		Branch	Fuse (R;S;T) (A)	Cable	
		Feeder 1	—	Al/Cu	mm²
		Feeder 2	—	Al/Cu	mm²
		Feeder 3	—	Al/Cu	mm²
		Feeder 4	—	Al/Cu	mm²
		Feeder 5	—	Al/Cu	mm²
		Feeder 6	—	Al/Cu	mm²
Remarks					

Attachment 5-4 Schedule of Electrical Measurement

	Date	Area	S/S from	Name of Feeder	Type of Demand
·20 kV Feeder					
	11/23	Rural	Bab Sharki SS	Younesiah	
	11/24	Rural	Nabek SS	Dair Atia	
	11/25	Rural	Midan 2 SS	Barada	
	11/26	Rural	Sydnaya SS	Kotaifah 1	
	11/28	Rural	Zabadani SS	Zabadanee	
	11/29	City	Amaween SS Mazzhe SS	Malki Al Tob	
	11/30	City	Ersal SS Qaboon 1 SS	Mojamah Abasien	
·Low Tension Feeder					
	12/2	Rural	Duma SS Adra 1 SS	Al Jallaa Betwanah Al Torik	Commercial Domestic Illegal Consumption
	12/3	Rural	Midan 2	Sahnaia Semex	Mixed Industrial
	12/6	City	Qaboon 1 SS Bab Sharki SS Mazzrha SS	Adawi Jallad Salhie 1	Domestic Industrial Mixed
	12/7	City	Qaboon 2 SS	Warwar	Illegal Consumption
	12/9	City	Dawar Al Matar SS	Al Jamal	Commercial

CHAPTER VI

SYSTEM IMPROVEMENT PROGRAM IN THE STUDY AREA

Chapter 6 System Improvement Program In the Study Area

6.1 Urban Development and Industrialization Programs

The Team tried to obtain official information on regional development policies or development programs for the study area from SPC and other governorate offices. However, similarly to the national development plan mentioned in Chapter 2, approved or published policies or programs related to regional development have not been obtained up to the present.

While, the Team obtained information on power system development plans in the study area up to the year 2000 from PEDEEE. PEDEEE explained that the PEDEEE's plans were prepared on the basis of the past trends of energy sales and peak demand recorded and part of available development information, because detailed information on regional and industrial development plans have not been officially announced publicly by any authority. However, PEDEEE estimated that the electricity demand of the Damascus rural governorate would grow at a higher rate than that of the city governorate, because the development of the city has been almost saturated, and industrial and commercial sectors are expected to expand their activities into the rural area. In fact, many new industrial and housing plans are now under execution in the rural area. Therefore, it can be assured that the substantial portion of regional and industrial development plans are well incorporated in the PEDEEE's expansion plan.

During the site investigation period, the Team collected the following unofficial information through PEDEEE regarding the development programs for industrial zone and residential area in the study area.

(a) Industrial Development

The development of a large scaled industrial zone is in progress at Adra area. A part of factories will starts operation in 2000.

(b) Development of New Residential Towns

As the development of residential area in the City has been almost saturated, new residential towns are being developed or under planning in the Damascus Rural as follows:

	Location	Scale	Commissioning
–	Kafersuseh district	Approx. 200,000 people	from 2000
–	Dummar district	Expansion of the existing residential area (approx. 100,000 people)	from 2000
–	Yamrook district	Approx. 50,000 people	from 2001
–	Kudseia district	Approx. 100,000 people	from 2000

The above information has been considered in the power demand and peak load forecast by substation as described in the Section 4.2. Power system improvement programs for distribution facilities in the study area are to be formulated below on the basis of this information.

6.2 Programs for 230 kV System Development in the Study Area

PEEGT is at present implementing the following projects in the study area to reinforce the 230 kV transmission network to enable PEDEEE to secure reliable and stable power supply in near future to consumers in the study area.

(a) Construction of 230/66/20 kV substation at Dimas

The Dimas substation (2 x 125 MVA) is under construction and expected to be commissioned in early 1999. The associated 230 kV transmission line between Fursan and Dimas in 16 km length has already been constructed.

(b) Construction of 230/66 kV substations at Zahera and Mazzrha

The tenders for construction of the Zahera and Mazzrha substations (both 2 x 125 MVA) were called and are at present under evaluation by PEEGT. The substations are expected to be completed in 2001. The associated transmission lines between Nasrieh and Mazzrha and between Tishrin and Zahera will be constructed by PEEGT with its own finance.

In addition, PEEGT has a plan to construct three (3) 230/66kV substations as well as the associated transmission lines in the study area, namely Baramekha, Al Faihaa and Saiedeh Zanab to increase the power supply capacity to the distribution network in the Damascus and Damascus Rural area. Three substations are to be provided with 2 units of 125 MVA, 230/66 kV transformers. The finance for this project is yet to be decided. The completion is expected before year 2010.

6.3 66 kV Network Development Plans in the Study Area

(a) SCADA and Telecommunication System in Southern Region

The project for SCADA and Telecommunication System in the Southern region as a part of the entire development project of SCADA system covering whole the country has been just commenced with the EU's finance. A Regional Control Center will be constructed at Kafersuseh in Damascus under the project to facilitate rapid, efficient, flexible and safe operation of the 66 kV network in the southern region. ICB for procurement of system equipment is now under evaluation. The completion of the project is expected in 2002.

(b) 66/20 kV Kafersuseh Substation

A 66/20 kV substation furnished with 1 x 30 MVA transformers will be completed in 1999. Its trial operation started in December 1998.

(c) 66/20 kV substations under construction

Two 66/20 kV substations are under construction by PEDEEE's own finance at Harash with 1 x 30MVA transformers and Khan Al Shih with 1 x 20 MVA transformers. Both substations are to be put into operation within 1999.

The Harash substation will be connected to the 66 kV Mazzrha – Amaween underground cable line with IN/OUT arrangement. The Khan Al Shih substation will be connected to the Kisweh substation by a 66 kV overhead line and from Khan Al Shih to Qunaitra.

(d) Construction of Eight Substations in Damascus City

The following eight 66/20 kV substations are to be constructed in the study area with the finance received from the Islamic Development Bank (IDB). Tenders for these eight substations have been closed and are under evaluation at present. These substations are planned to be commissioned by the end of 2001.

(i)	Barzeh	2 x 30 MVA
(ii)	Zablatani	2 x 30 MVA
(iii)	Ibn Al Nafis	2 x 30 MVA
(iv)	Jalaa	2 x 30 MVA
(v)	Hosh Blas	2 x 30 MVA
(vi)	Sheikh Hasan	2 x 30 MVA
(vii)	Qsoor	2 x 30 MVA
(viii)	Jaramana	2 x 30 MVA

The associated 66 kV transmission lines, underground cable lines in 12 km in total and an overhead line, are to be constructed under the PEDEEE's own finance.

(e) Three Substations in Damascus Rural Area

Three substations, Yalda, Jededat Artouz and Bludan, are to be constructed for commissioning in 2003. Financing for these substations is under discussion with the Saudi Development Bank and/or the Abu Dhabi Bank. Associated transmission lines, overhead lines of 10 km long, will be financed from PEDEEE's own fund.

(f) Ten Substations in Damascus Rural Area

The following ten substations are planned to be constructed for commissioning in between 2005 and 2010. Financing for these substations is under negotiation with the European Investment Bank. 20 km of underground cable lines and 350 km of overhead lines are required for these substations.

(i)	Al Tal	2 x 30 MVA
(ii)	Yabroud	2 x 30 MVA
(iii)	Harasta	2 x 30 MVA
(iv)	Nashabieh	2 x 30 MVA
(v)	Al Melcha	2 x 30 MVA
(vi)	Saiedeh Zanab	2 x 30 MVA
(vii)	Kudseia I	2 x 30 MVA
(viii)	Kudseia II	2 x 30 MVA
(ix)	Extension of Transformers	2 x 30 MVA
(x)	Darea	2 x 30 MVA

A single line diagram of 66 kV network including the above planned substations is shown on Fig. 7.4-8.

(g) Procurement and installation of 66/20 kV, 30 MVA transformers

30 units of 66/20kV, 30 MVA transformers are scheduled to be procured and installed replacing the existing smaller capacity transformers by the PEDEEE's own finance. The contract for supply and installation of 10 units of transformers was finalized for execution. Out of 10 units under the Contract, four units will be delivered to Damascus Rural Company to replace the existing transformers at the Marrad, Fursan, Al Matar and Midan-2 substations.

Tenders for the remaining twenty (20) units of transformer are still under evaluation. Destinations of these transformers are yet to be determined.

The separate contract for supply and installation of 2 x 30 MVA transformers for the Ersal substation to replace the existing 2 x 20 MVA transformers is also under evaluation at present. The replacement will be completed in 2000.

6.4 Programs for 20/0.4 kV Distribution Network

(a) Procurement and Installation of 20 kV Static Capacitors by PEDEEE

In order to maintain 66 kV system voltage at the desired level by compensating reactive power in the system, PEDEEE is now promoting a project to install 20 kV static capacitors at 20 kV buses of its 66/20 kV substations in two stages as mentioned below:

Stage-1 for capacitor installation in the Damascus City and Rural area
20 kV static capacitors of 145 MVar in total capacity are being installed at the 66/20 kV substations in the Damascus and Damascus rural area. The details of capacities and locations of installation of static capacitors are referred to Table 5.1-2 (1) and (2). The installation of all capacitors will be completed by March 1999.

Stage-2 for capacitor installation in the whole country
As the second stage of the capacitor installation project, PEDEEE is planning to purchase and install 20 kV static capacitors of 300 MVA to be distributed in the whole country. The project is to be completed in 1999.

(b) Replacement of 20 kV Circuit Breakers at Distribution Substations

PEDEEE will procure 125 sets of 20 kV circuit breakers of SF6 gas type with its own finance and install these circuit breakers in the existing substations in Syria, to replace old model and deteriorated 20 kV circuit breakers. Out of 125 sets, 73 circuit breakers will be allocated to the Damascus Company to replace the existing 20 kV circuit breakers with particulars as given below:

Midan-1	28 nos.
Qaboon-1	10 nos.
Ersal	35 nos.

The replacement works will be implemented in 1999.

(c) Replacement of 20 kV Switchgear Cubicles at Distribution Substations

The Damascus City Distribution Company plans to replace the existing 20 kV switchgear cubicles complete with SF6 Gas Insulated Switchgear (GIS) at the Ashmar and Thawra substations. Finance will be arranged from PEDEEE's own source. The new cubicles will be provided with double busbars for flexible operations in maintenance and emergency cases. The project will be implemented in the year 2000.

(d) Expansion of 20 kV Switchgear Cubicles at Distribution Substations

The Damascus Rural Distribution Company plans to install new 20 kV switchgear cubicles to expand the existing 20 kV switchgear at the Zabadani, Duma and Adra-1 substations with PEDEEE's own finance. The new cubicles will be provided with SF6 type circuit breakers. The project will be implemented in the year 2000.

(e) Procurement and installation of 20 kV Load Break Switches

PEDEEE plans to procure approximately 5,000 numbers in total of 20 kV Load Break Switches for whole Syria to replace the existing load break switches in distribution transformer stations with its own finance. Out of 5,000 in total PEDEEE will allocate 800 sets to the Damascus City Company and 500 sets to the Damascus Rural Company. The replacement works will be implemented in 1999 to 2000.

(f) Procurement of 20/0.4 kV Distribution Facilities

PEDEEE procures and supplies equipment and materials for 20/0.4 kV networks to the Distribution Companies every year with its own finance for extension, improvement and maintenance of the 20/0.4 kV network. The following table shows the details of procurement schedule for the Damascus and Damascus Rural area in accordance with the PEDEEE's 5-year plan:

Table 6.4-1 Procurement Schedule of Distribution Facilities

Descriptions		1996	1997	1998	1999	2000	Total
Damascus City							
20/0.4 kV Distribution Trans.	(Nos.)	121	70	104	117	125	537
20 kV line	(km)	108.8	78	100	100	95	481.8
0.4 kV line	(km)	55.7	16	50	69	97	287.7
Damascus Rural							
20/0.4 kV Distribution Trans	(Nos.)	180	65	117	127	130	619
20 kV line	(km)	108.6	127	114	122	129	605.6
0.4 kV line	(km)	113.2	70	93	104	120	500.2

6.5 Development Programs for Operation and Maintenance

(a) Computer Aids for 20 kV Distribution Control Centers

PEDEEE plans to introduce computer aids to facilitate the 20 kV distribution control centers to incorporate necessary functions that will contribute towards data rendering for network representation, operational and long term network planning, with finance from EU under the ESSP in Syria.

PEDEEE will identify a suitable distribution company to introduce computer aided 20 kV network representation under the project.

The introduction of computer aided 20 kV network representation will provide PEDEEE with useful experiences in the use of modern distribution system management tools in the future. The implementation of a pilot computer-based distribution network maps and operation database will contribute the demonstration of the overall modernization of the distribution system.

The project will be commenced from the middle of 1999 and require 12 months. The provisional budget is estimated at 485,000 ECU.

(b) Aleppo Training Center

The development of electricity sector training centers was set up in Aleppo as a prototype and a model for future centers with finance from EU under the ESSP. The purpose of the Aleppo Training Center is to provide high quality distribution technical training to the staff of PEDEEE, e.g. engineers, line workers, cable jointers, substation workers, operators and consumer service staff.

The first stage of the development of the Aleppo Training Center was implemented from 1996 to 1998 for construction of 4 training classrooms, 6 workshops and outdoor training yards.

The second stage development is under implementation for the completion in 2000.

CHAPTER VII

BASIC REHABILITATION PLAN OF DISTRIBUTION SYSTEM

Chapter 7 Basic Rehabilitation Plan for Distribution System

7.1 Standards for Facilities

At present, PEDEEE and two Public Distribution Companies for Damascus City and Damascus Rural are feeling inconvenience due to non-availability of formally documented standards for the planning and design of their distribution networks. Distribution facilities including 66 kV substations and transmission lines have been planned and designed in accordance with certain standard practices that have been applied long time in Syria for the development of distribution network.

It is therefore important to establish standards most appropriate for the planning and design of power facilities of Syrian distribution network in documented forms to attain the following merits:

- Lower cost in planning and design due to application of unified practices.
- Less quantity of spare parts by use of common parts due to application of same design.
- Easier operation and maintenance.

The recommended standards for planning and design of the following distribution facilities are described in this chapter. The standards were formulated by the Team referring to the present standard practices of PEDEEE and also standards employed by worldwide Power Utilities.

