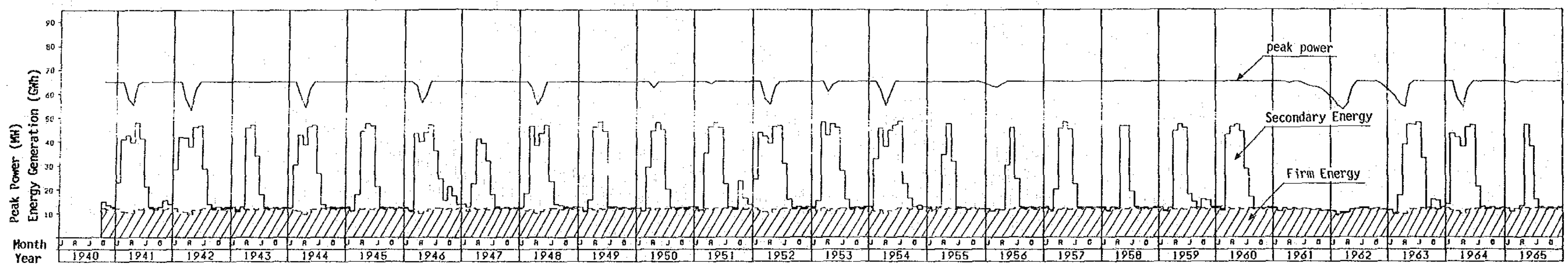
Table 9-20 Peak Power Duration of Olur Project

Unit: MW

NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P
1	4010	65.00	61	4610	65.00	121	5106	65.00	181	5704	65.00	241	6405	65.00	301	7008	65.00	361	7706	65.00	421	8610	65.00	481	7801	63.91	541	8901	60.76
2	4011	65.00	62	4611	65.00	122	5107	65.00	182	5705	65.00	242	6406	65.00	302	7009	65.00	362	7707	65.00	422	8611	65.00	482	8702	63.86	542	6201	60.75
3	4012	65.00	63	4612	65.00	123	5108	65.00	183	5706	65.00	243	6407	65.00	303	7110	65.00	363	7708	65.00	423	8612	65.00	483	5501	63.84	543	6604	60.66
4	4001	65.00	64	4601	65.00	124	5109	65.00	184	5707	65.00	244	6408	65.00	304	7111	65.00	364	7709	65.00	424	8601	65.00	484	7102	63.66	544	5204	60.55
5	4002	65.00	65	4602	65.00	125	5210	65.00	185	5708	65.00	245	6409	65.00	305	7112	65.00	365	7810	65.00	425	8606	65.00	485	8910	63.55	545	7403	60.49
6	4006	65.00	66	4603	65.00	126	5211	65.00	186	5709	65.00	246	6510	65.00	306	7105	65.00	366	7811	65.00	426	8607	65.00	486	5205	63.55	546	8002	60.40
7	4007	65.00	67	4604	65.00	127	5212	65.00	187	5810	65.00	247	6511	65.00	307	7106	65.00	367	7805	65.00	427	8608	65.00	487	8501	63.44	547	7004	60.36
8	4008	65.00	68	4605	65.00	128	5201	65.00	188	5811	65.00	248	6512	65.00	308	7107	65.00	368	7806	65.00	428	8609	65.00	488	7401	63.40	548	5305	60.23
9	4009	65.00	69	4606	65.00	129	5202	65.00	189	5812	65.00	249	6501	65.00	309	7108	65.00	369	7807	65.00	429	8710	65.00	489	7703	63.39	549	8004	60.13
10	4110	65.00	70	4607	65.00	130	5203	65.00	190	5801	65.00	250	6502	65.00	310	7109	65.00	370	7808	65.00	430	8711	65.00	490	8202	63.37	550	8209	60.10
11	4111	65.00	71	4608	65.00	131	5206	65.00	191	5802	65.00	251	6503	65.00	311	7210	65.00	371	7809	65.00	431	8712	65.00	491	6205	63.36	551	7003	59.91
12	4112	65.00	72	4609	65.00	132	5207	65.00	192	5803	65.00	252	6504	65.00	312	7211	65.00	372	7910	65.00	432	8706	65.00	492	4503	63.33	552	6112	59.84
13	4101	65.00	73	4710	65.00	133	5208	65.00	193	5804	65.00	253	6505	65.00	313	7212	65.00	373	7911	65.00	433	8707	65.00	493	8012	63.31	553	7501	59.73
14	4102	65.00	74	4711	65.00	134	5209	65.00	194	5805	65.00	254	6506	65.00	314	7201	65.00	374	7912	65.00	434	8708	65.00	494	7511	63.25	554	4303	59.13
15	4106	65.00	75	4712	65.00	135	5310	65.00	195	5806	65.00	255	6507	65.00	315	7202	65.00	375	7901	65.00	435	8709	65.00	495	8102	63.24	555	8902	59.12
16	4107	65.00	76	4701	65.00	136	5311	65.00	196	5807	65.00	256	6508	65.00	316	7203	65.00	376	7902	65.00	436	8810	65.00	496	6008	63.24	556	8003	59.06
17	4108	65.00	77	4702	65.00	137	5312	65.00	197	5808	65.00	257	6509	65.00	317	7204	65.00	377	7903	65.00	437	8811	65.00	497	8605	63.21	557	6202	58.97
18	4109	65.00	78	4706	65.00	138	5301	65.00	198	5809	65.00	258	6610	65.00	318	7205	65.00	378	7904	65.00	438	8812	65.00	498	7001	63.21	558	8310	58.86
19	4210	65.00	79	4707	65.00	139	5302	65.00	199	5910	65.00	259	6611	65.00	319	7206	65.00	379	7905	65.00	439	8801	65.00	499	8206	63.18	559	4505	58.71
20	4211	65.00	80	4708	65.00	140	5306	65.00	200	5911	65.00	260	6612	65.00	320	7207	65.00	380	7906	65.00	440	8802	65.00	500	7304	63.14	560	8903	58.60
21	4212	65.00	81	4709	65.00	141	5307	65.00	201	5912	65.00	261	6605	65.00	321	7208	65.00	381	7907	65.00	441	8803	65.00	501	7303	63.09	561	6804	58.52
22	4201	65.00	82	4810	65.00	142	5308	65.00	202	5901	65.00	262	6606	65.00	322	7209	65.00	382	7908	65.00	442	8804	65.00	502	5502	63.06	562	4705	58.47
23	4202	65.00	83	4811	65.00	143	5309	65.00	203	5902	65.00	263	6607	65.00	323	7310	65.00	383	7909	65.00	443	8805	65.00	503	7802	62.97	563	8311	58.41
24	4203	65.00	84	4812	65.00	144	5410	65.00	204	5903	65.00	264	6608	65.00	324	7311	65.00	384	8010	65.00	444	8806	65.00	504	6009	62.81	564	8603	58.27
25	4204	65.00	85	4801	65.00	145	5411	65.00	205	5904	65.00	265	6609	65.00	325	7312	65.00	385	8006	65.00	445	8807	65.00	505	8911	62.80	565	7504	58.18
26	4205	65.00	86	4802	65.00	146	5412	65.00	206	5905	65.00	266	6710	65.00	326	7301	65.00	386	8007	65.00	446	8808	65.00	506	5105	62.79	566	8703	58.10
27	4206	65.00	87	4803	65.00	147	5401	65.00	207	5906	65.00	267	6711	65.00	327	7305	65.00	387	8008	65.00	447	8905	65.00	507	5503	62.66	567	6303	58.07
28	4207	65.00	88	4804	65.00	148	5402	65.00	208	5907	65.00	268	6712	65.00	328	7306	65.00	388	8009	65.00	448	8906	65.00	508	6110	62.64	568	6312	58.03
29	4208	65.00	89	4805	65.00	149	5403	65.00	209	5908	65.00	269	6701	65.00	329	7307	65.00	389	8110	65.00	449	8109	64.99	509	4703	62.56	569	6101	57.89
30	4209	65.00	90	4806	65.00	150	5404	65.00	210	5909	65.00	270	6702	65.00	330	7308	65.00	390	8111	65.00	450	6005	64.98	510	7103	62.56	570	4003	57.77
31	4310	65.00	91	4807	65.00	151	5405	65.00	211	6010	65.00	271	6705	65.00	331	7309	65.00	391	8112	65.00	451	7702	64.96	511	6105	62.54	571	6703	57.72
32	4311	65.00	92	4808	65.00	152	5406	65.00	212	6011	65.00	272	6706	65.00	332	7410	65.00	392	8105	65.00	452	6902	64.94	512	8205	62.54	572	7502	57.71
33	4312	65.00	93	4809	65.00	153	5407	65.00	213	6012	65.00	273	6707	65.00	333	7411	65.00	393	8210	65.00	453	7104	64.93	513	6212	62.52	573	5103	57.63
34	4301	65.00	94	4910	65.00	154	5408	65.00	214	6001	65.00	274	6708	65.00	334	7405	65.00	394	8211	65.00	454	8602	64.87	514	4904	62.44	574	4103	57.42
35	4302	65.00	95	4911	65.00	155	5409	65.00	215	6002	65.00	275	6709	65.00	335	7406	65.00	395	8212	65.00	455	8701	64.87	515	6602	62.43	575	8304	57.24
36	4306	65.00	96	4912	65.00	156	5510	65.00	216	6003	65.00	276	6810	65.00	336	7407	65.00	396	8305	65.00	456	7101	64.78	516	8502	62.41	576	8907	56.90
37	4307	65.00	97	4901	65.00	157	5511	65.00	217	6006	65.00	277	6811	65.00	337	7408	65.00	397	8306	65.00	457	7812	64.75	517	7803	62.33	577	8301	56.72
38	4308	65.00	98	4902	65.00	158	5505	65.00	218	6106	65.00	278	6812	65.00	338	7409	65.00	398	8307	65.00	458	7804	64.72	518	8503	62.07	578	7503	56.59
39	4309	65.00	99	4903	65.00	159	5506	65.00	219	6107	65.00	279	6801	65.00	339	7505	65.00	399	8308	65.00	459	7012	64.70	519	8207	62.07	579	4504	56.21
40	4410	65.00	100	4905	65.00	160	5507	65.00	220	6108	65.00	280	6802	65.00	340	7506	65.00	400	8309	65.00	460	8809	64.70	520	6704	62.03	580	6203	55.59
41	4411	65.00	101	4906	65.00	161	5508	65.00	221	6109	65.00	281	6805	65.00	341	7507	65.00	401	8410	65.00	461	8104	64.69	521	4105	62.03	581	6104	55.56
42	4412	65.00	102	4907	65.00	162	5509	65.00	222	6210	65.00	282	6806	65.00	342	7508	65.00	402	8411	65.00	462	6402	64.69	522	4305	62.03	582	4704	55.51
43	4401	65.00	103	4908	65.00	163	5610	65.00	223	6206	65.00	283	6807	65.00	343	7509	65.00	403	8412	65.00	463	8201	64.69	523	8912	61.99	583	8106	55.36
44	4402	65.00	104	4909	65.00	164	5611	65.00	224	6207	65.00	284	6808	65.00	344	7610	65.00	404	8401	65.00	464	5512	64.59	524	8203	61.97	584	4004	55.30
45	4403	65.00	105	5010	65.00	165	5612	65.00	225	6208	65.00	285	6809	65.00	345	7611	65.00	405	8402	65.00	465	7412	64.59	525	7402	61.92	585	5104	55.27
46	4404	65.00	106	5011	65.00	166	5601	65.00	226	6209	65.00	286	6910	65.00	346	7612	65.00	406	8403	65.00	466	8005	64.58	526	8103	61.89	586	5304	55.20
47	4405	65.00	107	5012	65.00	167	5602	65.00	227	6310	65.00	287	6911	65.00	347	7601	65.00	407	8404	65.00	467	8101	64.52	527	6305	61.89	587	6102	54.96
48	4406	65.00	108	5001	65.00	168	5603	65.00	228	6311	65.00	288	6912	65.00	348	7602	65.00	408	8405	65.00	468	6004	64.49	528	8001	61.89	588	8302	54.54
49	4407	65.00	109	5002	65.00	169	5604	65.00	229	6312	65.00	289	6901	65.00	349	7603	65.00	409	8406	65.00	469	8011	64.46	529	7512	61.71	589	6204	54.40
50	4408	65.00	110	5003	65.00	170	5605	65.00	230	6301	65.00	290	6904	65.00	350	7604	65.00	410	8407	65.00	470	8512	64.41	530	7404	61.66	590	8604	54.26
51	4409	65.00	111	5005	65.00	171	5606	65.00	231	6302	65.00	291	6905	65.00	351	7605	65.00	411	8408	65.00	471	6403	64.39	531	6803	61.57	591	4304	54.24
52	4510	65.00	112	5006	65.00	172	5607	65.00	232	6306	65.00	292	6906	65.00	352	7606	65.00	412	8409	65.00	472	6903	64.33	532	6111	61.55	592	6304	54.23
53	4511	65.00	113	5007	65.00	173	5608	65.00	233	6307	65.00	293	6907	65.00	353	7607	65.00	413	8510	65.00	473	4005	64.32	533	7002	61.44	593	8704	54.09
54	4512	65.00	114	5008	65.00	174	5609	65.00	234	6308	65.00	294	6908	65.00	354	7608	65.00	414	8511	65.00	474	7510	64.31	534	8204	61.34	594	6103	53.15
55	4501	65.00	115	5009	65.00	175	5710	65.00	235	6309	65.00	295	6909	65.00	355	7609	65.00	415	8504	65.00	475	5504	64.26	535	5303	61.33	595	8303	53.15
56	4502	65.00	116	5110	65.00	176	5711	65.00	236	6410	65.00	296	7010	65.00	356	7710	65.00	416	8505	65.00	476	5004	64.20	536	8904	61.20	596	4104	53.15
57	4506	65.00	117	5111	65.00	177	5712	65.00	237	6411	65.00	297	7011	65.00	357	7711	65.00	417	8506	65.00	477	7302	64.18	537	7704	60.94	597	8108	44.80
58	4507	65.00	118	5112	65.00	178	5701	65.00	238	6412	65.00	298	7005	65.00	358	7712	65.00	418	8507	65.00	478	6211	64.14	538	8208	60.94	598	8909	26.53
59	4508	65.00	119	5101	65.00	179	5702	65.00	239	6401	65.00	299	7006	65.00	359	7701	65.00	419	8508	65.00	479	6007	63.96	539	6603	60.90	599	8908	21.16
60	4509	65.00	120	5102	65.00	180	5703	65.00	240	6404	65.00	300	7007	65.00	360	7705	65.00	420	8509	65.00	480	6601	63.93	540	8705	60.88	600	8107	15.25



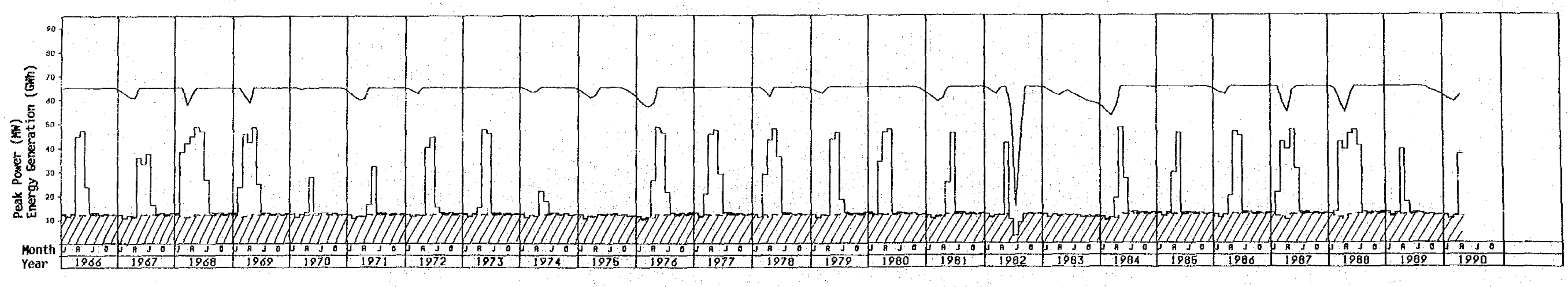


Fig. 9-21 Energy Generation of Olur Project

Table 9-21 Preliminary Cost Estimation of Olur Project

	Unit: Million TL
Relocation Road	14,000
Camp Facilities	5,000
Land Acquisition	51,752
Civil Work	295,542
Diversion	8,496
Care of River	9,857
Dam	107,510
Spillway	38,011
Outlet Works	4,356
Intake	3,216
Headrace Tunnel	108,479
Surge Tank	5,429
Penstock	2,617
Power House	6,800
Switchyard	771
Hydraulic Equipment	30,051
Electro-Mechanical Equipment	75,564
Contingency	36,735
Engineering and Administration Cost	42,016
Total	550,660
Interest During Construction	120,713
Grand Total	671,373
	(156.1 Million $)