(1) 66/20 kV Substations

(2) 66 kV Overhead and Underground Lines

(3) 20 kV and Low Voltage Distribution Facilities

7.1.1 Standards for 66/20 kV Substations

The recommended standards for planning and design of 66/20 kV substations are compiled in Attachment 7-1 "Standards for 66/20 kV Distribution Substations".

The Team would like to emphasize the following points in the recommended standards:

(1) Unit Capacity and Number of Units of Transformers

The unit capacity and number of transformer units provided in each of existing substations in Damascus and Damascus Rural area are given in the Table 5.1-2. All the existing transformers are of three-phase construction.

As shown in the table, typical 66/20 kV substations are provided with two or three units of 20 MVA transformer. While, the Thawra and Al Hajer Al Aswad substations are provided with two and three units of 30 MVA transformers, and the Qaboon-1 substation with three units of 40 MVA transformers. Necessity of larger capacity units is increasing with recent growth of demand.

Small 10 MVA transformers are used only in certain substations in rural areas.

Thus, majority of transformers in the existing substations in the Damascus and Damascus Rural area is of 20 MVA in unit capacity. However, to meet rapidly increasing demand, 30 and 40 MVA transformers have been recently installed for substations in high load density areas. 30 MVA transformer is now considered as the standard capacity for new purchase and installation.

It is recommended that, in addition to three types of standard unit capacity for transformers, e.g. 10 MVA, 20 MVA and 30 MVA, PEDEEE shall specify 40 MVA unit capacity transformer as one of standard unit capacities taking into account the recent rapid increase of demand. The existing small capacity transformers in high load density areas may be shifted for new or additional installation in rural areas.

Regarding the quantity of transformer units in a substation, two or three unit installation is recommended in view of reliability of supply. Complete loss of power can be avoided even when one unit of transformer fails to out of service. One unit installation shall be adopted only for a temporary or an emergency arrangement.

(2) Number of 20 kV Outgoing Feeders

In the existing system, the average number of 20 kV outgoing feeders per one 20 MVA transformer is 10 to 12 in city and 6 to 8 in rural area according to the result of team's site investigation. The data in Attachment 5-1 "List of 20 kV Feeders in Damascus and Damascus Rural" are referred to.

The number of 20 kV outgoing feeders should be determined after careful studies on the appropriate load per feeder and natures of supply area covered by the substation on a long-term basis.

The Team recommends the standard maximum numbers of outgoing feeders for each unit of transformer to be six for 10 MVA unit, eight for 20 MVA and 10 for 30 MVA. However, the number may be increased if it is desired taking into account the supply reliability, growing demand and future conversion to use of larger transformers, route alignment of 20 kV feeders, etc.

(3) Ratings of Circuit Breakers

In the Technical Report No.4 "Transmission Expansion Plan" included in the ESSP project by EU, EDF recommended a rated short-circuit capacity of 31.5 kA for 66 kV circuit breakers based on the result of computation of short-circuit current on the assumed 400/230/66 kV transmission network in whole Syria up to year 2010. This rating is used in recent future planning of the 230/66 kV network in Syria. The Team agrees to this value as the standard for future application based on the results of team's power system analysis.

As for 20 kV circuit breakers, the 20 kV short-circuit current on 66/20 kV network in the Damascus and Damascus Rural area was calculated during the power system analysis for load flow in years 2000, 2005 and 2010 of this study. The result shows that short-circuit current of the 20 kV network does not reach 25 kA even in year 2010. Therefore, the Team recommends to specify a short-circuit breaking capacity of 25 kA for 20 kV circuit breakers as a standard.

7.1.2 Standards for 66kV Transmission Lines

The recommended standards for Planning and Design of 66 kV Transmission Lines that were formulated by the Team are included in Attachment 7-2 for PEDEEE's reference.

The following points in the recommended standards are emphasized:

(1) Tower and Conductor Design for Overhead Lines

As seen in the foregoing Sub-clause 5.2.2, PEDEEE has adopted only one design of 66 kV overhead line in Syria. It is a single-circuit line with ASCR 240/40 conductors and two types of towers for suspension and tension. These 66 kV overhead lines are operated under various conditions in terms of climate, transfer capacity and regional circumstances. Therefore, some 66 kV overhead lines are facing with the shortage in transfer capacity (i.e. overloading) due to growth of demand.

From the above consideration, the Team recommends to consider application of double-circuit towers in the standards taking into account future difficulty in land acquisition along the line route, demand growth in future, coordination with the regional environment, etc. While, following economical study, it is recommended to apply larger conductor for demand increase in near future..

(2) Insulator Design

As mentioned in sub-clauses 3.5.2 for 230 kV lines and 3.6.2 for 66 kV lines, there are considerably large number of insulation breakdown faults in Syria according to past fault records. Especially, the fault rate of 66 kV lines is extraordinarily high. The surface flashover seems to occur due to morning dew on the dust contaminated surface of insulator. Dust in the desert area seems to contain a certain amount of salt.

It will not be practical to wash the insulator surface of long transmission lines, and only solution will be increase of the leakage distance of insulator string or use of special insulators with semi-conductive glaze. For increasing leakage distance, there are two ideas; the first is to increase the number of normal insulator discs in one string and the second is to use fog-type discs instead of normal discs. Larger towers are required to increase the number of discs in string but the same normal towers may be applicable for the use of fog-type insulators. The latter solution to use fog-type insulators will be appropriate to solve the problems of the existing lines by insulator replacing. Appropriate answers for new installation must be found out through either field exposure tests or technically arranged model tests.

Anyway, the extraordinary high fault rate of 66 kV lines must be lowered.

(3) Size of Underground Power Cables

All 66 kV underground power cables installed in Damascus and Damascus Rural area are CV (XLPE insulated and PVC sheathed) power cables with 300 mm^2 copper conductors.

It is recommended that the allowable transmission capacity of the said cable lines should be defined for three operating conditions, e.g. continuous, short-time and short-circuit ratings. The current capacity of power cable lines shall be checked under various cables laying conditions.

Where the 300 mm^2 copper conductor is not sufficient in its current capacity, conductors with larger sectional areas need to be taken up. For this purpose, larger size copper conductors with sectional areas of 625 mm^2, which is planned to be used for a 66kV underground cable line in the section of Midan-II – Al Hajer Al Aswad in Damascus, is specified in the standards.

7.1.3 Standards for 20 kV and 0.4 kV Distribution Facilities

Recommended standards for planning and design of 20 kV and LV distribution facilities are compiled in Attachment 7-3 " Standards for 20 kV and 0.4 kV Distribution Facilities".

In preparation of a distribution development plan, materials manufactured locally in Syria should be used with top priority. The following are major topics that were examined in detail for recommendation of standards:

(1) Supporting Structures

Three types of poles are used in Syria. The centrifugally processed concrete poles manufactured in Syria are used with top priority and the wooden poles in mountainous areas to where access by heavy vehicles is difficult. These two types of poles (single poles) are used at the straight sections and double poles or latticed steel poles are used at terminal and angle points.

The recommended span lengths, pole lengths and pole setting depths are presented in the standards in Attachment 7-3.

(2) Electrical Conductors and Cables

Kinds of conductors used for three types of 20 kV and LV distribution main feeders, overhead, underground cable and overhead cable, are as given below:

Table 7.1-1 Kinds of Conductors for Main Distribution Feeders

	20 kV Feeders	0.4 kV Feeders
Overhead line feeder	AS 120 mm^2	AL 120 mm^2
Overhead cable feeder	AL 185 mm^2	AL 120 mm^2
Underground cable feeder	AL 185 mm^2	Cu 120 mm^2

Smaller size conductors are also used for branch feeders.

The same size of conductors shall be used for entire length of main feeders to enable efficient line sectionalizing and interconnecting with other feeders.

Various problems have been noted regarding installation practices of overhead lines and underground cables. It is required to establish proper installation practices and to be followed by site working groups.

(3) Distribution Transformers

The supply area of a distribution transformer shall be independent among each other not overlapping with those of others and the length of LV lines shall not be too long to limit voltage drop and power loss within permissible ranges. A proper unit capacity must be selected according to the load density of the supply area. The unit capacity shall be relatively large in city area with high load density and small in rural area.

Distribution transformers are to be installed in ground mounted concrete structures (transformer stations) in city area and mounted on poles in rural area with overhead line.

The transformers are to be electrically protected by lightning arresters and fuses.

(4) Switching Apparatus

20 kV load break switches are to be used to sectionalize feeders and to interconnect with other feeders. These switches will be effective to separate the fault section in case a fault occurs on the line and to restore power supply to healthy sections. Such sectionalizing and interconnecting operations are to be performed under loaded conditions, therefore switches need to be capable to break load current.

7.2 Standards for Quality of Power Supply

The recommended standards for the quality of power supply are compiled in Attachment 7-4 " Standards for Planning Distribution Facilities".

7.2.1 Standards of System and Supply Voltage

To maintain the consumer supply voltage of various voltage classes in the desired range, system voltages must be properly controlled at all voltage levels. In case of the PEDEEE's power system, the system voltage shall be managed for each of 66 kV, 20 kV and 0.4 kV system.

(1) 66 kV System Voltage

The 66 kV system voltage is principally controlled at the 66 kV buses of 230/66 kV substations of PEEGT using on-load tap changers on main transformers and static capacitors as required. However, the 66 kV bus voltage of receiving substations (PEDEEE side) varies due to voltage drop in lines depending on line length, sending power, power factor, etc. The 66 kV bus voltage is to be regulated within ± 5% of rated voltage. In case that voltage drop in 66 kV lines is excessive, static capacitors are to be provided on the 20 kV bus of appropriate substations.

(2) 20 kV Supply Voltage

The following four methods are to be taken into account to regulate the 20 kV supply end voltage:

(a) On-load tap changers on 66/20 kV transformers:
Each 66/20 kV transformer is to be provided with an automatic on-load tap changer with tap range of around ±10%. Though the existing transformers are provided with ±16% taps, such a wide range will not be adequate. It is told that the tap changers of 66/20 kV transformers are at present operated manually, but the automatic operation is preferable to improve the service level. To compensate voltage drop in line, the setting voltage of tap changer had better be set high during peak load time and relatively low during off-peak time.

(b) Line drop compensators combined with on-load tap changers:
This is a device to adjust on-load tap changer setting voltage automatically according to amount of load, high voltage during heavy load time and lower during light load, to compensate voltage drop in 20 kV feeders. In actual devices, current values measured by CT represent load values. This device functions only when the on-load tap changer is operated in automatic mode.

(c) Static capacitors at line ends:
The best method to reduce voltage drop in a 20 kV feeder is to improve power factor of load

preferably to around 95%. For this purpose, 400V static capacitors are installed at many 20/0.4 kV transformer stations. It is recommended to promote installation of static capacitors by large 20 kV and 20/0.4 kV consumers. In Japan, the installation of static capacitors to improve power factor is requested in the supply contract between power utility and a large consumer and the supply line is energized after the installation of capacitors is confirmed. There is also an incentive measure to reduce tariff if the power factor is improved exceeding a certain target.

(d) Step voltage regulators at line mid-points:
In case that a line is long and the voltage drop is excessive even though the above countermeasures are taken, a step voltage regulator is usually installed at the mid-point of line to compensate voltage drop in line. The step voltage regulator is a single winding auto-transformer with taps to adjust the secondary voltage (say ± 2 x 2.5%). Widely used equipment is three to five MVA set mounted on pole, of either automatic type with an on-load tap changing device or manual type with an off-load tap changer.

(3) 0.4 kV Supply Voltage

20/0.4 kV distribution transformers are to be provided with off-load tap changers with taps of 400V ± 2 x 2.5% to adjust 400V delivery voltage. As the rated consumer end voltage is 380/220 V, 5% allowance is taken into account for voltage drop.

Long and heavy loaded LV lines shall not be planned to limit the voltage drop in line within the permissible value of 8%.

7.2.2 Standards of Supply Reliability

The supply reliability planning in Syria is in a primitive stage and there seem not established principles for proper planning. The reliability of supply is usually evaluated by continuity of supply, for instance as average annual duration of supply interruption. For generation planning, LOLP (Loss of Load Probability) is employed as a factor to judge reliability of power supply system.

Transmission and Distribution reliability indices may relate to the performance of the system as a whole (interconnected system indices) or the reliability of supplies at specific points on the network (load point indices). Transmission and distribution reliability criteria will either be deterministic or probabilistic. The deterministic criteria require that the system can withstand relatively frequent outage events without affecting service continuity. These are usually expressed as 'N-1' (single outage contingency) or 'N-2' (double outage contingency) criteria that load can still be supplied in the event of either a single or a double outage event. Loss of network components such as overhead lines, cables or transformers, possibly coupled with breakers is to be considered. In some cases more serious events such as a set of busbars, or cascading tripping is also considered. However, it will not be necessary that no supply interruptions occur for all contingencies considered, effects of outages shall also be taken into account. These indices may be calculated for pre-determined outage events.

Probabilistic criteria are intended to recognize the random nature of outage events and provide measures of system reliability on the basis of the outage statistics of the system components.

The majority of electricity utilities in the world are using deterministic criteria for planning their power systems, mostly on the 'N-1' criteria that ensures the supplies are not interrupted on the single contingency basis.

Deterministic indices can be calculated using a load flow program to simulate the effect of a chosen outage or outages, and information on line overloads, out of limit voltages, etc. can be obtained. The calculation of probabilistic indices is considerably more complex, both in view of computation technique and because of the difficulty in obtaining suitable data on the reliability of major system components.

For the distribution network of PEDEEE in the study area, it is recommended to satisfy the above 'N-1' criteria as far as possible. Major HV network is usually configured so that any supply interruption may not occur with the help of rapid circuit reclosing in the event of temporary faults. But, it is not practical to apply such severe reliability criteria to a distribution network. The reliability of a distribution network is designed so that the power supply can be restored at a shortest possible time after an interruption due to a fault. The distribution network of the Damascus and Damascus Rural area is proposed to be designed taking into account the following principle:

(1) 66 kV Network

Each feeder shall be provided with a low-speed, 3-phase reclosing mechanism for single shot auto-reclosing for quick supply restoration in the event of temporary faults.

Each substation shall be provided with at least two incoming lines so that necessary power can be received even when one circuit is lost. Circuit changeover after supply interruption may be required.

Each 66/20 kV transformer shall normally be operated independently without interconnection on the 20 kV side. However, the 20 kV side interconnection is required when one in plural transformers is lost. When one transformer is in fault, loading of the remaining transformer(s) shall not exceed 110% of the rated capacity.

(2) 20 kV Network

20 kV feeder system shall normally be configured in radial system of multi-divided and multi-connected, in

which a number of section and interconnection switches adequate for circuit changeover must be provided.