Table 9-22 Summary of Operation Study on Ayvalı Reservoir

Unit: 10^6 m^3

YEAR	INFLOW	POWER DISCHARGE	SPILL
1940	1082.08	1115.76	0.39
1941	1317.81	1256.24	31.60
1942	773.55	775.63	0.0
1943	1051.77	1028.94	0.0
1944	848.43	849.02	0.0
1945	1086.98	1080.58	0.0
1946	805.47	797.09	0.0
1947	1007.92	988.59	0.0
1948	810.01	821.36	0.15
1949	890.59	879.95	0.0
1950	921.85	925.14	0.0
1951	1183.25	1153.51	0.0
1952	996.32	991.03	0.0
1953	1260.45	1248.49	0.0
1954	708.58	730.59	0.0
1955	688.24	663.13	0.0
1956	849.97	843.32	0.29
1957	706.29	699.60	0.0
1958	827.92	819.66	0.0
1959	982.02	961.99	0.00
1960	438.50	491.39	0.0
1961	479.24	518.37	0.0
1962	1183.65	1074.61	10.92
1963	1095.44	1096.85	0.0
1964	675.70	667.98	0.0
1965	720.90	723.24	0.0
1966	712.94	689.60	0.0
1967	1467.16	1216.24	250.83
1968	891.76	894.50	0.0
1969	522.21	524.13	0.0
1970	551.57	540.16	0.0
1971	672.37	661.15	0.0
1972	695.18	684.07	0.50
1973	518.94	527.82	0.0
1974	462.12	518.21	0.0
1975	800.14	709.47	0.0
1976	736.88	746.07	0.68
1977	790.94	786.78	0.31
1978	666.49	646.74	0.0
1979	727.95	746.12	0.42
1980	602.56	581.63	0.30
1981	604.96	580.07	0.00
1982	435.09	518.14	0.0
1983	662.15	574.28	0.0
1984	569.04	581.53	0.0
1985	665.10	642.17	1.04
1986	922.51	908.57	0.04
1987	992.15	978.57	0.0
1988	532.92	556.43	0.0
1989	647.93	594.78	0.06
AVERAGE	804.88	792.18	5.95

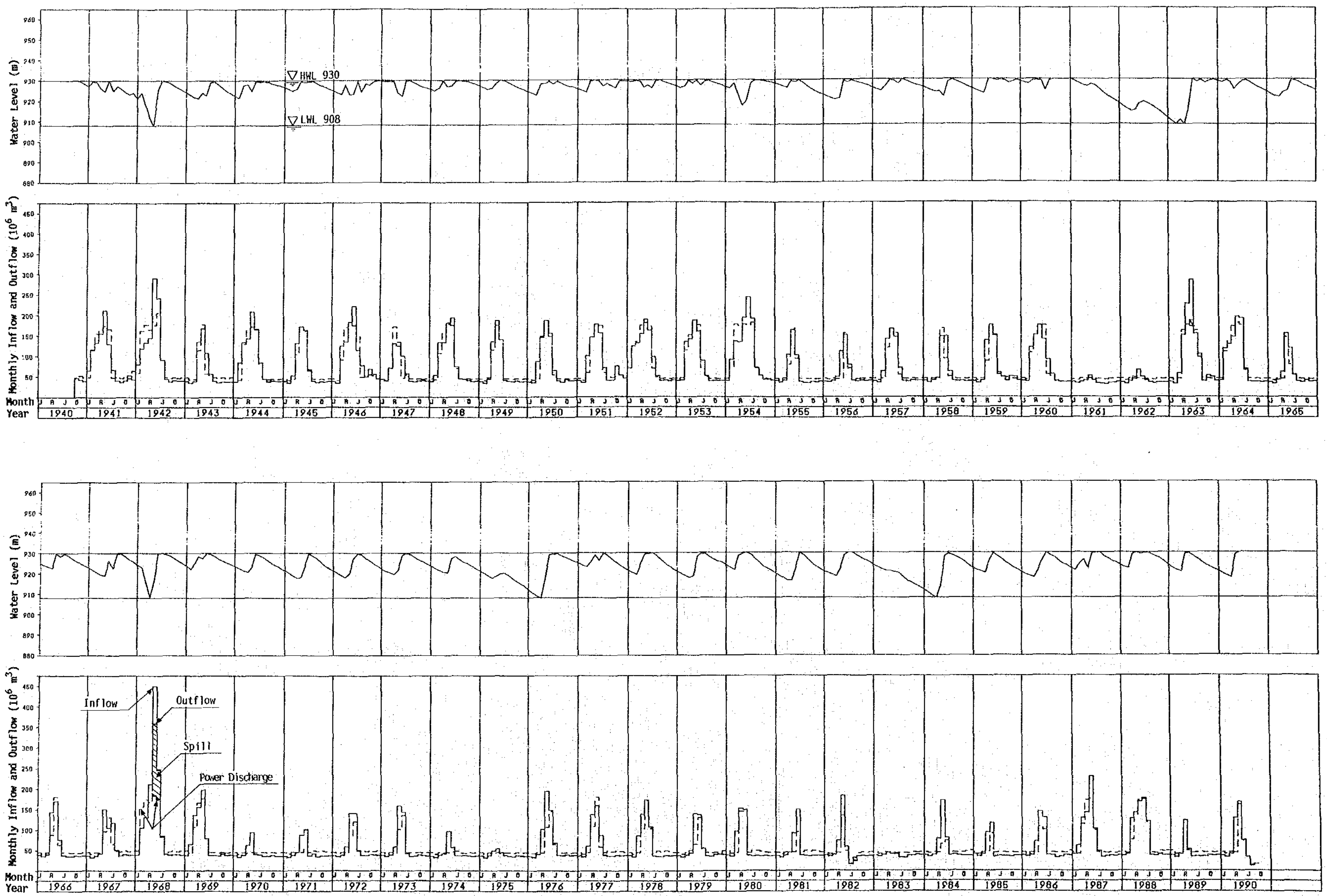


Fig. 9-22 Ayvalı Reservoir Operation

Table 9-23 Total Energy Generation of Ayvalı Project

Unit: GWh

NO.	Month Year	< OCT >	< NOV >	< DEC >	< JAN >	< FEB >	< MAR >	< APR >	< MAY >	< JUN >	< JUL >	< AUG >	< SEP >	<TOTAL>
1	1940	24.99	26.87	24.99	24.99	62.14	82.55	87.26	91.71	85.97	24.99	24.99	24.18	585.59
2	1941	24.99	24.18	33.31	30.54	83.11	87.33	79.47	86.84	90.00	47.19	24.99	24.18	636.13
3	1942	24.99	24.18	24.99	24.99	22.57	22.32	59.10	91.61	29.55	27.76	24.99	24.18	401.22
4	1943	24.99	24.18	24.99	22.76	21.78	68.26	87.56	90.83	85.97	41.64	22.70	21.99	537.64
5	1944	22.83	22.22	23.12	23.32	21.10	23.37	55.01	89.31	83.28	33.31	22.78	22.18	441.83
6	1945	23.10	22.53	23.38	23.28	20.95	47.84	89.01	93.00	90.00	77.73	24.99	26.87	562.66
7	1946	27.76	26.87	23.10	23.34	21.26	36.65	88.66	69.40	24.18	27.76	22.95	22.38	414.31
8	1947	23.31	22.67	23.46	23.37	21.90	56.98	82.78	91.61	90.00	36.09	22.85	22.30	517.32
9	1948	23.21	22.64	23.62	23.54	21.18	23.42	60.39	91.69	72.54	22.77	22.89	22.32	430.21
10	1949	23.26	22.65	23.31	23.21	20.88	23.37	77.23	91.75	80.60	27.76	22.72	22.15	458.89
11	1950	23.06	22.44	23.37	23.36	21.03	31.17	77.77	91.77	90.00	30.54	24.99	24.18	483.66
12	1951	24.99	26.87	23.12	36.42	62.99	69.69	90.00	93.00	88.66	36.09	24.99	22.23	599.03
13	1952	23.17	22.64	23.59	23.52	21.24	59.89	80.30	91.80	90.00	36.09	24.99	22.14	519.37
14	1953	23.01	22.43	23.38	23.48	38.42	92.91	87.58	86.71	90.00	93.00	36.09	26.87	643.87
15	1954	22.99	22.47	23.45	23.66	21.29	23.49	41.28	88.18	48.36	22.83	23.02	22.48	383.50
16	1955	23.35	22.49	23.13	23.02	21.42	22.81	22.07	23.36	81.13	36.09	22.80	22.24	343.91
17	1956	23.21	22.71	23.49	23.40	21.06	23.41	63.44	86.68	80.60	27.76	22.80	22.21	440.77
18	1957	23.16	22.63	23.49	23.41	21.07	23.25	22.48	86.06	48.36	24.99	22.84	22.25	363.99
19	1958	23.17	22.61	23.44	23.35	21.01	23.18	46.51	89.40	77.91	27.76	24.99	24.18	427.50
20	1959	22.92	22.39	23.32	23.37	22.14	57.10	80.41	91.08	90.00	27.76	25.69	19.52	505.69
21	1960	18.72	18.74	19.71	22.22	21.44	23.59	22.53	22.82	21.24	21.71	21.89	21.56	256.16
22	1961	22.67	21.96	22.57	22.40	20.07	22.05	21.16	21.16	20.19	20.75	20.77	20.32	256.08
23	1962	21.34	20.94	21.69	21.48	19.22	21.33	77.37	85.34	90.00	83.28	49.97	24.18	536.15
24	1963	22.92	22.48	23.46	23.67	58.89	71.17	89.64	93.00	90.00	33.31	22.71	22.07	573.32
25	1964	22.93	22.33	23.20	23.17	20.81	22.95	22.14	74.96	40.30	27.76	22.74	22.12	345.40
26	1965	22.97	22.30	23.13	23.21	20.95	23.11	45.98	93.00	32.24	22.69	22.65	21.97	374.18
27	1966	22.84	22.30	23.16	23.03	20.67	22.73	21.91	49.97	67.16	33.31	24.99	24.18	356.25
28	1967	24.99	24.18	24.99	24.99	79.10	84.45	81.49	93.00	90.00	44.42	22.66	24.18	618.43
29	1968	24.99	24.18	24.99	24.99	22.57	55.91	88.14	92.31	40.30	22.68	22.54	21.81	465.39
30	1969	22.54	21.85	22.71	22.88	20.77	22.83	21.61	22.33	21.96	22.53	22.50	21.83	266.40
31	1970	22.63	21.98	22.83	22.85	20.49	22.53	21.69	21.91	26.87	22.70	24.99	24.18	275.62
32	1971	24.99	24.18	22.72	22.84	21.23	22.55	21.55	44.42	61.79	24.99	24.99	24.18	340.41
33	1972	24.99	24.18	24.99	22.85	20.63	22.74	22.07	52.75	69.85	22.70	22.70	22.09	352.53
34	1973	23.02	22.41	23.27	23.15	20.78	22.88	22.07	22.62	24.18	24.34	21.84	21.36	271.90
35	1974	22.45	22.12	22.96	22.82	20.47	22.49	21.57	21.37	20.35	20.85	20.89	20.47	258.80
36	1975	21.51	21.13	21.81	21.60	20.02	21.22	21.10	55.52	75.22	33.31	22.74	22.06	357.25
37	1976	22.86	22.20	23.11	23.29	20.95	23.26	57.53	93.00	29.55	22.66	24.99	24.18	387.57
38	1977	24.99	24.18	22.82	22.85	20.53	23.02	54.90	89.29	53.73	22.75	24.99	24.18	408.22
39	1978	24.99	24.18	22.74	22.77	20.45	22.51	21.73	33.31	67.16	27.76	22.70	22.03	332.33
40	1979	22.90	22.11	24.99	24.99	21.34	23.36	77.55	75.25	21.97	24.99	24.99	24.18	388.60
41	1980	22.50	21.87	22.71	22.65	20.32	22.34	21.55	22.18	48.36	22.68	24.99	24.18	296.32
42	1981	24.99	24.18	22.67	22.80	20.49	22.57	22.04	69.40	24.50	7.27	15.84	21.65	298.40
43	1982	22.84	22.48	23.30	23.17	20.82	22.91	21.93	22.48	20.71	20.77	20.74	20.34	262.48
44	1983	21.41	20.85	21.48	21.46	20.04	21.24	20.86	33.04	37.61	22.70	22.57	21.75	285.01
45	1984	22.47	24.18	24.99	22.19	20.14	22.35	24.18	47.19	21.88	22.63	22.89	22.39	297.48
46	1985	23.15	22.27	22.88	22.73	20.43	22.51	21.95	55.52	51.04	22.75	22.96	22.44	330.63
47	1986	23.13	22.18	24.99	22.71	20.89	59.10	89.32	91.69	51.04	22.91	23.11	22.47	473.54
48	1987	23.31	22.58	23.27	23.15	21.59	39.47	72.17	91.81	90.00	61.07	22.75	21.94	513.13
49	1988	24.99	24.18	24.99	24.99	19.92	22.16	29.55	24.99	22.06	23.07	23.39	22.53	286.80
50	1989	23.15	22.29	22.91	22.77	20.43	22.50	22.42	86.04	37.47	15.96	5.96	7.36	309.26
TOTAL		1170.56	1145.63	1178.05	1180.95	1304.97	1772.87	2558.01	3417.47	2885.83	1551.19	1184.39	1121.19	20471.06
AVE		23.41	22.91	23.56	23.62	26.10	35.46	51.16	68.35	57.72	31.02	23.69	22.42	409.42
MAX		27.76	26.87	33.31	36.42	83.11	92.91	90.00	93.00	90.00	93.00	49.97	26.87	643.87
MIN		18.72	18.74	19.71	21.46	19.22	21.22	20.86	21.16	20.19	7.27	5.96	7.36	256.08