Each feeder from substation shall be provided with a low-speed, 3-phase auto-recloser for 3-shot auto-reclosing for quick supply restoration in the event of temporary faults. The system shall be combined with section switches with automatic fault locating function for automatic supply restoration up to reaching the fault section.

Explanation of automatic successive reclosing and supply restoration is as follows: When a fault is detected by relays at the substation the feeder is tripped by the circuit breaker for feeder, then all section switches are opened automatically. The circuit breaker is reclosed after a pre-determined no-voltage time (say one minute), then the first section switch is automatically closed after a pre-set time (say 7 or 14 seconds) by detecting line voltage from the power source side. Successively the next switch is also closed automatically in the same manner. When such closing operation reached the fault section (not cleared), the substation circuit breaker is tripped again by detecting a fault and the successive closing function of the section switch of the fault section is blocked. The circuit breaker is reclosed again and section switches are closed successively in the same manner as mentioned above. The closing operation of the section switches of the fault section is blocked. Thus, the power supply before reaching the fault section can be restored automatically. The fault section is indicated on the control board of the substation.

Power supply to the sections farther than the fault section can be restored by connecting the sections with other feeders by closing interconnecting switches.

(3) 0.4 kV Network

Loading of a 20/0.4 kV distribution transformer shall not exceed its rated capacity.

LV system shall be of radial formation, but influence due to a fault shall be minimized by properly arranging protection fuses.

7.3 Operation and Maintenance System of Facilities

7.3.1 Principles in Operation and Maintenance

Major target of PEEGT and PEDEEE for equipment maintenance is:

> "To maintain Transmission and Distribution plant and equipment as necessary to both maximize its effective life and to retain optimum performance of the system components throughout their lives."

This policy forms the basis of maintenance practices in both establishments.

As discussed in the foregoing Sub-clause 5.5.2, the Team observed several items in the PEDEEE's present operation and maintenance system to be improved. ESSP also has investigated and examined the system in 1996 and given to PEDEEE its recommendations to improve the present maintenance standards and practices of PEDEEE. PEDEEE plans to implement the recommended improvements soon. The summary of ESSP's recommendations are as follows:

(a) Spare parts lists are to be prepared for equipment of all voltage levels, with detailed specifications of requirements and availability or possibility of local manufacture investigated.

(b) Transformers:

Prepare a program of divertor maintenance for a sample number of 66/20 kV transformers. Review the findings and develop a program for future maintenance. List makes and types of all tap changers together with required parts list, and arrange for spares to be available.

Stress the importance of silicagel breathers and institute a planned system of the regular changing of silicagel.

(c) Tower line:

A review is required regarding all tools and equipment used for the purpose of manipulation of tensioned conductors. Any of this type of equipment found to be defective is to be scrapped and replaced with new rated gear.

A system is to be initiated for routine and regular checking of these equipment, with records kept on conditions and projected replacement dates.

(d) Develop a computer-based system for keeping centralized records and producing information on age profile, maintenance needs, estimated replacement, future work load and expenditure. Use this system to forecast short, medium and long term manpower and financial requirements of the distribution maintenance function.

(e) Introduce a form of safety rules system together with a standard operational procedures document.

(f) Standard operating diagrams should be produced, together with a system ensuring that they are kept up to date at all voltage level.

(g) The whole operational situation should be investigated and documented, which would lead to further recommendations as future requirements.

In addition, ESSP stressed the need of training of PEDEEE's staff and maintenance personnel either in overseas or local presentations and on-job training. The most valid areas to be considered for specialist training are:

- Computerized recording system for the central storage and management of plant and circuit information.

- Safety and operations. In order to install a safety regime, it would be necessary for intensive training throughout the country in the Arabic language.
- New installation. As part of specifications for new switchgear, local training should be prescribed regarding care and maintenance of a new plant.

7.3.2 Introduction of Simple Database System

A simple database system was created aiming at the adequate operation and the maintenance management of distribution facilities and equipment. Individual items which shall be managed by the database system are quite different each other between respective distribution facilities. All distribution facilities were, therefore, put into several categories, as mentioned below, for enabling PEDEEE's staffs to manage these facilities easily by the database system.

(a) 20/0.4kV Transformer
(b) Supports (Steel Tower, Concrete Pole, Wooden Pole)
(c) Conductors
(d) Line switches
(e) Arresters
(f) Underground Cables
(g) Special Equipment(Fault detector and Fault point indicator)

For preparing the database system, Microsoft software "Access 97" that is a database software for general purpose is adopted aiming at simple and easy database system to operate, taking into account user interface. Furthermore, since Microsoft software "Excel" is excellent in the data processing and editing, a function to exchange the stored data between "Access" and "Excel" is added in order to edit the data easily.

The database system was installed in the computer systems of both Damascus City and Damascus Rural companies and PEDEEE during the study period, and the operating method was transferred to the counterpart personnel by the Study Team.

As described in Clause 5.7.4, both distribution companies did not have the detailed data of distribution facilities other than 20/0.4kV transformers. The persons in charge of facility management had, therefore, started to input the data of 20/0.4kV transformers into the database system. All data of 20/0.4kV transformers which had been recorded in the separate offices are integrated in the same database system, and at the result the unified management for loading data and past operating records of transformers became to be possible.

For the other distribution facilities, it is necessary to execute the following preparatory works in order to utilize database system:

(a) Collection and storing of design and layout drawings

(b) Numbering of facilities

First of all, it is necessary to renew all the drawings of design, layout, single line, etc. for the facilities according to the latest information. Next, it is necessary to put a number on each equipment and facility to be managed by database system. The number shall be an alphanumeric character to suit database system. Numbering on the facilities shall be started from a point of reference which shall be decided in advance, and then continued to the next facility or equipment. For instance, a reference point for overhead lines is normally taken at a support and that for underground lines is an equipment/facility (transformers, line switches, supports, etc.) which exists along the line.

By introducing the database system to the management of distribution facilities, the following effects are expected in future:

(a) Improvement and rehabilitation plans for the distribution system can be made efficiently.

(b) Utilization of database system in the patrol on the facilities prevents accidents from taking place.

(c) After getting the database system prepared at every emergency office, the database system can be used for an efficient analysis on the investment plan to the facilities and determination of facility development plans when compared with other emergency offices.

(d) For a full-scale database system by the large computer system in future, all the data stored in the simple database system can be transferred to the new system easily.

It is expected to use the simple database system provided by the Team effectively by the personnel in charge of both distribution companies for the purpose of control and management of not only 20/0.4kV transformers but also other distribution facilities by preparing necessary data.

The outline of simple database system prepared by the Team is described in the Attachment 7.9.

7.4 Power Flow Analysis

7.4.1 66 kV Network

(1) General

The present network of the 400/230 kV transmission system in whole Syria and the 66 kV network in South region are shown on Fig. 3.5-1 and Fig. 5.1-1 respectively.

In carrying out power flow analysis in the study area, the 400/230 kV transmission network in the whole Syria and the 66 kV network in the study area are combined into one transmission network comprising major and secondary systems. In the system, 66 kV networks in other regions were not taken into account. Small amount of exchange of electricity between other regions and the study area through 66 kV lines was neglected.

Particulars of the existing power generating facilities in Syria are listed in Table 3.4-2. Generation and 400/230 kV transmission facilities in Syria are assumed to be developed according to recommendations in the master plan study under ESSP.

Peak loads of 230 kV substations in the other regions were obtained from the results of load forecast study in the Generation and Transmission Master Plan under ESSP. For the study area, forecasted simultaneous peak loads in Sub-clause 4.2.3 "Peak Load Forecast" are applied to all 66 kV substations.

The power flow of the 66 kV network in the study area are analyzed in three stages, e.g. the years 2000, 2005 and 2010, for which years improvement plans of distribution network are to be formulated.

The allowable current and power transmission capacities of various types of conductors and cables are as shown in Table 7.4-1.

Under normal operation, transmission lines are to be operated at less than 80% of their thermal rating, which is the target level prescribed by PEEGT. Under contingency loading conditions conductors can be operated up to the 100% of thermal rating (allowable maximum current). These criteria are used to judge loading situations of the lines in the power flow analysis.

Table 7.4-1 Power Transmission Capacity of Lines

Voltage (kV)	Conductor Size (mm^2)	Allowable Current & Transmission Capacities	
		Normal Condition	Emergency Condition
400	2 x 550	2 x 800 A 1,000 MVA/Circuit	2 x 1000 A 1,400 MVA/Circuit
230	400	600 - 650 A 260 MVA/Circuit	850 A 340 MVA/Circuit
66	240/40	480 A 55 MVA/Circuit	600 A 68 MVA/Circuit
66	Cable, Cu 300	400 A 45 MVA/Circuit	500 A 57 MVA/Circuit

(2) Results of Analysis in Year 2000

Configuration of the 400/230 kV network and as well as location of generating facilities in the whole Syria in the year 2000 are almost same with those of the present network. To the present distribution network in the study area, three 66/20 kV substations now under construction, Kafersuseh, Harash and Khan Al Shih, are to be added. Single line diagram of the 400/230 kV network for whole Syria is shown on Fig. 7.4-1 and diagram for the study area on Fig. 7.4-2.

The result of power flow analysis in the year 2000 is shown on Fig. 7.4-3 and points to be noted are summarized below:

(a) The South region that include the study area will need to import electric power of 514 MW in total from the Central region through 400/230 kV transmission lines as follows:

- 400 kV line of Jandar – Adra II	234 MW
- 230 kV line of Jandar – Adra II	181 MW
- 230 kV line of Qattineh – Qaboon II	141 MW

(b) All the 66 kV lines in the study area are operated with load flows less than 80% of thermal rating under the normal operation. Only a few lines will carry relatively heavy loads of near to 80% of thermal capacity as follows:

- 66 kV cable line of Midan II – Dawar Al Matar	49 MVA/circuit
- 66 kV cable line of Dummar – Amaween, 2 circuits	46 MVA/circuit
- 66 kV overhead line of Midan II – Al Hajar	57 MVA/circuit

(c) Voltage levels at 66 kV busbars of all the 66/20 kV substations will be maintained within ± 5% of rated voltage. Static capacitors of 305 MVar in total as shown on the single line diagram were required to regulate the 66 kV bus voltage according to the power flow analysis.

(d) 230/66 kV transformers at Qaboon II and Dummar will be slightly overloaded compared with the installed capacities as follows:

Substation	Load	Existing Installed Capacity
Qaboon II	221 MVA	3 x 70 MVA = 210 MVA
Dummar	167 MVA	2 x 80 MVA = 160 MVA

This overloading problem will dissipate by 2005 by construction of new substations. Further load dispatching study will be required to decide temporary countermeasures against the above overloading.

As stated above, under the normal operation there will be no serious problems in the load flow in the 66 kV network of the study area except the overloading of 230/66 kV transformers, which will be discussed in detail in Clause 8.1.

To confirm supply reliability with 'N-1' criteria under single contingency cases, power flow analyses were repeated for the same network under the typical contingency conditions of the above heavy loaded lines being lost. The results show that some overloadings may appear on 66 kV lines as follows:

	Contingency Conditions	Overloaded lines	Overloading (%) against thermal rating
(1)	One line of Dummar - Amaween section is open.	The other circuit of the same section	140 %
(2)	One line of Midan II - Al Hajar Al Aswad section is open.	Midan-II - Dawar Al Matar line	130 %
(3)	One line of Midan II - Dawar Al Matar is open.	Midan-II – Al Hajar Al Aswad line	100 %

The countermeasures for reinforcement of the above overloaded lines are discussed in Clause 7.5, and further in Clause 8.1.

As for single contingency faults by loss of one of transformers, many substations do not satisfy the 'N-1' criteria. In case that one transformer is lost under peak load in two-unit substations, the remaining transformers will be overloaded in many cases. This problem will be further discussed in Clause 7.5 and Clause 8.1.

(3) Results of Analysis in the Year 2005

Configuration of the 400/230 kV network and as well as location of generating facilities in the whole Syria in year 2005 are as shown on Fig.7.4-4 prepared in accordance with the recommended development plan in the Generation and Transmission Master Plan of ESSP. Outline of development plans between 2000 and 2005 are assumed below:

(a) Steam generation plant at Al Zara with 3 x 200 MW units will be commissioned by the year 2001.

(b) In accordance with recommendations in the Generation Expansion Plan by EU, one set of 330 MW combined cycle plant is to be constructed at Dier Ali in the study area.

(c) The 400 kV transmission system will be extended to connect Adra II, Deir Ali, Dimas and Jandar to form a ring around Damascus, and connected to Jordan. Further, the 400 kV system in the Jandar – Hama 2 section is to be reinforced by adding a second circuit.

(d) Two 230/66 kV substations are to be constructed in the study area at Mazzrha and Zahera. Both substations will be provided with 2 x 125 MVA, 230/66 kV transformers. The Mazzrha substation will be fed mainly from Nasriah and the Zahera substation from Tishreen. The both substations are to be connected with the 66 kV network as shown on Fig. 7.4-5.

(e) Particulars of eleven (11) 66/20 kV substations to be constructed and put into operation by the year 2005 are as follows:

Names: Barzeh, Qsoor, Ibn Al Nafis, Zablatani, Sheik Hassan, Jaramana, Hosh Blas, Jalaa, Jededat Artouz, Yalda and Bludan.

All these substations are to be provided with 2 x 30 MVA transformers. The 66 kV network in year 2005 including the above two 230/66 kV substations and eleven 66/20 kV substations will be configured as shown on Fig. 7.4-5. In addition, increase of substation capacity is planned at various substations as detailed in Clause 8.1.

The result of power flow analysis in 2005 is shown on Fig. 7.4-6 and major points to be noted are summarized as follows:

(a) Although the South region will add a generating plant of 1 x 330 MW at Dier Ali, the region including the Damascus and Damascus Rural area will need to import electric power of 740 MW in total from the Central region through 400 kV and 230 kV transmission lines as given below:

- 400 kV line of Jandar -- Adra II	241 MW
- 400 kV line of Jandar – Dimas	195 MW
- 230 kV line of Jandar – Adra I	170 MW
- 230 kV line of Qattineh – Qaboon II	134 MW

(b) All the 66 kV lines in the study area are operated within the thermal capacity of respective line under normal operation. Some 66 kV lines will carry relatively heavy loads of about 80% of thermal rating as follows:

- 66 kV cable line of Zahera – Dawar Al Matar	49 MVA/circuit
- 66 kV Cable line of Mazzrha – Ersal	45 MVA/circuit
- 66 kV Cable line of Mazzrha – Thawra	48 MVA/circuit

(c) Voltage levels at the 66 kV busbars of all 66/20 kV substations will be maintained within ± 5% of the rated voltage. Static capacitors of 585 MVar in total will be required in the study area according to the power flow analysis.