Table 9-24 Firm Energy Generation of Ayvalı Project

Unit: GWh

NO.	Month Year	< OCT >	< NOV >	< DEC >	< JAN >	< FEB >	< MAR >	< APR >	< MAY >	< JUN >	< JUL >	< AUG >	< SEP >	<TOTAL>
1	1940	23.25	22.50	23.25	23.25	21.00	23.25	22.50	23.25	22.50	23.25	23.25	22.50	273.75
2	1941	23.25	22.50	23.25	23.25	20.78	21.85	20.24	21.72	22.50	23.25	23.25	22.50	268.34
3	1942	23.25	22.50	23.25	23.25	21.00	22.19	22.50	23.25	22.50	23.25	23.25	22.50	272.69
4	1943	23.25	22.50	23.25	22.76	21.75	23.25	22.50	23.25	22.50	23.25	22.70	21.99	272.96
5	1944	22.83	22.22	23.12	23.25	21.00	23.25	22.50	23.25	22.50	23.25	22.78	22.18	272.11
6	1945	23.10	22.50	23.25	23.25	20.95	23.25	22.50	23.25	22.50	23.25	23.25	22.50	273.54
7	1946	23.25	22.50	23.10	23.25	21.00	23.25	22.50	23.25	22.50	23.25	22.95	22.38	273.19
8	1947	23.25	22.50	23.25	23.25	21.75	23.25	22.50	23.25	22.50	23.25	22.85	22.30	273.90
9	1948	23.21	22.50	23.25	23.25	21.00	23.25	22.50	23.25	22.50	22.77	22.89	22.32	272.70
10	1949	23.25	22.50	23.25	23.21	20.88	23.25	22.50	23.25	22.50	23.25	22.72	22.15	272.70
11	1950	23.06	22.44	23.25	23.25	21.00	23.25	22.50	23.25	22.50	23.25	23.25	22.50	273.50
12	1951	23.25	22.50	23.12	23.25	21.75	23.25	22.50	23.25	22.50	23.25	23.25	22.23	274.10
13	1952	23.17	22.50	23.25	23.25	21.00	23.25	22.50	23.25	22.50	23.25	23.25	22.14	273.31
14	1953	23.01	22.43	23.25	23.25	21.00	23.25	21.90	21.69	22.50	23.25	23.25	22.50	271.28
15	1954	22.99	22.47	23.25	23.25	21.00	23.25	22.50	23.25	22.50	22.83	23.02	22.48	272.79
16	1955	23.25	22.49	23.13	23.02	21.42	22.81	22.07	23.25	22.50	23.25	22.80	22.24	272.23
17	1956	23.21	22.50	23.25	23.25	21.00	23.25	22.50	23.25	22.50	23.25	22.80	22.21	272.97
18	1957	23.16	22.50	23.25	23.25	21.00	23.25	22.48	23.25	22.50	23.25	22.84	22.25	272.98
19	1958	23.17	22.50	23.25	23.25	21.00	23.18	22.50	23.25	22.50	23.25	23.25	22.50	273.59
20	1959	22.92	22.39	23.25	23.25	21.75	23.25	22.50	23.25	22.50	23.25	23.25	19.52	271.08
21	1960	18.72	18.74	19.71	22.22	21.00	23.25	22.50	22.82	21.24	21.71	21.89	21.56	255.35
22	1961	22.67	21.96	22.54	22.30	19.91	21.84	21.11	20.99	20.12	20.75	20.77	20.26	255.22
23	1962	21.10	20.60	21.29	21.01	18.73	20.79	20.12	21.35	22.50	23.25	23.25	22.50	256.50
24	1963	22.92	22.48	23.25	23.25	21.75	23.25	22.50	23.25	22.50	23.25	22.71	22.07	273.18
25	1964	22.93	22.33	23.20	23.17	20.81	22.95	22.14	23.25	22.50	23.25	22.74	22.12	271.39
26	1965	22.97	22.30	23.13	23.21	20.95	23.11	22.50	23.25	22.50	22.69	22.65	21.97	271.21
27	1966	22.84	22.30	23.16	23.03	20.67	22.73	21.90	23.25	22.50	23.25	23.25	22.50	271.38
28	1967	23.25	22.50	23.25	23.25	21.21	21.38	20.70	23.25	22.50	23.25	22.66	22.50	269.70
29	1968	23.25	22.50	23.25	23.25	21.00	23.25	22.50	23.25	22.50	22.68	22.54	21.81	271.78
30	1969	22.54	21.85	22.71	22.88	20.77	22.88	21.48	22.33	21.96	22.53	22.50	21.83	266.28
31	1970	22.63	21.98	22.83	22.85	20.49	22.47	21.60	21.60	22.50	22.70	23.25	22.50	267.39
32	1971	23.25	22.50	22.72	22.84	21.23	22.51	21.39	23.25	22.50	23.25	23.25	22.50	271.19
33	1972	23.25	22.50	23.25	22.85	20.63	22.74	22.07	23.25	22.50	22.70	22.70	22.09	270.53
34	1973	23.02	22.41	23.25	23.15	20.78	22.88	22.07	22.62	22.50	23.25	21.84	21.36	269.11
35	1974	22.45	22.12	22.96	22.82	20.47	22.45	21.57	21.31	20.35	20.85	20.89	20.47	258.71
36	1975	21.34	20.86	21.47	21.18	19.55	20.68	20.76	23.25	22.50	23.25	22.74	22.06	259.64
37	1976	22.86	22.20	23.11	23.25	20.95	23.25	22.50	23.25	22.50	22.66	23.25	22.50	272.28
38	1977	23.25	22.50	22.82	22.85	20.53	23.02	22.50	23.25	22.50	22.75	23.25	22.50	271.72
39	1978	23.25	22.50	22.74	22.77	20.45	22.45	21.65	23.25	22.50	23.25	22.70	22.03	269.54
40	1979	22.90	22.11	23.25	23.25	21.34	23.25	22.50	23.25	21.97	23.25	23.25	22.50	272.82
41	1980	22.50	21.85	22.71	22.65	20.26	22.21	21.39	21.99	22.50	22.68	23.25	22.50	266.50
42	1981	23.25	22.50	22.67	22.80	20.49	22.54	22.04	23.25	22.50	7.27	15.84	21.65	246.80
43	1982	22.84	22.48	23.25	23.17	20.82	22.91	21.93	22.48	20.71	20.77	20.73	20.27	262.36
44	1983	21.20	20.48	21.00	20.96	19.58	20.70	20.43	22.98	22.50	22.70	22.57	21.75	256.86
45	1984	22.47	22.50	23.25	22.00	20.00	22.23	22.50	23.25	21.88	22.63	22.89	22.39	268.00
46	1985	23.15	22.27	22.88	22.73	20.42	22.45	21.95	23.25	22.50	22.75	22.96	22.44	269.75
47	1986	23.13	22.18	23.25	22.71	20.89	23.25	22.50	23.25	22.50	22.91	23.11	22.47	272.15
48	1987	23.25	22.50	23.25	23.15	21.59	23.25	22.50	23.25	22.50	23.25	22.75	21.94	273.18
49	1988	23.25	22.50	23.25	23.25	19.70	21.96	22.50	23.25	22.06	23.07	23.25	22.50	270.54
50	1989	23.15	22.29	22.91	22.77	20.42	22.44	22.42	23.25	22.50	15.96	5.96	7.36	231.44
	TOTAL	1142.64	1110.21	1146.79	1145.80	1040.40	1137.10	1102.92	1147.40	1115.27	1122.58	1116.22	1088.79	13416.12
	AVE	22.85	22.20	22.94	22.92	20.81	22.74	22.06	22.95	22.31	22.45	22.32	21.78	268.32
	MAX	23.25	22.50	23.25	23.25	21.75	23.25	22.50	23.25	22.50	23.25	23.25	22.50	274.10
	MIN	18.72	18.74	19.71	20.98	18.73	20.68	20.12	20.99	20.12	7.27	5.96	7.36	231.44

Table 9-25 Monthly Peak Power of Ayvalı Project

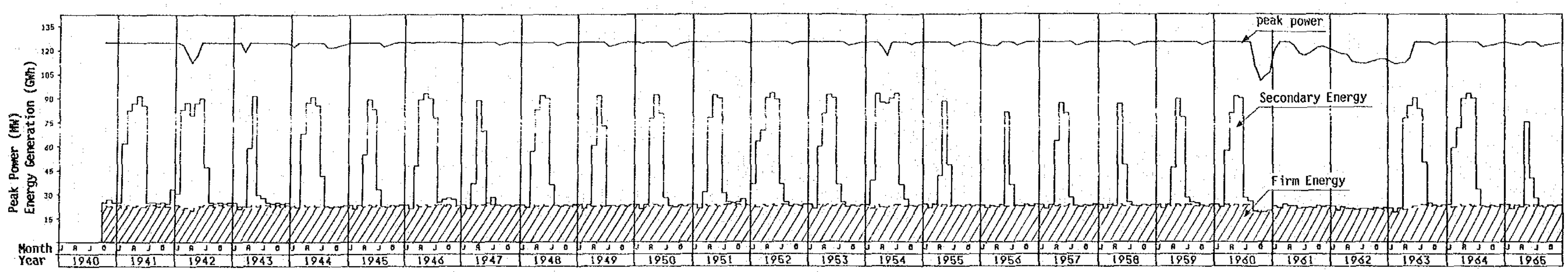
Unit: MW

NO.	Month Year	< OCT >	< NOV >	< DEC >	< JAN >	< FEB >	< MAR >	< APR >	< MAY >	< JUN >	< JUL >	< AUG >	< SEP >	<TOTAL>
1	1940	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	1500.00
2	1941	125.00	125.00	125.00	125.00	123.69	117.47	112.45	116.79	125.00	125.00	125.00	125.00	1470.40
3	1942	125.00	125.00	125.00	125.00	125.00	119.28	125.00	125.00	125.00	125.00	125.00	125.00	1494.28
4	1943	125.00	125.00	125.00	122.37	125.00	125.00	125.00	125.00	125.00	125.00	122.06	122.19	1491.62
5	1944	122.73	123.43	124.28	125.00	125.00	125.00	125.00	125.00	125.00	125.00	122.46	123.20	1491.09
6	1945	124.18	125.00	125.00	125.00	124.67	125.00	125.00	125.00	125.00	125.00	125.00	125.00	1498.86
7	1946	125.00	125.00	124.21	125.00	125.00	125.00	125.00	125.00	125.00	125.00	123.38	124.36	1496.95
8	1947	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	122.87	123.87	1496.74
9	1948	124.80	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	122.43	123.06	124.02	1494.31
10	1949	125.00	125.00	125.00	124.79	124.26	125.00	125.00	125.00	125.00	125.00	122.14	123.05	1494.25
11	1950	123.96	124.67	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	1498.62
12	1951	125.00	125.00	124.29	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	123.50	1497.79
13	1952	124.58	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	123.01	1497.59
14	1953	123.70	124.60	125.00	125.00	125.00	125.00	121.68	116.62	125.00	125.00	125.00	125.00	1486.60
15	1954	123.61	124.82	125.00	125.00	125.00	125.00	125.00	125.00	125.00	122.73	123.76	124.90	1494.83
16	1955	125.00	124.92	124.36	123.75	123.13	122.62	122.62	125.00	125.00	125.00	122.58	123.56	1487.54
17	1956	124.79	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	122.57	123.38	1495.74
18	1957	124.51	125.00	125.00	125.00	125.00	125.00	124.90	125.00	125.00	125.00	122.80	123.61	1495.81
19	1958	124.56	125.00	125.00	125.00	125.00	124.61	125.00	125.00	125.00	125.00	125.00	125.00	1499.16
20	1959	123.24	124.38	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	108.42	1481.04
21	1960	100.62	104.11	105.99	119.44	125.00	125.00	125.00	122.71	118.02	116.70	117.67	119.75	1400.02
22	1961	121.86	121.98	121.20	119.87	118.53	117.42	117.28	112.87	111.75	111.56	111.68	112.57	1398.57
23	1962	113.45	114.45	114.47	112.95	111.47	111.78	111.78	114.81	125.00	125.00	125.00	125.00	1405.17
24	1963	123.23	124.89	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	122.11	122.59	1492.81
25	1964	123.27	124.07	124.72	124.57	123.90	123.38	122.99	125.00	125.00	125.00	122.24	122.86	1487.02
26	1965	123.47	123.87	124.35	124.76	124.68	124.24	125.00	125.00	125.00	121.98	121.76	122.06	1486.17
27	1966	122.81	123.90	124.52	123.81	123.01	122.21	121.67	125.00	125.00	125.00	125.00	125.00	1486.92
28	1967	125.00	125.00	125.00	125.00	121.89	114.95	115.00	125.00	125.00	125.00	121.85	125.00	1473.68
29	1968	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	121.93	121.17	121.18	1489.28
30	1969	121.16	121.42	122.12	123.02	123.65	123.02	119.36	120.07	122.00	121.11	120.97	121.28	1459.17
31	1970	121.67	122.12	122.73	122.83	121.94	120.83	119.98	116.15	125.00	122.02	125.00	125.00	1465.27
32	1971	125.00	125.00	122.15	122.79	122.00	121.02	118.84	125.00	125.00	125.00	125.00	125.00	1481.81
33	1972	125.00	125.00	125.00	122.83	122.82	122.26	122.62	125.00	125.00	122.02	122.06	122.74	1482.35
34	1973	123.75	124.50	125.00	124.44	123.71	123.00	122.59	121.59	125.00	125.00	117.40	118.66	1474.63
35	1974	120.70	122.86	123.45	122.67	121.85	120.72	119.81	114.56	113.05	112.11	112.33	113.74	1417.86
36	1975	114.75	115.89	115.41	113.85	112.33	111.17	115.36	125.00	125.00	125.00	122.28	122.56	1418.59
37	1976	122.92	123.36	124.27	125.00	124.68	125.00	125.00	125.00	125.00	121.81	125.00	125.00	1492.03
38	1977	125.00	125.00	122.70	122.84	122.18	123.78	125.00	125.00	125.00	122.32	125.00	125.00	1488.82
39	1978	125.00	125.00	122.27	122.44	121.71	120.73	120.28	125.00	125.00	125.00	122.02	122.39	1476.83
40	1979	123.10	122.83	125.00	125.00	122.63	125.00	125.00	125.00	122.07	125.00	125.00	125.00	1490.63
41	1980	120.97	121.38	122.10	121.77	120.59	119.43	118.85	118.23	125.00	121.95	125.00	125.00	1460.27
42	1981	125.00	125.00	121.89	122.57	121.98	121.21	122.45	125.00	125.00	39.07	85.14	120.30	1354.60
43	1982	122.81	124.86	125.00	124.56	123.93	123.18	121.84	120.88	115.03	111.66	111.47	112.64	1437.84
44	1983	113.95	113.76	112.93	112.80	112.52	111.31	113.50	123.56	125.00	122.02	121.32	120.81	1403.47
45	1984	120.82	125.00	125.00	118.30	119.07	119.52	125.00	125.00	121.55	121.65	123.07	124.41	1468.39
46	1985	124.46	123.72	122.99	122.23	121.55	120.68	121.97	125.00	125.00	122.31	123.43	124.66	1478.00
47	1986	124.37	123.25	125.00	122.12	124.32	125.00	125.00	125.00	125.00	123.19	124.23	124.82	1491.29
48	1987	125.00	125.00	125.00	124.46	124.06	125.00	125.00	125.00	125.00	125.00	122.33	121.91	1492.76
49	1988	125.00	125.00	125.00	125.00	117.29	118.05	125.00	125.00	122.53	124.03	125.00	125.00	1481.90
50	1989	124.47	123.86	123.18	122.42	121.55	120.62	124.58	125.00	125.00	85.81	32.06	40.87	1269.41
	TOTAL	6143.23	6167.87	6165.57	6160.23	6140.57	6113.44	6127.37	6168.84	6195.98	6035.37	6001.21	6048.83	73468.50
	AVE	122.86	123.36	123.31	123.20	122.81	122.27	122.55	123.38	123.92	120.71	120.02	120.98	1469.37
	MAX	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	125.00	1500.00
	MIN	100.62	104.11	105.99	112.80	111.47	111.17	111.78	112.87	111.75	39.07	32.06	40.87	1269.41