(d) The loading of 230/66 kV transformers at the Adra II substation will reach the installed capacity as follows:

Substation	Loading	Available Installed Capacity
Adra II	325 MVA	2 x 125 + 80 MVA = 330 MVA

Thus, so far as the power flow analysis of the 66 kV distribution network in 2005 is reviewed, no serious problems are found in load flow of the lines under normal operation except full loading of the above 230/66 kV transformers.

The power flow analysis was also repeated in the same system under contingency conditions to confirm safe operation under 'N-1' criteria. The heavy loaded lines stated above are supposed to be overloaded under the contingency conditions, of which the results are shown below:

	Contingency Conditions	Overloaded lines	Overloading (%) against thermal rating
(1)	One line of Zahera - Dawar Al Matar is open.	No overloading found	-
(2)	One line of Mazzrha - Ersal section is open.	Mazzrha - Thawra line	112 %
(3)	One line of Midan II – Kafersuseh section is open.	No overloading found /1	-
(4)	One line of Fursan – Jalaa is open	No overloading found	-

/1: In this case, the Kafersuseh – Midan I line shall be opened and the power to Midan I shall be sent from Dawar Al Matar by closing the Midan I – Dawar Al Matar line.

The reinforcement of the above overloaded lines will be necessary to satisfy the system reliability under 'N-1' criteria.

For the loss of one transformer unit, the 'N-1' criteria are mostly satisfied on the condition that overloading of 120 to 130% is allowed for short time.

(4) Results of System Analysis in the Year 2010

The 400/230 kV transmission network in the whole Syria in the year 2010 is shown on Fig. 7.4-7. The developments during 2005 to 2010 are assumed as mentioned hereunder, in accordance with the recommended development plans in the Generation and Transmission Master Plan of ESSP.

(a) The following generating plants will be developed:

Location	Capacity
Dier Ali	3 x 330 MW (2 x 330 MW added to the year 2005 plant)
Nasriah	2 x 330 MW
Latakia	2 x 330 MW
Tayem	2 x 330 MW
Total	9 x 330 MW

(b) The 400 kV transmission system is to be expanded toward the East direction connecting Aleppo F, Thawra and Tayem, and finally to be connected with the Iraqi system. In addition, the 400 kV system will be extended from Hama 2 to Zayzoun and Aleppo-F.

(c) 230 kV transmission lines are to be newly constructed commensurate with the completion of generating plants at Nasriah and Dier Ali as shown on the single line diagram.

(d) Three 230/66 kV substations, the Al Faibaa, Baramekha and Saiedeh Zanab substations, are planned in the study area by the year 2010. Each substation will be provided with 2 x 125

MVA transformers.

(e) Eight (8) 66/20 kV substations will be constructed and put into operation by the year 2010 as follows:

Names: Yabroud, Al Tal, Harasta, Nashabieh, Melcha, Darea, Kudseia I and Kudseia II

All these substations are to be provided with 2 x 30 MVA transformers. The 66 kV network in the year 2010 including the above three 230/66 kV substations and eight 66/20 kV substations is shown on Fig. 7.4-8. In addition, increase of substation capacity is planned at various substations as detailed in Clause 8.1.

The result of power flow analysis on the assumed 66 kV network is shown on Fig. 7.4-9. Summary of the results to be noted are mentioned hereunder:

(a) The generating facilities in South region will increase their capacity to meet the power demand in South region with the completion of Dier Ali (3 x 330 MW) and Nasrieh (2 x 330 MW). The South region will still need to import 152 MW power from the Central region.

(b) All the 66 kV lines in the study area will be operated within 80% of the thermal capacity of lines under normal operation, except the following line:

- 66 kV overhead line of Kafersuseh - Baramekhe 46.4 MVA/circuit (81.8 %)

(c) Voltage levels at the 66 kV busbars of all substations will be maintained within ± 5 % of the rated voltage. Static capacitors of 745 MVar in total will be required to regulate the 66 kV bus voltage in allowable range according to the power flow analysis.

Thus, from the results of power flow analysis on the assumed 66 kV network in 2010, no serious problems are found in the load flow on lines under the normal operation except overloading of the above 230/66kV transformers.

To confirm safe operation of the system even under 'N-1' criteria, the following heavy loaded lines were assumed to be lost in power flow analysis. The results are shown below:

	Contingency Conditions	Overloaded lines	Overloading (%) against thermal rating
(1)	One line of Zahera - Dawar Al Matar is open.	S. Hassan - D. Al Matar cable line	112 %
(2)	One line of Dummar - Amaween section is open.	The other circuit of the same section	111 %
(3)	One line of Zahera - S. Hassan is open.	No overloading found[/1]	-
(4)	One line of Mazzrha - Ersal is open.	Mazzrha – Thawra cable line	103 %
(5)	One line of S. Zinab - Maarad is open	The other circuit of the same section	114 %

/1: In this case, over-loading on lines can be solved by opening of the Zahera - Dawar Al Matar line and Bab Sharki - Jaramana line.

The reinforcement of the above overloaded lines will be necessary to maintain the system reliability under 'N-1' criteria. The proposed reinforcement will be discussed in Clause 8.1.

As for the loss of one transformer, the 'N-1' criteria will be almost satisfied with minor overloading even under contingency conditions.

(5) Short-Circuit Current and Losses

(a) Short-Circuit Current

Three phase short-circuit analyses were conducted to check short circuit current at each 230/66 kV substation and 66/20 kV substations for the three stages of the years 2000, 2005 and 2010. The results are shown in Table 7.4-2.

As seen in the table, the largest short-circuit current at the 20 kV busbar is 23.6 kA at the Qaboon I substation for the year 2010. The rated short-circuit breaking current of 25 kA in the proposed equipment standards for 66/20 kV substations will be enough for all 20 kV circuit breakers in the study area.

For the 66 kV circuits, the largest short-circuit current is 31.8 kA at the Mazzrha substation in 2010, which slightly exceeds the rating of 31.5 kA proposed in the standards. The short-circuit current at all other locations is within 31.5 kA. Six heavily loaded lines are connected to the Mazzrha substation and the circuit separation planning is difficult at the present stage. Actual operation plan need is to be reviewed later when the situation advanced. In the calculation of short-circuit current, most of 66 kV lines are assumed to be interconnected except some limited separations. The short-circuit current under the actual operation when 66 kV lines are mostly operated in radial formation will be reduced to less than 31.5 kA. It is, therefore, considered that the proposed rating of 31.5 kA for 66 kV circuit breakers will satisfy the requirements up to 2010.

(b) Losses

The total loss (only ohmic loss in lines) in the 66 kV lines in the network of the study area are calculated through the power flow analysis for each of three stages as follows:

Table 7.4-3 Losses in 66 kV Lines

		2000	2005	2010
Total Supply at 230 kV substations	(MW)	1,205.7	1,660.2	2,319.5
Loss in 66 kV lines	(MW)	15.4	16.4	14.4
	(%)	1.27	0.99	0.62

As shown in the above table, the loss factors in 66 kV lines will decrease gradually with the addition of new 230/66 kV substations in future. The equivalent line length of 66 kV lines from the source 230/66 kV substations to 66/20 kV substations seems to become shorter, and loss factor declined. The above losses do not include losses in 66/20 kV transformers and station use in substations.

7.4.2 20 kV and 0.4 kV Networks

The 20 kV and 0.4 kV distribution networks in the study area are basically operated in radial formation and do not form loop. Therefore, power flow characteristics of 20 kV and 0.4 kV feeders, voltage profile and power loss, were calculated using simple computer programs for radial feeders emanating from substation buses and from distribution transformers. The current flowing out from a substation can be obtained by summing up current corresponding to transformer loads. Network analyses were carried out on the following cases to understand power loss and voltage drop of the following lines:

- Heavily loaded 20 kV feeders that may cause large loss and excessive voltage drop
- Typical models of 0.4 kV feeders to find out conditions that cause large loss and excessive voltage drop

The following conditions are assumed on network calculations of 20 kV and 0.4 kV systems in the study area.

(1) 20 kV networks

- Load of each transformer is proportional to transformer capacity.
- Power factor at the outgoing point from substation is 0.9.
- Voltage at the outgoing point (20 kV of 66/20 kV substation) is 19 kV.

(2) 0.4 kV networks

- Feeder loads are uniformly distributed along the whole length of lines.
- Phase currents are individually modeled.
- Neutral lines are not earthed.

The results of calculations are used to evaluate loss and voltage drop discussed in Chapters 5, 7 and 9. Examples of results of network calculations for 20 kV and 0.4 kV networks are presented in Attachment 7-5 and 7-6 respectively.

7.5 Basic Rehabilitation Plan for 66 kV Facilities

7.5.1 Basic Plan

Principles for planning rehabilitation and expansion of the 66 kV network including 66/20 kV substations and 66 kV lines were established by the JICA Study Team through consultation with PEDEEE prior to the formulation of system improvement plans based on the recommended standards for planning, design and operation of the distribution facilities as discussed in Clauses 7.1 and 7.2. The standards were recommended taking into account the present problems of the system, the growing power demand in the study area, power supply plans to the distribution system by PEEGT, and the system improvement plans already committed or planned by PEDEEE as described in Chapter 6.

Two major points of the principles for rehabilitation of 66 kV facilities are as follows:

(1) Overloading on Transformer Capacities

The most biggest problem in the 66kV facilities is that Distribution Companies or PEDEEE is not able to fulfill the requirement of their customers in supplying the electricity due to overloading on transformers in many substations during peak load time. Partial load shedding is sometimes imposed. To resolve this situation, it is urgently necessary to construct new 66/20 kV substations at appropriate locations in accordance with the increase of power demand and to increase transformer capacities of substations with the result of power demand forecast taking into account the supply reliability as described by N-1 criteria.

(2) Replacement of Old and Deteriorated Facilities

As most of substation equipment in many substations are very old and deteriorated, these equipment sometimes do not function properly. Spare parts for them are out of stock and are not obtainable now. Such old and deteriorated equipment shall be replaced with new ones to secure the reliable operation of substations.

7.5.2 Improvement Plans in Future

In accordance with the principles for planning rehabilitation and expansion of 66 kV facilities as mentioned above, improvement plans in future are to be prepared as follows:

(1) Construction of New Substations

To meet the rapidly growing power demand in the study area, new substations with sufficient quantity and capacity of 66/20 kV transformers need to be constructed. At first, substations that have already been planned by PEDEEE up to 2010 are to be taken into account. Then, the necessity of new substations in addition to the planned substations is reviewed referring to the review of power flow analysis and site-specific problems.

(2) Transformer Capacity

The transformer capacity of each substation in the study area, for both the existing substations and newly constructed substations, are examined to increase the capacity by replacing with a larger capacity one or installing an additional transformer unit, according to the peak load forecast described in Sub-clause 4.2.3. Unit capacity of transformers and quantity of transformer units shall comply with the equipment standards for substations. The 'N-1' criteria for system reliability shall be applied step by step in designing the transformer capacity of 66/20 kV substations in the study area, to fulfill the requirements by year 2010.

(3) 20 kV Circuit Breakers

The existing 20 kV circuit breakers of low oil content type have been in service for more than 15 years. The equipment have heavily deteriorated and the lack of spare parts makes maintenance difficult, and need to be replaced with new 20 kV circuit breakers of SF6 gas or vacuum type. By the 2010, all minimum oil content type circuit breakers need to be replaced.

The short-circuit interrupting capacity of each substation shall be checked through system analysis, and in case that short-circuit capacity is not enough replacement of 20 kV circuit breakers with lager capacity ones shall be planned. The replaced circuit breakers can be re-used in substations in rural areas.

(4) Protection Relays on 20 kV Feeder Bays

Most of protection relays equipped on 20 kV feeder bays, e.g. over-current relays and earth fault relays, are of electromechanical type and have been out-of-dated, and their maintenance is difficult as spare parts are run out. Those relays need to be replaced with new static protection relays of digital type to improve reliability of protection and coordination with other systems. However, it is not practical to replace only such protection relays with new relays in panels as fundamental modification of all system including power source, operating sequence, etc. is required. It is recommended to renew the relaying system when a complete set of 20 kV cubicles including protection relays, current transformers, measuring instruments, indicators and other accessories are replaced with new cubicles. It is proposed to replace the complete 20 kV switchgear with new switchgear equipment of conventional metal-enclosed type or GIS type. Substations important to operation of the distribution network shall be replaced at first priority.

In connection with the above Item (3), it is proposed to execute both replacement of 20 kV circuit breaker only and replacement of complete switchgear cubicles including protection relays and auxiliaries for the period up to the year 2005. After the year 2005, the replacement works is to be executed by complete 20 kV cubicles only.

Thus, most of 20 kV switchgear with protection relays will be renewed by the year 2010.

(5) Reinforcement of 66 kV Network

As the results of power flow analysis for the years 2000, 2005 and 2010, several 66 kV lines will be overloaded in addition to those planned by PEDEEE. Therefore, it is required to reinforce transmission capacities of these lines by adding new circuits or lines or by replacing the conductors with those of larger cross sections to increase transmission capacity.

(6) Replacement of 66 kV Circuit Breakers

The rated short-circuit interrupting current of the existing 66 kV circuit breakers is 16 to 31.5 kA. According to the Transmission Expansion Plan conducted by EDF under ESSP, the 31.5 kA interrupting capacity is recommended as the standard rating. Based on the result of short-circuit current calculation on the 66 kV system, the rated short-circuit breaking current of the 66 kV circuit breakers shall be examined regularly. In case that the calculated short-circuit current exceeds the existing rating, the circuit breakers need to be replaced with those with larger rating. It is required to try to use the replaced circuit breakers at rural substations with smaller short-circuit capacity. All the circuit breakers to be purchased newly shall be of 31.5 kA short-circuit interrupting capacity, following the recommendation of EDF.

(7) Replacement of 66 kV Switchgear and Control Devices

Regarding 66 kV switchgear and control equipment other than circuit breakers and main transformers, no serious problems were found through Team's site investigation, although most of switchgear equipment are old and seem heavily deteriorated. Therefore, it is recommended that 66 kV switchgear shall be maintained through periodical inspection and maintenance. In case that any improper function or heavy damage is found in the equipment, those equipment will be replaced with a spare. This is considered as a routine maintenance, and is not proposed as a sub-project for rehabilitation project.

7.6 20 kV Distribution Facilities

7.6.1 Basic Plan

As described in the Section 5.7.3 item (2), more than 90% of the unserved energy due to outages in the whole network in 1997 was caused by outages on 20kV network. Thus the system reliability of the existing 20 kV network lies in the very low level because of its present network configuration, and therefore the improvement of system reliability on 20kV network is urgently required.