Table 9-26 Peak Power Duration of Ayvalı Project

Unit: MW

NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P	NO.	DATE	P
1	4010	125.00	61	4602	125.00	121	5207	125.00	181	6206	125.00	241	7507	125.00	301	8804	125.00	361	6511	123.87	421	5407	122.73	481	6702	121.89	541	8803	118.05
2	4011	125.00	62	4603	125.00	122	5208	125.00	182	6207	125.00	242	7601	125.00	302	8805	125.00	362	4709	123.87	422	7012	122.73	482	8112	121.89	542	6006	118.02
3	4012	125.00	63	4604	125.00	123	5312	125.00	183	6208	125.00	243	7603	125.00	303	8808	125.00	363	8911	123.86	423	4410	122.73	483	6110	121.86	543	6008	117.67
4	4001	125.00	64	4605	125.00	124	5301	125.00	184	6209	125.00	244	7604	125.00	304	8809	125.00	364	6601	123.81	424	6005	122.71	484	7402	121.85	544	4103	117.47
5	4002	125.00	65	4606	125.00	125	5302	125.00	185	6312	125.00	245	7605	125.00	305	8905	125.00	365	7703	123.78	425	7712	122.70	485	6708	121.85	545	6103	117.42
6	4003	125.00	66	4607	125.00	126	5303	125.00	186	6301	125.00	246	7606	125.00	306	8906	125.00	366	5408	123.76	426	7401	122.67	486	8204	121.84	546	7308	117.40
7	4004	125.00	67	4710	125.00	127	5306	125.00	187	6302	125.00	247	7608	125.00	307	5511	124.92	367	7310	123.75	427	7902	122.63	487	7607	121.81	547	8802	117.29
8	4005	125.00	68	4711	125.00	128	5307	125.00	188	6303	125.00	248	7609	125.00	308	5409	124.90	368	5501	123.75	428	5504	122.62	488	8001	121.77	548	6104	117.28
9	4006	125.00	69	4712	125.00	129	5308	125.00	189	6304	125.00	249	7710	125.00	309	5704	124.90	369	8511	123.72	429	5503	122.62	489	6508	121.76	549	4105	116.79
10	4007	125.00	70	4701	125.00	130	5309	125.00	190	6305	125.00	250	7711	125.00	310	6311	124.89	370	7302	123.71	430	7204	122.62	490	7802	121.71	550	6007	116.70
11	4008	125.00	71	4702	125.00	131	5412	125.00	191	6306	125.00	251	7704	125.00	311	8211	124.86	371	5310	123.70	431	7304	122.59	491	5304	121.68	551	5305	116.62
12	4009	125.00	72	4703	125.00	132	5401	125.00	192	6307	125.00	252	7705	125.00	312	5411	124.82	372	4102	123.69	432	6309	122.59	492	7010	121.67	552	7005	116.15
13	4110	125.00	73	4704	125.00	133	5402	125.00	193	6405	125.00	253	7706	125.00	313	8609	124.82	373	6902	123.65	433	5508	122.58	493	6604	121.67	553	7511	115.89
14	4111	125.00	74	4705	125.00	134	5403	125.00	194	6406	125.00	254	7708	125.00	314	4810	124.80	374	5709	123.61	434	8101	122.57	494	8407	121.65	554	7512	115.41
15	4112	125.00	75	4706	125.00	135	5404	125.00	195	6407	125.00	255	7709	125.00	315	4901	124.79	375	5410	123.61	435	5608	122.57	495	7305	121.59	555	7504	115.36
16	4101	125.00	76	4707	125.00	136	5405	125.00	196	6504	125.00	256	7810	125.00	316	5610	124.79	376	5509	123.56	436	7509	122.56	496	8502	121.55	556	8206	115.03
17	4106	125.00	77	4811	125.00	137	5406	125.00	197	6505	125.00	257	7811	125.00	317	6501	124.76	377	8305	123.56	437	8806	122.53	497	8902	121.55	557	6704	115.00
18	4107	125.00	78	4812	125.00	138	5510	125.00	198	6506	125.00	258	7805	125.00	318	6412	124.72	378	5109	123.50	438	4408	122.46	498	8406	121.55	558	6703	114.95
19	4108	125.00	79	4801	125.00	139	5505	125.00	199	6605	125.00	259	7806	125.00	319	6502	124.68	379	6510	123.47	439	8104	122.45	499	6911	121.42	559	6205	114.81
20	4109	125.00	80	4802	125.00	140	5506	125.00	200	6606	125.00	260	7807	125.00	320	7602	124.68	380	7412	123.45	440	7801	122.44	500	8011	121.38	560	7510	114.75
21	4210	125.00	81	4803	125.00	141	5507	125.00	201	6607	125.00	261	7912	125.00	321	4502	124.67	381	4411	123.43	441	4807	122.43	501	8308	121.32	561	7405	114.56
22	4211	125.00	82	4804	125.00	142	5611	125.00	202	6608	125.00	262	7901	125.00	322	5011	124.67	382	8508	123.43	442	8901	122.42	502	6909	121.28	562	6212	114.47
23	4212	125.00	83	4805	125.00	143	5612	125.00	203	6609	125.00	263	7903	125.00	323	8509	124.66	383	5609	123.38	443	7809	122.39	503	8103	121.21	563	6211	114.45
24	4201	125.00	84	4806	125.00	144	5601	125.00	204	6710	125.00	264	7904	125.00	324	5803	124.61	384	6403	123.38	444	4301	122.37	504	6112	121.20	564	8310	113.95
25	4202	125.00	85	4910	125.00	145	5602	125.00	205	6711	125.00	265	7905	125.00	325	5311	124.60	385	4608	123.38	445	8708	122.33	505	6809	121.18	565	7501	113.85
26	4204	125.00	86	4911	125.00	146	5603	125.00	206	6712	125.00	266	7907	125.00	326	8904	124.58	386	7611	123.36	446	7707	122.32	506	6808	121.17	566	8311	113.76
27	4205	125.00	87	4912	125.00	147	5604	125.00	207	6701	125.00	267	7908	125.00	327	5210	124.58	387	6410	123.27	447	8507	122.31	507	6910	121.16	567	7409	113.74
28	4206	125.00	88	4903	125.00	148	5605	125.00	208	6705	125.00	268	7909	125.00	328	6401	124.57	388	8611	123.25	448	7508	122.28	508	6907	121.11	568	8304	113.50
29	4207	125.00	89	4904	125.00	149	5606	125.00	209	6706	125.00	269	8006	125.00	329	8201	124.56	389	5910	123.24	449	7812	122.27	509	7103	121.02	569	6210	113.45
30	4208	125.00	90	4905	125.00	150	5607	125.00	210	6707	125.00	270	8008	125.00	330	5810	124.56	390	6310	123.23	450	7203	122.26	510	8010	120.97	570	7406	113.05
31	4209	125.00	91	4906	125.00	151	5711	125.00	211	6709	125.00	271	8009	125.00	331	6612	124.52	391	4409	123.20	451	6408	122.24	511	6908	120.97	571	6201	112.95
32	4310	125.00	92	4907	125.00	152	5712	125.00	212	6810	125.00	272	8110	125.00	332	5710	124.51	392	8607	123.19	452	8501	122.23	512	8205	120.88	572	8312	112.93
33	4311	125.00	93	5012	125.00	153	5701	125.00	213	6811	125.00	273	8111	125.00	333	7311	124.50	393	8512	123.18	453	6603	122.21	513	7003	120.83	573	6105	112.87
34	4312	125.00	94	5001	125.00	154	5702	125.00	214	6812	125.00	274	8105	125.00	334	8910	124.47	394	8203	123.18	454	4309	122.19	514	8410	120.82	574	8301	112.80
35	4302	125.00	95	5002	125.00	155	5703	125.00	215	6801	125.00	275	8106	125.00	335	8510	124.46	395	5502	123.13	455	7702	122.18	515	8309	120.81	575	8209	112.64
36	4303	125.00	96	5003	125.00	156	5705	125.00	216	6802	125.00	276	8212	125.00	336	8701	124.46	396	7910	123.10	456	7112	122.15	516	7803	120.73	576	6109	112.57
37	4304	125.00	97	5004	125.00	157	5706	125.00	217	6803	125.00	277	8306	125.00	337	7301	124.44	397	8408	123.07	457	4908	122.14	517	7403	120.72	577	8302	112.52
38	4305	125.00	98	5005	125.00	158	5707	125.00	218	6804	125.00	278	8411	125.00	338	8409	124.41	398	4808	123.06	458	6912	122.12	518	7410	120.70	578	4104	112.45
39	4306	125.00	99	5006	125.00	159	5811	125.00	219	6805	125.00	279	8412	125.00	339	5911	124.38	399	4909	123.05	459	8601	122.12	519	8503	120.68	579	7408	112.33
40	4307	125.00	100	5007	125.00	160	5812	125.00	220	6806	125.00	280	8404	125.00	340	8610	124.37	400	6901	123.02	460	7011	122.12	520	8903	120.62	580	7502	112.33
41	4401	125.00	101	5008	125.00	161	5801	125.00	221	7006	125.00	281	8405	125.00	341	5512	124.36	401	6903	123.02	461	6308	122.11	521	8002	120.59	581	7407	112.11
42	4402	125.00	102	5009	125.00	162	5802	125.00	222	7008	125.00	282	8505	125.00	342	4609	124.36	402	5209	123.01	462	8012	122.10	522	8109	120.30	582	6204	111.78
43	4403	125.00	103	5110	125.00	163	5804	125.00	223	7009	125.00	283	8506	125.00	343	6512	124.35	403	6602	123.01	463	7906	122.07	523	7804	120.28	583	6203	111.78
44	4404	125.00	104	5111	125.00	164	5805	125.00	224	7110	125.00	284	8612	125.00	344	8602	124.32	404	7303	123.00	464	6509	122.06	524	6905	120.07	584	6106	111.75
45	4405	125.00	105	5101	125.00	165	5806	125.00	225	7111	125.00	285	8603	125.00	345	5112	124.29	405	8512	122.99	465	7208	122.06	525	7004	119.98	585	6108	111.68
46	4406	125.00	106	5102	125.00	166	5807	125.00	226	7105	125.00	286	8604	125.00	346	4412	124.28	406	6404	122.99	466	4308	122.06	526	6101	119.87	586	8207	111.66
47	4407	125.00	107	5103	125.00	167	5808	125.00	227	7106	125.00	287	8605	125.00	347	7612	124.27	407	7610	122.92	467	7808	122.02	527	7404	119.81	587	6107	111.56
48	4511	125.00	108	5104	125.00	168	5809	125.00	228	7107	125.00	288	8606	125.00	348	4902	124.26	408	4708	122.87	468	7207	122.02	528	6009	119.75	588	8208	111.47
49	4512	125.00	109	5105	125.00	169	5912	125.00	229	7108	125.00	289	8710	125.00	349	6503	124.24	409	7411	122.86	469	8307	122.02	529	8403	119.52	589	6202	111.47
50	4501	125.00	110	5106	125.00	170	5901	125.00	230	7109	125.00	290	8711	125.00	350	8608	124.23	410	6409	122.86	470	7007	122.02	530	6001	119.44	590	8303	111.31
51	4503	125.00	111	5107	125.00	171	5902	125.00	231	7210	125.00	291	8712	125.00	351	4612	124.21	411	7701	122.84	471	7102	122.00	531	8003	119.43	591	7503	111.17
52	4504	125.00	112	5108	125.00	172	5903	125.00	232	7211	125.00	292	8703	125.00	352	4510	124.18	412	7001	122.83	472	6906	122.00	532	6904	119.36	592	5909	108.42
53	4505	125.00	113	5211	125.00	173	5904	125.00	233	7212	125.00	293	8704	125.00	353	6411	124.07	413	7911	122.83	473	6111	121.98	533	4203	119.28	593	6012	105.99
54	4506	125.00	114	5212	125.00	174	5905	125.00	234	7205	125.00	294	8705	125.00	354	8702	124.06	414	7201	122.83	474	8102	121.98	534	8402	119.07	594	6011	104.11
55	4507	125.00	115	5201	125.00	175	5906	125.00	235	7206	125.00	295	8706	125.00	355	8807	124.03	415	7202	122.82	475	6507	121.98	535	8004	118.85	595	6010	100.62
56	4508	125.00	116	5202	125.00	176	5907	125.00	236	7312	125.00	296	8707	125.00	356	4809	124.02	416	6610	122.81	476	8504	121.97	536	7104	118.84	596	8907	85.81
57	4509	125.00	117	5203	125.00	177	5908	125.00	237	7306	125.00	297	8810	125.00	357	5010	123.96	417	8210	122.81	477	8007	121.95	537	7509	118.66	597	8108	85.14
58	4610	125.00	118	5204	125.00	178	6002	125.00	238	7307	125.00	298	8811	125.00	358	8202	123.93	418	5708	122.80	478	7002	121.94	538	6102	118.53	598	8909	40.87
59	4611	125.00	119	5205	125.00	179	6003	125.00	239	7505	125.00	299	8812	125.00	359	6611	123.90	419	7101	122.79	479	6807	121.93	539	8401	118.30	599	8107	39.07
60	4601	125.00	120	5206	125.00	180	6004	125.00	240	7506	125.00	300	8801	125.00	360	6402	123.90	420	7209	122.74	480	8709	121.91	540	8005	118.23	600	8908	32.06