The following system configurations are generally considered to be efficient to improve supply reliability:

(a) Two circuit lines

By receiving from either circuit of two-circuit line, the supply reliability can be much improved. Since construction cost of two circuit lines is higher, this arrangement can be adopted for the important areas.

(b) Closed loop configuration

System reliability can be improved by applying the loop system. However, the loop configuration requires highly reliable telecommunication channels to send protection signals. Many circuit breakers are to be installed in feeders, and therefore its facility cost is high.

As the above system configurations are very complicated and need a large amount of investment, it is not recommendable for the 20kV system in the study area.

The Team, therefore, proposes to apply "One line circuit with multi-divided and multi-connected configuration" to the 20kV network in the study area based on the standards mentioned in Clause 7.2.2,

System Configuration (One Line Circuit with Multi-Division and Multi-Connection)

In the Damascus city area, most of 20 kV feeders are arranged in the form of open loop system, and the end of feeder is connected with another feeder through a section switch that is normally open. While, in the Damascus Rural area, most of 20 kV feeders are arranged in the radial form. Thus most of 20 kV feeders are of one circuit construction. It is recommended to adopt "One line circuit with multi-divided and multi-connected configuration" as it will be the most effective way to improve system reliability of the present 20 kV system.

In this system, main feeders are divided into several sections with section switches (normally closed) and each section shall be connected to other feeders through interconnection switches (normally open). Thus, in supply interruption due to a fault, the power supply will be able to be restored by switching operation of section and interconnection switches except for the fault section

Through the whole length of main feeders from the starting point to the end should be provided with the same size of conductors to operate feeders effectively even under contingency conditions. This is to be prescribed in the recommended Standards for Distribution Facilities.

Typical system configuration of the multi-divided and multi-connected systems is depicted in Sub-clause 3.4 of Attachment 7-3. The section and interconnection switches shall be of load break type to perform switching operations under the loaded conditions.

The process of switching operations of section switches for supply restoration when a fault occurred on feeder is explained in Sub-clause 7.2.2.

If a line fault occurs near the outgoing point from a substation, the electricity supply can be restored by receiving power from another feeder as feeders in Damascus city area is mostly lightly loaded and have enough allowance to feed an adjacent feeder.

This practice is applied to the 6.6 kV distribution system of the Tokyo area, feeder peak current of its system is almost same as that of the Damascus 20 kV feeder (about 1-3 MW).

7.6.2 Improvement Plan In Future

Based on the basic plan as mentioned above, improvement plans for 20kV facilities in future are to be prepared in the following ways:

(1) Reinforcement and Improvement of 20 kV Network

(a) Main lines

No branch feeders are provided to the underground 20 kV systems, therefore all the underground 20 kV feeders are regarded as main lines. While, many branch feeders are provided to overhead 20 kV systems. Branch feeders to which large loads are connected and ends of which can be connected to another feeder are regarded as main lines of feeders. Each feeder must have one main stem line.

(b) Conductors of main lines

According to the Standards for Distribution Facilities, conductors of main lines should be ACSR 120AS for overhead feeders, and Cable 185AL for cable lines.

(c) Length of main lines

To avoid excessive voltage drops even after circuit changeover due to occurrence of a fault, the following criterion is to be applied.

- Even after switching operation due to occurrence of a fault, the total length of main line should not exceed 20 km.

For instance, in case of 20 kV feeder line with 120AS conductors and having line current of 320 A (power factor, 0.9) throughout total length of 20 km, the voltage drop is calculated at 16%. Even under contingency cases, the permissible drop of 20 kV receiving voltage is to be within 10%. As the adjustable range of on-load tap changers is around ± 10%, the line end voltage will be able to be marginally kept within the permissible range.

(d) Current flowing in main lines

In case that the main feeder line is connected to other feeder, the peak current of connected feeder should be not more than 50% of rated current capacity of the main feeder and the sum of peak currents in main feeder and connected feeder should not exceed the thermal capacity of the main feeder. In case that the sum may exceed the limit, a new feeder or new connection should be planned. For example, in case that the total current of two feeder lines with 70AS conductors exceeds its allowable current of 260A, the feeder conductors should be changed to 120AS for connecting to other feeders.

(e) Connection to other feeders

The existing 20 kV feeders are mostly connected to other feeders with disconnecting switches without load breaking function, and switching operation can be performed only under off-load condition. In this study, it is planned to replace such disconnecting switches with load-break switches that are capable of breaking load current. The assembly of feeders that can be switched another feeder with such connection is called " a block" in this chapter.

(f) Reinforcement of 20 kV main lines

There are many main feeders with conductors smaller than 120AS. Due to lack of current capacity, in many cases switching operations to restore power supply after fault can not be performed. It is proposed to prepare a plan to reinforce the existing feeders with small conductors by replacing the existing conductors with 120AS overhead conductors or 185AL cables as mentioned in the above 'Main line currents'. Branch conductors should also be reinforced to 120AS in case that new 20 kV main feeders are to be connected to these branch feeders through interconnection switches.

(g) Construction of 20 kV main lines

As mentioned in Clause 5.3, the present peak current of many feeders is less than 100 A. The current capacity of main feeders in the recommended Standard for Distribution Facilities is 320 A. Therefore, the number of new feeders to be constructed in the study period will not be many. However in rural area, a number of heavily loaded feeders are sometimes running in the same direction and it is not possible to reduce feeder loads to the mean value without adding new feeders. Therefore, construction of some new feeders will be needed to improve system reliability of such rural heavy loaded feeders. The following criterion is stressed in construction of new main lines.

- In case that total loads in a block of feeders exceeded 160A multiplied by the number of feeders for the block, construction of additional line(s) should be planned.

The load in one block of area is not always equally distributed to existing feeders. Operating ratios are quite different among each other. Load switching under normal operation will be needed to improve the conditions of large loss and voltage drops. For example, as shown in the Fig. 8.2.1, a part of the Maarad Al Nour feeder can be switched to the Dawar Al Matar Kazzaz feeder if conductors of the Kazzaz feeder are reinforced to 120AS. Many feeders have possibility of load switching in similar cases. Only the total loads in a block are considered including feeders that can be easily connected in consideration of load switching among feeders under normal operation.

(h) Installation of section switches

The separation between adjacent auto fault locating switches should be arranged so that each section has at least 1 MVA (About 50A) load. Because the peak current of an ideal feeder is 160A (half of current capacity of 120AS and C185AL), and the feeder is divided into three blocks, each with about 53A load current. Feeders with peak load of not more than 50A will not need auto fault location systems. Numbers of switches on main feeders that should be installed on main feeders are shown in the following Table 7.6-1.

Table 7.6-1 Numbers of Switches Installed on Main Feeders

Peak current	Number of fault locating switches	Number of terminal on-load switches
100-160 A	3	1
50-100A	2	1

(i) Construction of 20 kV branch feeders

In overhead 20 kV systems, 20 kV branch lines from main feeders need to feed new 20/0.4kV transformers.

(2) Replacement of Old Oil Impregnated Paper Insulated Cables

As mentioned in Clause 5.3, a lot of old oil-impregnated paper insulated cables are still used in the city area in spite of considerable oil leakage from cables. A number of joints are installed on most of cables, and prevent circulation of oil. This makes cables dry and has caused cable faults as observed sometimes. If new joints are installed, these cause similar troubles in the same principle. To improve the supply reliability by reducing the same kinds of faults, replacement of the oil-impregnated cables with CV (XLPE insulated and PVC sheathed) cables is proposed in this report.

(3) Repair of Existing Facilities and Removal of Unnecessary Junk Equipment

To ensure safety of the public and laborers of electrical works and also to protect distribution facilities, the following repairing works should be planned and executed:

- Proper enclosing of cables.
- Proper protection of cables to avoid access of the public
  (Example: Installation of protective pipes to the rising cables toward the top of poles from the underground).
- Installation of proper fuses.
- Removal of unnecessary junk cables.

7.7 Low Voltage Distribution Facilities

7.7.1 Basic Plan

The major problems of low voltage distribution facilities including 20/0.4kV distribution transformers are the following two points:

(a) Overloading of distribution transformers

As it is understood from the Table 8.3-1 of the Clause 9.3, almost 50% of 20/0.4kV distribution transformers are operated under overloading conditions or with nearly 100% load of the rated capacity of the transformer during peak load time at present. Taking into account the rapid increase of power demand, it is urgently required to increase the transformer capacities by installing additional transformers or by replacement with larger capacity transformers.

(b) Large voltage drop and losses in low voltage feeders

The long distance and heavily loaded low voltage feeder lines normally suffer from remarkably large voltage drop and large losses as described in the Clause 5.7.2 (2).

For the preparation of the rehabilitation plans for low voltage distribution facilities, the above two major problems are considered as a matter of the highest priority.

7.7.2 Improvement Plan in Future

Based on the basic plan as mentioned above, improvement plans for low voltage distribution facilities in future are to be prepared in the following ways:

(1) Unit Capacities of Distribution Transformers

From their natures, 20/0.4 kV distribution transformers should regularly be added to particular spots of distribution network according to the growth of area demand. In preparing a rehabilitation plan of the low voltage network in the Damascus City and Rural area, the same capacities of distribution transformers as the existing ones in the area are assumed to be added under the new plan.

In case of the city system, 20/0.4kV transformers have been often replaced with those having larger capacity to increase the total supply capacity instead of increasing the number of units, due to difficulty in acquiring additional sites for transformer installation. The replaced transformers can be used at other places with smaller load requirement. The overall construction cost can be reduced by installing larger units instead of adding smaller capacity ones as the latter requires extension of 20 kV lines. While power loss and voltage drop will increase by installing larger units. Under such circumstance, the overall cost that includes construction, O&M, evaluated loss cost and cost for necessary measures to reduce voltage drop must be compared. A representative calculation for cost comparison was carried out on a sample 20/0.4 kV transformer on a 20 kV line from the Adra-1 substation (See Attachment 7-7 'Example on Selection of Transformers Capacities). This transformer (200 kVA) is at present operated under overloaded condition during peak load time, and conceived two solutions, to add one more transformer of the same capacity (200 kVA) and to replace the transformer with a double capacity unit (400 kVA), are compared economically. It is understood that in this case the installation of a same size transformer is more cost effective compared with the replacement with a larger transformer.

The loss was evaluated using an ideal model (See Attachment 7-8 'Relation between Capacities of Transformers and Loss in Low Voltage Lines). Based on this model, the results in the table below were obtained regarding loss in low voltage feeders under the area load density of 500 kW/km^2.

Loss in low voltage feeders classified by capacities of transformers was calculated using an ideal model as shown in the following Table 7.7-1.

To reduce loss in a LV system, the transformer capacity should not be too large. An appropriate transformer capacity should be selected taking into account the recommended standards. In the rehabilitation plan, the capacity of 20/0.4 kV transformers will be selected after loss calculations taking into account merits to adopt the same capacity as the existing transformers. The area loss factor is proportional to $\sqrt{(C/D)}$, where C is transformers capacity and D is demand density. Therefore, if C is constant, then the loss factor will gradually decline in future with increase of D.

Table 7.7-1 Relation Between Transformer Capacity and Loss in Low Voltage Feeders

Transformer capacity	50 kVA × 1000 nos.	100 kVA × 500 nos.	200 kVA × 250 nos.	400 kVA × 125 nos.	630 kVA × 80 nos.	1000 kVA × 50 nos.	630kVA x 2 units x 40 sets
Length of a LV lines	320 m	450 m	630 m	890m	1,120 m	1,410 m	1,590 m
Loss of a LV lines	3.74 kW	5.3 kW	7.5 kW	10.6 kW	13.3 kW	16.7 kW	18.8 kW
Total loss of LV lines	1,577.9 kW (3.2%)	2,231.5 kW (4.5%)	3,155.8 kW (6.3%)	4,462.9 kW (8.9%)	5,600.9 kW (11.2%)	7,056.5 kW (14.1%)	7,920.9 kW (15.8%)
Total length of LV lines	133.5 km	188.7 km	266.9 km	377.5 km	473.7 km	596.9 km	667.0 km

Conditions: An area = 100 km^2, Demand = 50 MW, Conductor = 120AS, Demand density = 500 kW/km^2, Current on a low voltage line = 200 A, Voltage = 380/220 V

(2) Reinforcement and Construction of Low Voltage Distribution Feeders

By installing additional distribution transformers, the number of overloaded LV lines will decrease and the voltage drop in LV feeders will be reduced to a certain level. In addition, LV feeders will need to be reinforced according to requirements of site by site. Plans to reinforce LV feeders will be prepared based on the following conditions:

- Even after installation of additional distribution transformers, overloading or voltage drop problems of LV lines may not be improved to a certain level. (Basically, additional distribution transformers are to be installed to solve the overloading of the transformers and not to solve the overloading or excessive voltage drop of LV feeders.)
- The conductor size of LV feeder shall not be larger than the standard sizes (i.e. overhead conductors of ACSR 120 mm^2 or cables of Cu 185 mm^2).

(3) Repair of Existing Facilities and Removal of Unnecessary Junk Equipment

To ensure safety of the public and laborers of electrical works, and also to protect distribution facilities, the following repairing works should be planned and executed:

- To secure safe clearance between live parts and other structures.
- Proper protection of cables to avoid access by the public (Example: Installation of protective pipes to the rising cables toward the top of poles from underground).
- To keep the door of transformer station being locked.
- To close holes on the walls of transformer stations to prevent ingress of dust, insects or small animals.
- To install proper fuses.
- To remove unnecessary junk cables.
- To clean the transformer stations (i.e. To remove unnecessary junk parts in the transformer stations, and to clean dust on conductors).

(4) Countermeasures against Illegal Connections

As the technical countermeasures to reduce the illegal connections, the Team recommends the followings:

- Introduction of PVC covered wires to overhead feeders
- Installation of meter boxes outside of customers' buildings

It is recommended to implement those countermeasures along with the expansion or rehabilitation works, except those cases that the illegal connections cause serious problems.

7.8 Protection System

7.8.1 66 kV System

In the present transmission system, the design concept of European standard practice is employed for the protection relaying of the 66 kV network, and there will be no need to change the basic concept of the protection system except for the following points.

(1) Use of Digitalized Static Relays

The old electro-mechanical relays have been applied worldwidely for a long time as standard protective relays. Similarly, in Syria all old relays are of this electro-mechanical type. With progress in the semiconductor technology in the world, the type of relays has made fundamental change from analogue electro-mechanical type to digital static relays through short time adoption of analog static-relays. Due to superiority and flexibility of characteristics of digital relays, the electro-mechanical relays are no more used for new application. Manufacturers have already stopped manufacture of old electro-mechanical relays, and therefore spare parts of electro-mechanical relays are going to be run out and their purchase is not possible. It is recommended to replace old relay boards with electro-mechanical relays gradually with those provided with new digital relays.

(2) Line Protection

(a) Distance protection:

It is considered that there is no need to change the present distance protection practice, three-stage time-stepped protection, for overhead lines and relatively long underground cable lines.

It is recommended that the 66 kV overhead line protection system is provided with single-shot, three-phase, low-speed auto-reclosing function for quick supply restoration after occurrence of faults of temporary nature and fault clearance.

The digital distance relays are usually provided with the fault locating function for overhead lines. But this function is not applicable to cable sections, for which measuring accuracy can not be attained due to large capacitance of the cables.

(b) Pilot-wire protection:

Though not applied in the existing system in Syria, the pilot-wire protection is the technology applied world-widely to the protection of short distance transmission lines (up to several kilo-meters), both overhead and underground lines. Formerly, the pilot-wire relays perform their protective functions by comparing analogue current signals exchanged through communication cables. There are various methods regarding preparation of signals and methods of signal comparison.

At present, there is a tendency toward use of digital type relays instead of analogue pilot-wire relays. For signal exchange, optic fibers instead of normal communication cables are required to attain high-speed signal communication for digital relaying.

The three-phase segregated current comparison (or differential) scheme is applied to various transmission lines. The current comparison practice provided with the low-speed three-phase auto reclosing function to 66 kV lines is recommended for application in the study area.

(c) Backup protection:

The present protection practice for the backup protection to use overcurrent protection and directional earthfault protection will be applicable on the condition that the protective relays are digitalized.

(3) Protection of Substation Facilities

(a) For transformers, the ratio-differential relays will be applied for main protection and overcurrent relays for backup protection.

(b) Though no relay protection is applied at present to bus, the bus protection will need to be applied to important substations. The current differential protection is to be applied generally. In case of a substation with double bus, the current differential protection is to be applied to individual buses, and the voltage differential protection to the double bus combined.

7.8.2 20 kV System

As mentioned in Clause 5.3, protection relays for 20 kV feeders are provided only at the outgoing points of the substations for necessary tripping by circuit breakers in case of faults on feeders. In the existing system, lightning arresters are provided at the branching point of an overhead line and an underground cable to protect the underground cable, and at some distribution transformers to protect them.

Cutout fuses are provided at the primary sides of distribution transformers to prevent spreading of fault.

Except relay protection problems of substations, no serious problems have been observed regarding the facility protection of the present 20 kV network. Therefore, it is considered that no special rehabilitation will be required for the protection of the 20 kV network.

7.8.3 0.4 kV System

To protect 0.4 kV main feeders, fuses are installed at the outgoing points from transformer stations. No other protections are provided to LV conductors and cables. However, it is recommended to install fuses at the branching points of service wires to protect service wires and cables and to prevent spreading of fault. Based on the present tariff system and circuit configuration, no current limiting devices or over-current circuit breakers are provided on the consumer service circuits. Actually, it is difficult to determine adequate sizes of consumer service wires and cables. Under such a situation the installation of fuses to limit consumer current with capacities to be determined taking into account the contract kVA and sizes of service wires/cables is recommended.

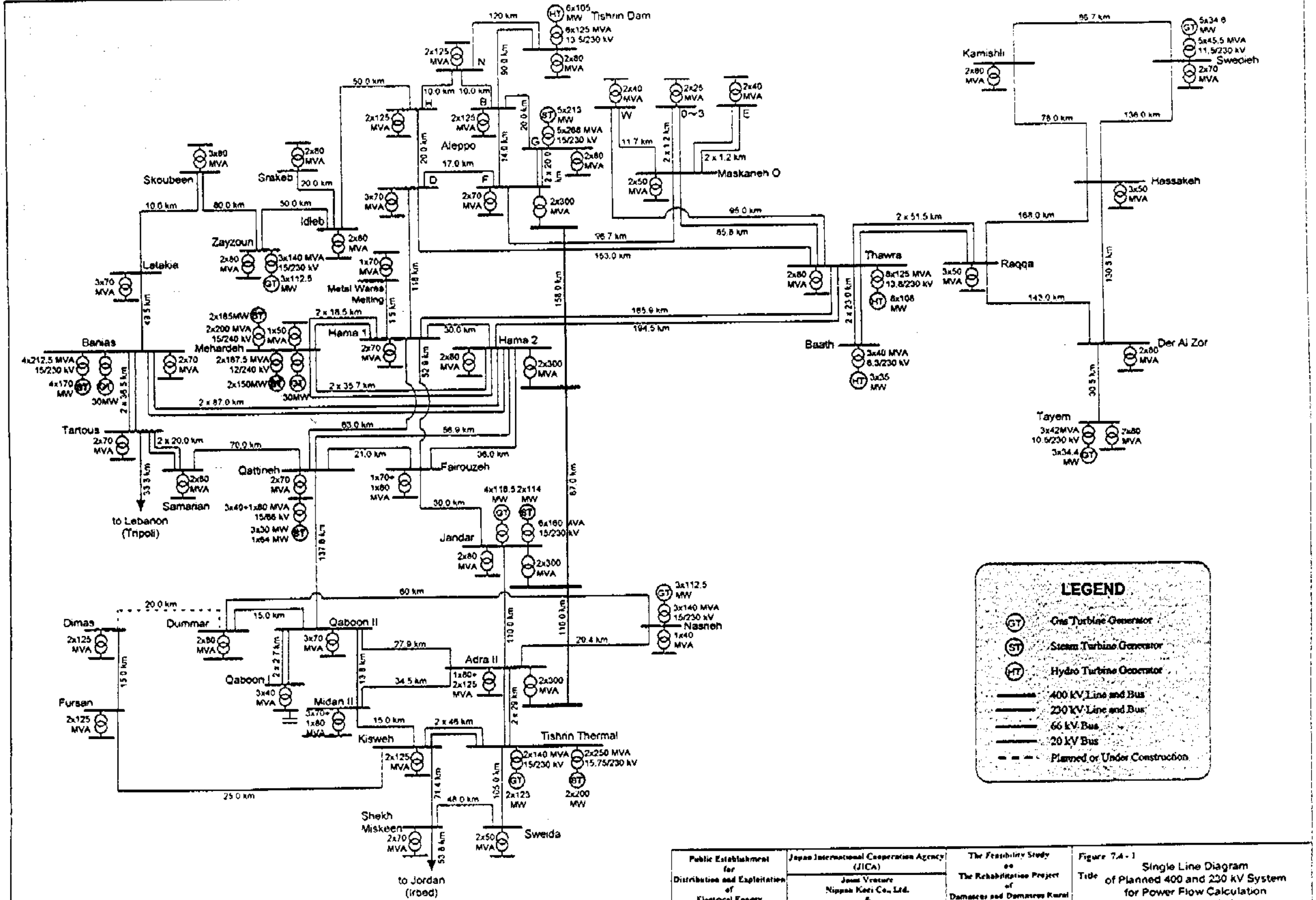
Table7.4-2 Three Phase Short-Circuit Current for Substations

Damascus City (kA)

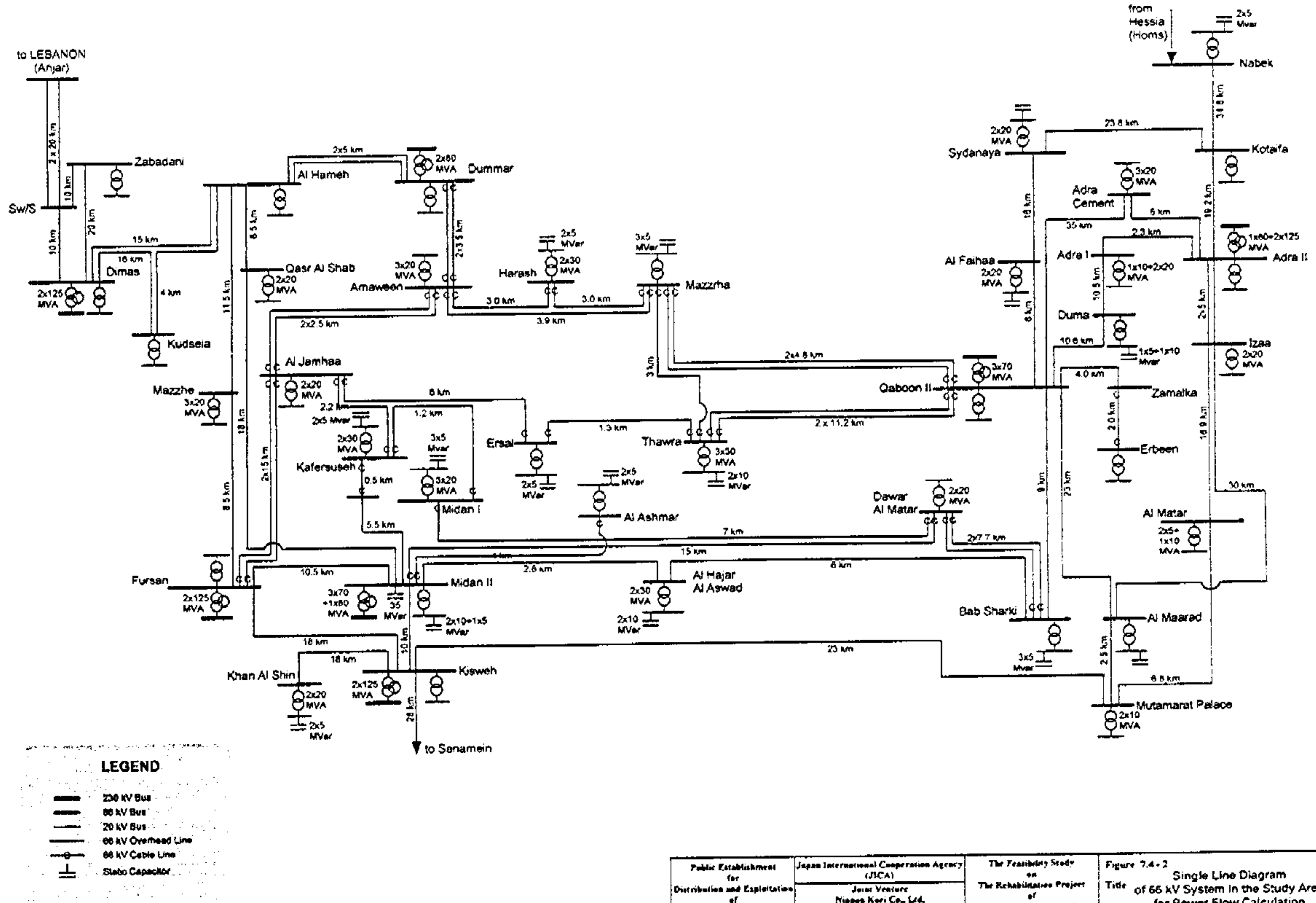
Name of Substation	66kV Busbar 2000	66kV Busbar 2005	66kV Busbar 2010	20kV Busbar 2000	20kV Busbar 2005	20kV Busbar 2010	Rated Shrot-Current 66kV	Rated Shrot-Current 20kV	Remarks
1. Mazzeha	17.6	24.4	31.8	14.2	15.2	16.1	40	25	
2. Amaween	18.1	24.2	31.3	14.5	15.5	22.7	16/31.5		
3. Mazzhe	9.5	11.0	12.1	11.9	12.4	12.8	1500MVA		
4. Midan I	16.6	19.7	27.6	14.2	14.6	15.4	13		
5. Midan II	17.4	23.5	29.5	18.1	19.3	22.0	16/20/25	25	
6. Al Ashmar	13.9	20.7	25.1	10.0	10.6	15.2			
7. Ersal	16.4	22.8	30.1	10.2	15.2	23.0			
8. Bab Sharki	15.7	20.5	25.1	14.0	14.7	15.1			
9. Qasr Al Shab	9.3	10.8	11.7	8.7	9.1	9.2			
10. Qaboon I	-	-	-	21.2	22.7	23.6		16	
11. Qaboon II	17.6	23.1	30.5	12.5	13.0	15.7	14/22	20	
12. Al Hajar Al Aswad	13.5	21.0	26.1	13.2	14.8	21.3	20	20	
13. Al Jamha	18.1	24.0	31.4	10.3	10.6	10.9	31.5	20	
14. Thawra	16.8	22.6	29.7	19.0	20.7	22.8	31.5	25	
15. Dawar Al Matar	16.0	20.7	25.3	10.2	10.5	15.2	31.5	25	
16. Dummar	17.3	22.6	28.8	10.4	15.1	15.9			
17. Kafersuseh	17.2	21.5	28.2	14.3	14.9	15.8	31.5	25	
18. Harash	16.7	22.2	28.0	13.9	14.8	22.1			
19. Barzeh		21.7	27.8		15.0	15.4			
20. Jalaa		19.3	23.5		14.5	15.0			
21. Sh. Hasan		20.4	25.1		14.7	15.1			
22. Qsoor		22.6	29.3		15.0	15.6			
23. Zablatani		19.6	23.8		14.7	15.3			
24. Hosh Blas		16.6	19.0		14.1	14.4			
25. Ibn Al Nafis		22.1	28.2		14.9	15.4			
26. Baramekha			31.3			-			

Damascus Rural (kA)

Name of Substation	66kV Busbar 2000	66kV Busbar 2005	66kV Busbar 2010	20kV Busbar 2000	20kV Busbar 2005	20kV Busbar 2010	Rated Shrot-Current 66kV	Rated Shrot-Current 20kV	Remarks
1. Duma	6.1	10.5	15.3	8.8	14.7	18.2	13	16/25	
2. Adra I	11.4	15.5	19.7	11.1	14.0	19.9	15	20	
3. Adra II	15.4	18.7	23.4	5.5	14.6	15.0	22	12.5/25	
4. Kotaifa	4.6	7.8	10.6	2.5	4.9	8.9	20	15/16	
5. Nabek	2.6	3.6	6.2	5.1	7.3	9.7	13	25	
6. Al Hameh	14.4	18.2	21.8	10.0	14.4	20.6		25	
7. Sydanaya	2.2	4.0	8.5	4.5	6.4	11.1	16	25	
8. Zabadani	3.5	6.0	7.0	6.0	7.7	10.3	16	25	
9. Fursan	16.3	21.2	26.5	14.2	14.9	15.4	20/31.5	25	
10. Al Matar	7.1	7.8	10.2	6.7	8.5	12.1	20		
11. Izaa	12.1	15.2	16.8	9.4	10.1	10.0	20	20	
12. Moatamrat Palace	8.2	9.0	15.4	4.9	5.0	5.4			
13. Adra Cement	9.8	11.0	12.2	11.9	12.5	12.7			
14. Kisweh	14.5	17.0	19.1	9.9	10.2	14.5	31.5	20	
15. Al Maarad	8.0	8.8	15.1	11.0	8.8	18.2		20	
16. Dimas	11.0	14.8	17.5	5.2	5.4	10.1			
17. Nasrieh	-	-	-	8.5	8.7	8.9		31.5	
18. Kudseia	10.2	12.2	-	2.8	5.4	-			
19. Erbeen	9.6	11.1	15.9	9.0	9.3	13.7	31.5	25	
20. Al Faihaa	1.6	2.4	21.2	3.6	4.8	15.0		20	
21. Khan Al Shih	2.2	4.2	4.3	6.4	6.6	6.6			
22. Jededat Artouz		8.2	8.8		11.1	11.4			
23. Babila		16.1	22.6		13.9	15.1			
24. Bludan		4.3	4.7		7.9	8.4			
25. Jaramana		15.6	3.4		13.8	7.0			
26. Al Tal			14.5			13.3			
27. Yabroud			7.7			10.6			
28. Harasta			14.4			13.2			
29. Nashabieh			11.1			12.3			
30. Meleha			3.8			7.4			
31. Saiedeh Zanab			22.0			-			
32. Kudseia I			14.9			13.7			
33. Kudseia II			12.9			12.8			
34. Darea			17.5			14.1			
35. Zabera		22.0	27.3			-			



Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA) Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd.	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure 7.4-1 Title: Single Line Diagram of Planned 400 and 230 kV System for Power Flow Calculation as of year 2000



Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA) Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure 7.4-2 Title: Single Line Diagram of 66 kV System in the Study Area for Power Flow Calculation as of year 2000

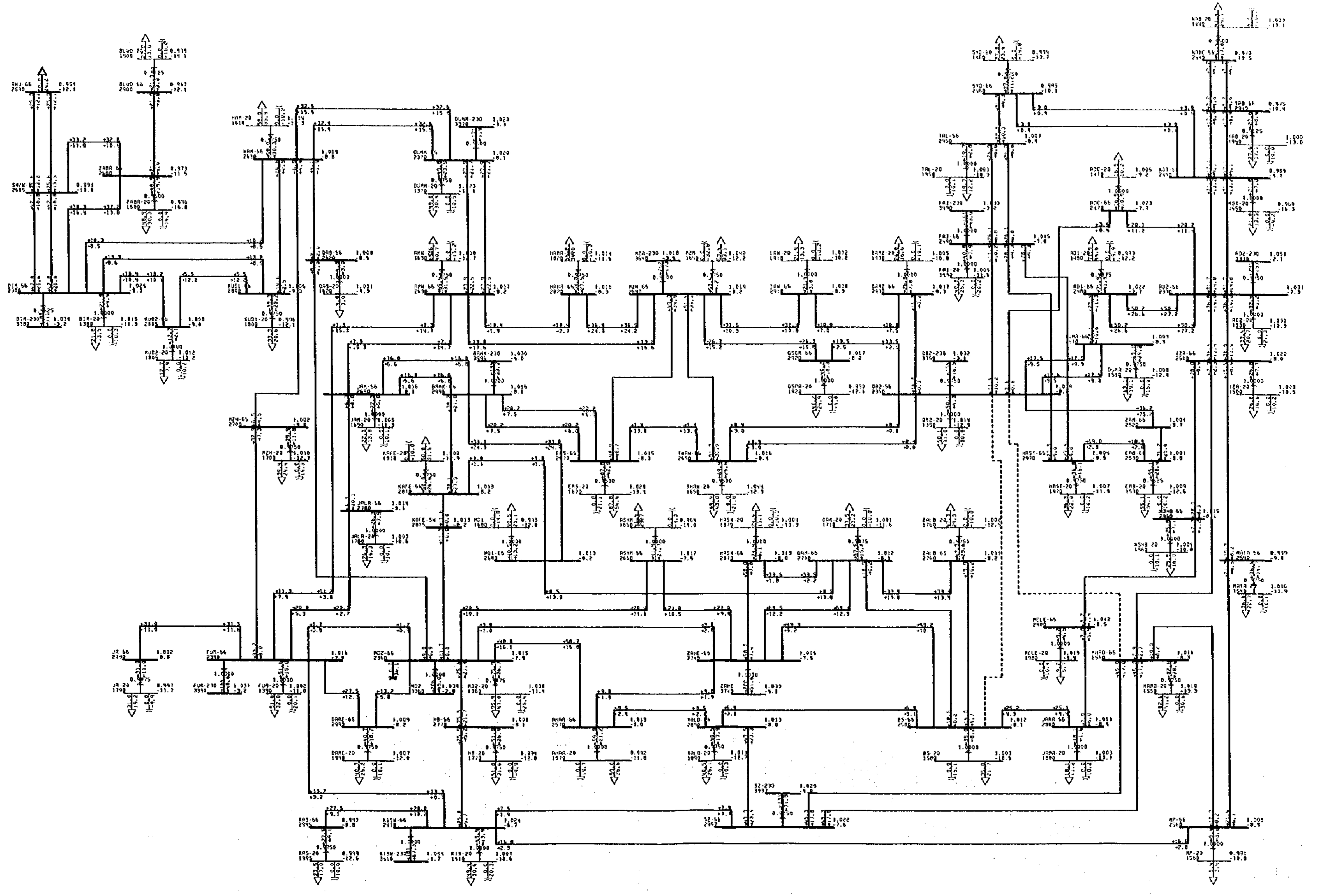
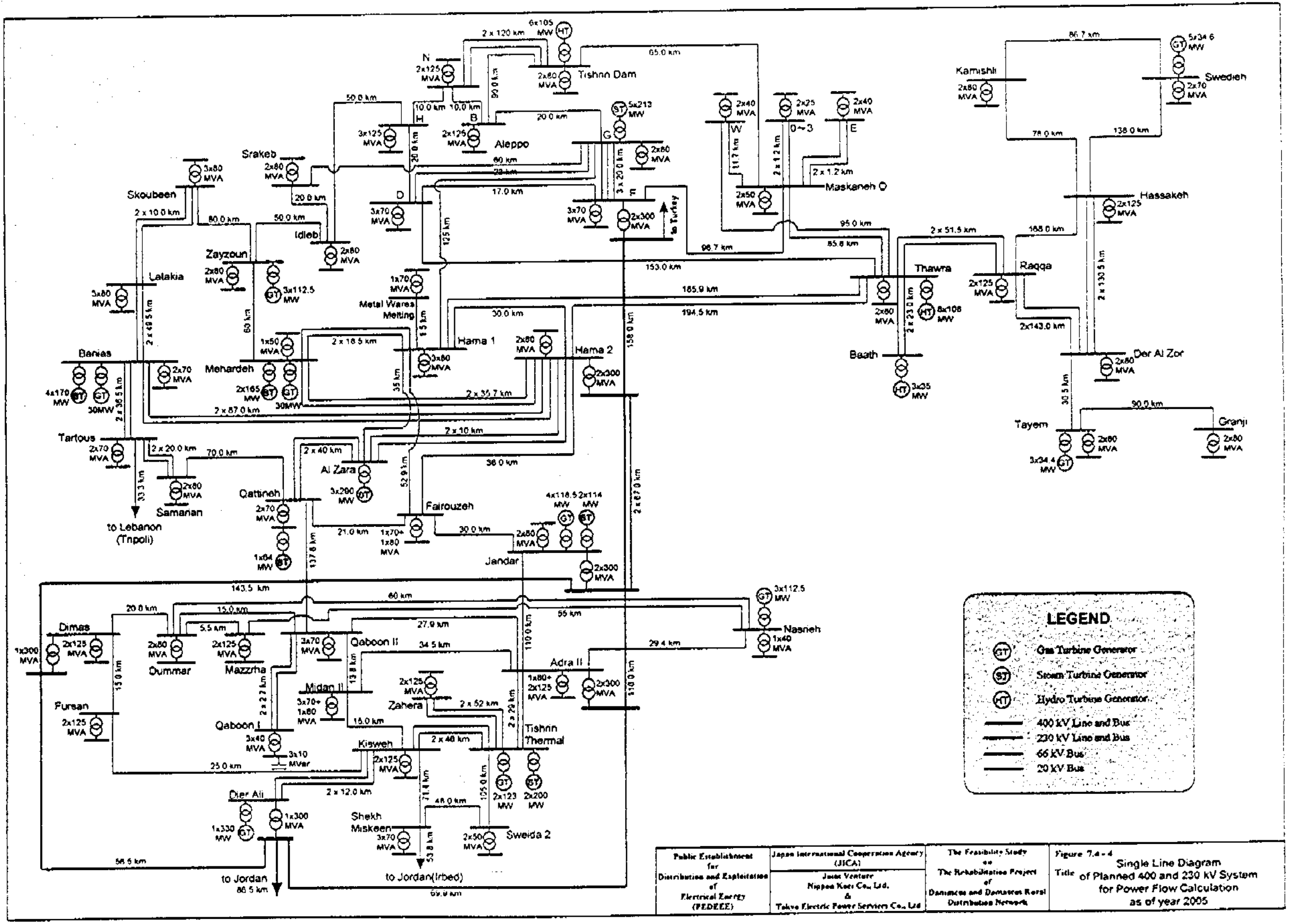
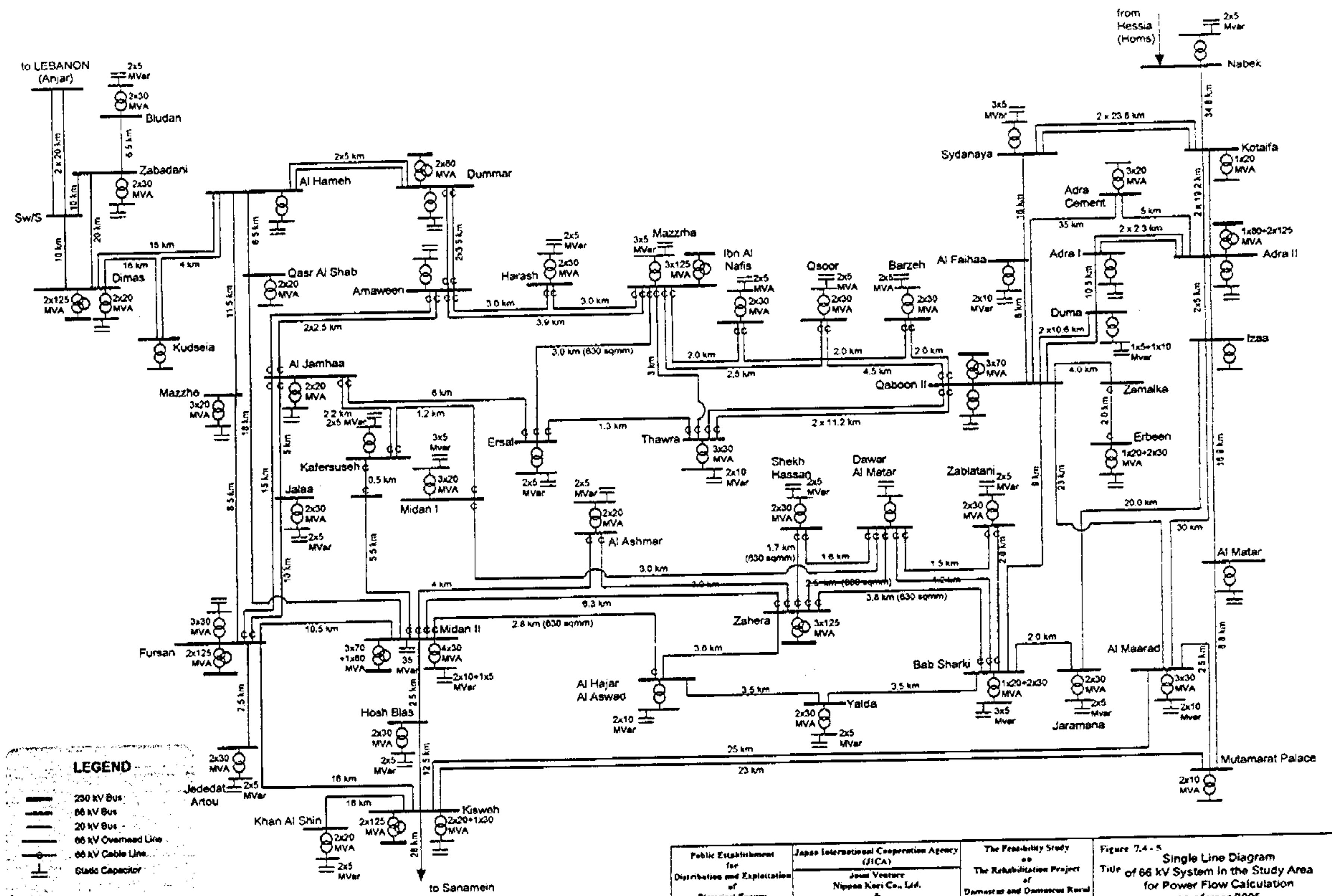


Figure7.4-9 Result of Power Flow Calculation for the Study Area as of year 2010



Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA) Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure 7.4-4 Title: Single Line Diagram of Planned 400 and 230 kV System for Power Flow Calculation as of year 2005



Public Establishment for Distribution and Exploitation of Electrical Energy (PEDEEE)	Japan International Cooperation Agency (JICA) Joint Venture Nippon Koei Co., Ltd. & Tokyo Electric Power Services Co., Ltd.	The Feasibility Study on The Rehabilitation Project of Damascus and Damascus Rural Distribution Network	Figure 7.4-5 Title: Single Line Diagram of 66 kV System in the Study Area for Power Flow Calculation as of year 2005

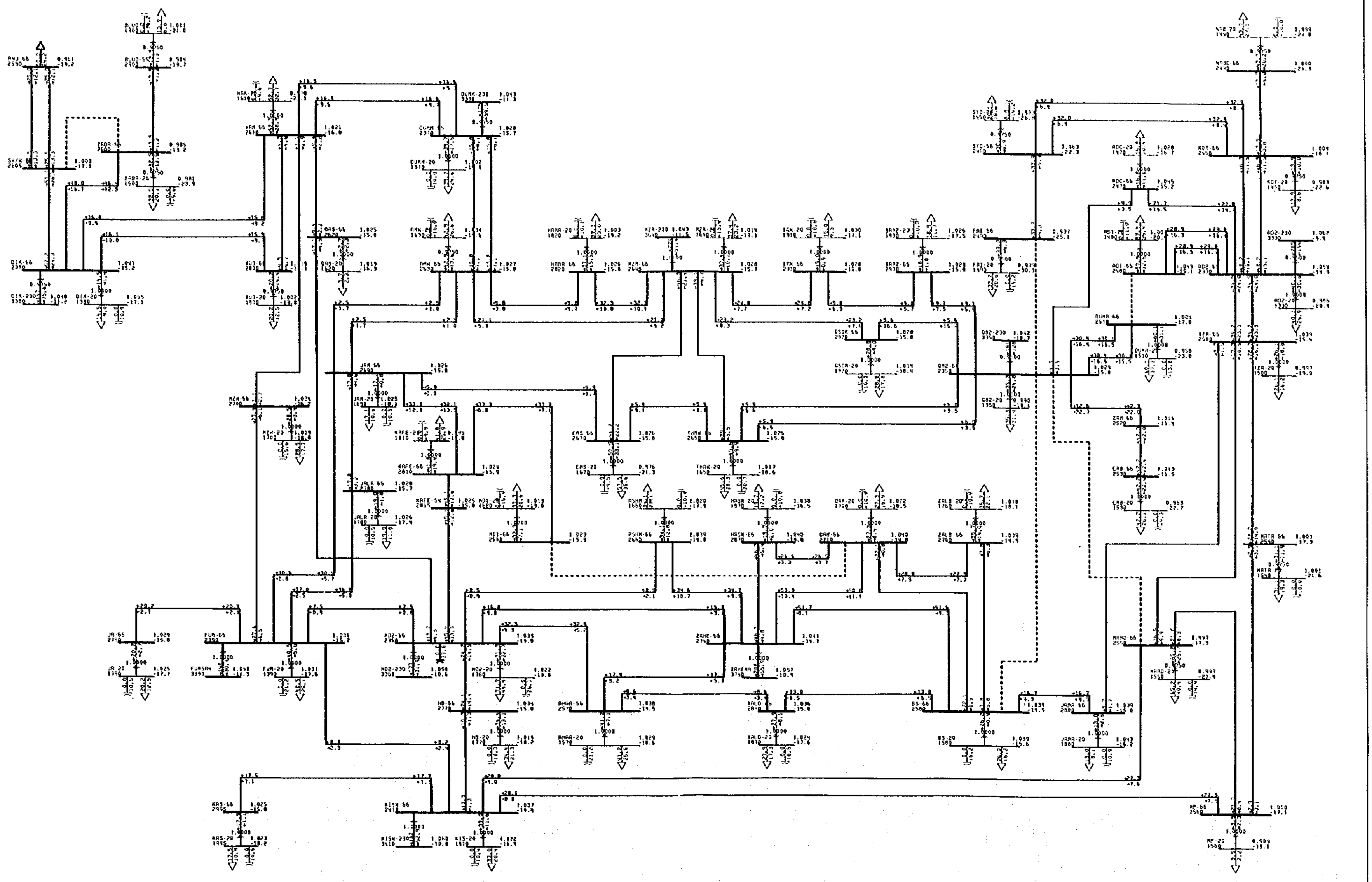
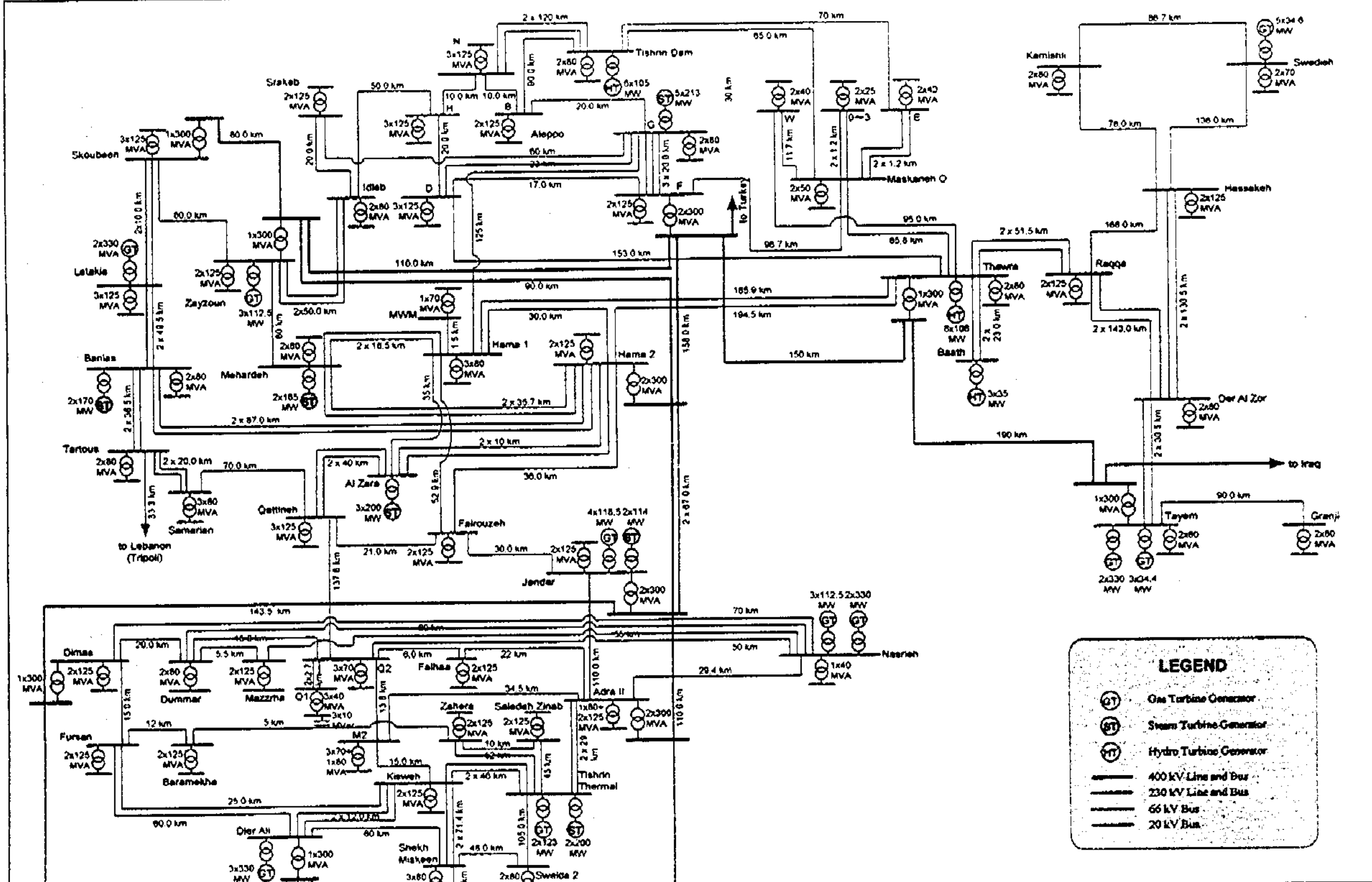


Figure7.4-6 Result of Power Flow Calculation for the Study Area as of year 2005



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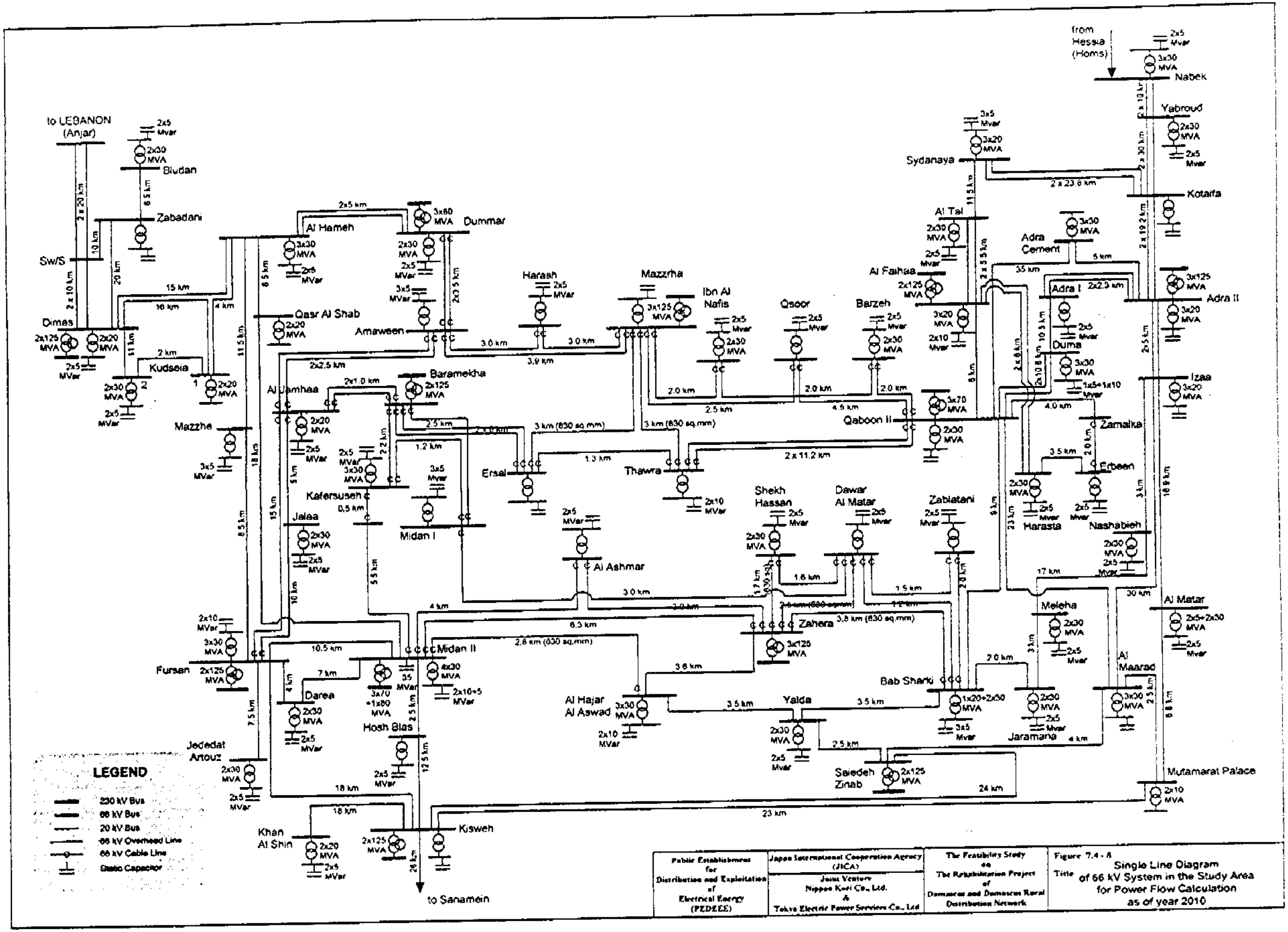

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Figure 7.4-8
Title: Single Line Diagram of 66 kV System in the Study Area for Power Flow Calculation as of year 2010

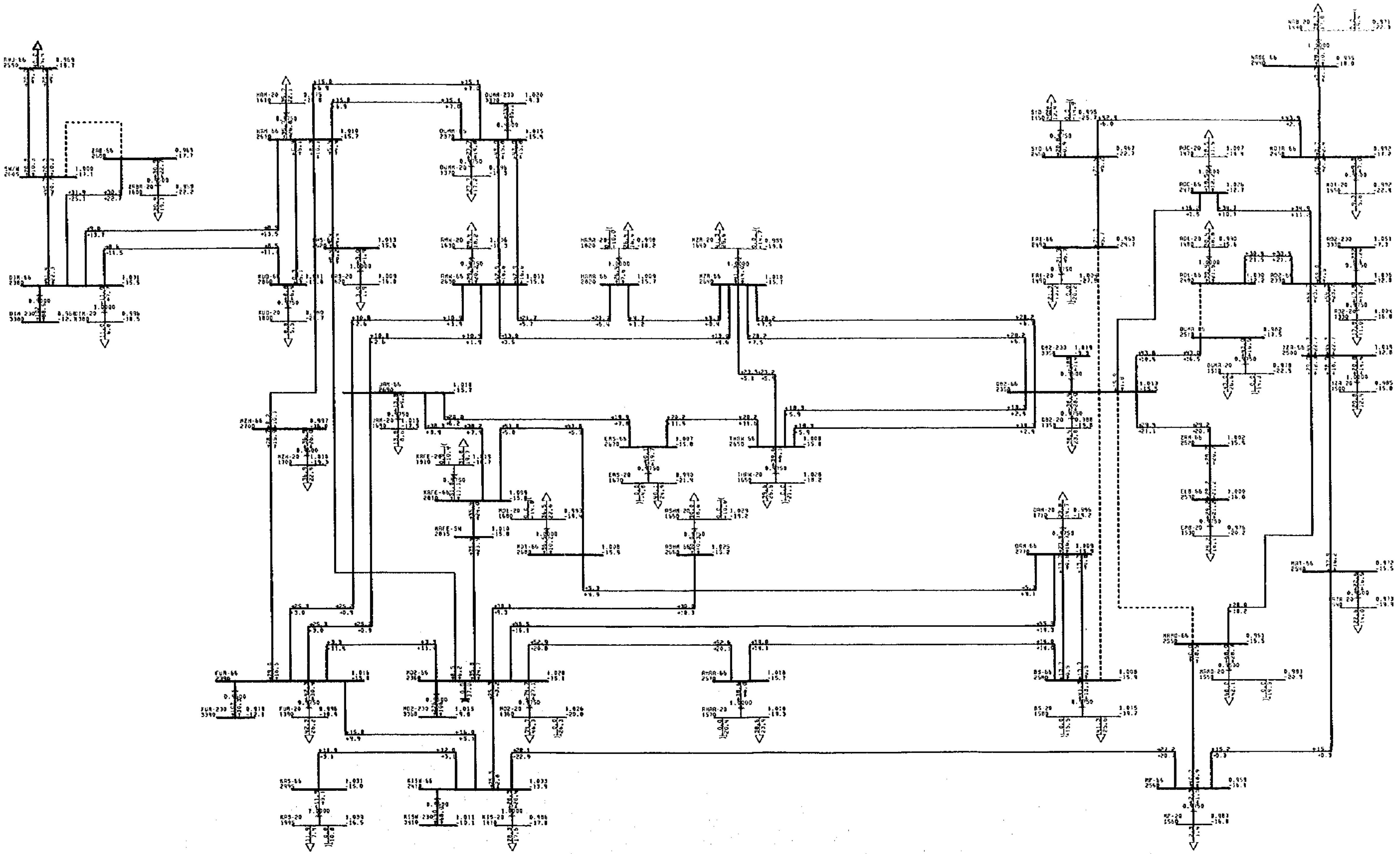

Figure7.4-3 Result of Power Flow Calculation for the Study Area as of year 2000