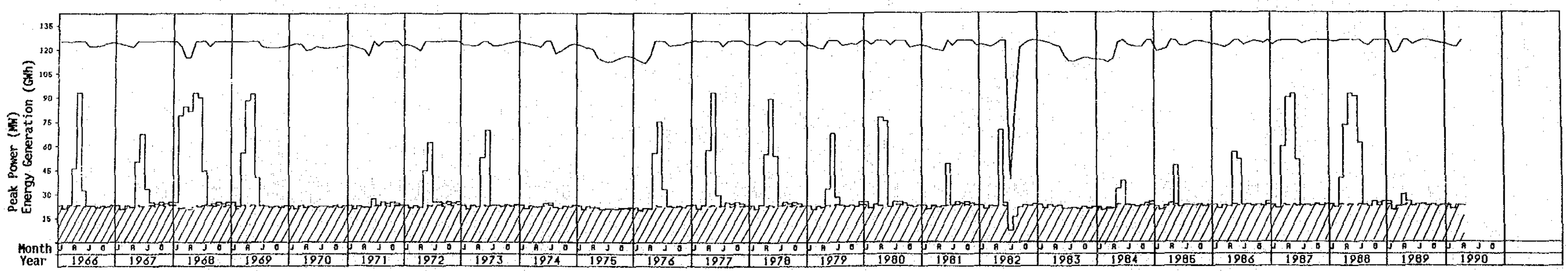


Fig. 9-23 Energy Generation of Ayvalı Project

Table 9-27 Preliminary Cost Estimation of Ayvalı Project

Unit: Million TL

Relocation Road	28,000
Camp Facilities	5,000
Land Acquisition	34,106
Civil Work	486,819
Diversion	9,742
Care of River	14,147
Dam	242,823
Spillway	63,358
Outlet Works	4,748
Intake	3,238
Penstock	2,333
Power House	21,340
Tailrace	123,914
Switchyard	1,176
Hydraulic Equipment	24,883
Electro-Mechanical Equipment	96,516
Contingency	58,052
Engineering and Administration Cost	64,122
Total	797,497
Interest During Construction	190,508
Grand Total	988,005
	(230 Million $)

Chapter 10 TRANSMISSION SYSTEM PLANNING AND SYSTEM STABILITY

Chapter 10

TRANSMISSION SYSTEM PLANNING AND SYSTEM STABILITY

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Chapter 10 TRANSMISSION SYSTEM PLANNING AND SYSTEM STABILITY

10.1 TEK's Transmission System and Oltu Project

Turkish Electricity industry has been mainly managed and operated by Turkish Electricity Authority (TEK). The power system in Turkey consists of 380 kV for main grid to be connected between big power plants and load centers, and 154 kV for subsidiary grids to be connected among 380 kV grid, medium/small scale power plans and local load centers.

Power Development Program covers only the detail power generation plants by 1995, but the power generation program after 1995 is not clear enough for the system planning. Fortunately, TEK has a transmission system plan idea for 380 kV system plan of 2010 (see Fig. 10-1), and then we discussed far future based on the TEK's idea. We had considered that the power produced by the Oltu Project be used for some load centers located in the eastern region, but we found that the load in eastern regions is not so prospected since the power in the region will be supplied by local power plants through the existing and planned 154 kV transmission lines. Therefore, the power produced by the Oltu Project should be transmitted to the 380 kV main grid through Yusufeli Switching Station which is to be a part of Yusufeli Hydropower Project.

The transmission system of the River Hydroelectric Power Development Project is shown in Fig. 10-2.

10.2 Transmission Line Route Survey

In accordance with the original schedule, the survey for the 154 kV transmission line routes from Olur Hydropower Plant to the eastern region and to the Yusufeli Switching Station through Ayvali Hydropower Plant was performed. The route from Olur

Hydropower Plant to the eastern region was not selected for the transmission line in this Project because the power produced by this Project will be transmitted to the 380 kV main grid through Yusufeli Switching Station based on the meeting among EIE, TEK and JICA Mission. The route from Olur Hydropower Plant to Yusufeli Switching Station by 154 kV transmission line is technically feasible, however, the cost will be much more than the cost of ordinary transmission line due to the bad access to the location of towers in the steap/wild slopes. At the stage of detail design of the transmission lines, the exact location of the towers shall be decided based on the geological profiles of the route.

10.3 Site Survey of Yusufeli Switching Station

For sending the electric power produced by the Oltu Project to the 380 kV main grid, two circuits of incoming facilities for 154 kV transmission from the Ayvalı Hydropower Plant and a step-up transforming facilities from 154 kV to 380 kV in the Yusufeli Switching Station to be constructed as a part of the Yusufeli Hydropower Project are necessary. According to the site survey, it has been confirmed that the site is wide enough for installing the necessary facilities for the Oltu Hydropower Project. At the present, the Yusufeli Switching Station is designed as a conventional outdoor switching station, but the design may be changed to that of Gas-insulated Switching (GIS) in the future. If so, the space requirement for the facilities will be small, then the space for the facilities for Olur Project has no problem at all.

10.4 Transmission System Plan for Oltu Hydropower Project

10.4.1 Conditions for Planning

(1) The electric power shall be transmitted to the demands area economically

(2) The proposed plan shall be in accordance with TEK's power system plan

(3) The transmission line design shall be in accordance with TEK's standard design criteria

(4) The proposed system shall be stable even though system disturbance occurring on the system

10.4.2 Demand Areas and System Interconnecting Point

The electric power is to be sent to the demand area in whole Turkey through 380 kV, therefore, the Olur and Ayvalı Hydropower Plants are to be connected to the 380 kV system by 154 kV transmission lines at the Yusufeli Switching Station.

10.4.3 Transmission Line Voltage

The transmission voltage to be considered for this project may be 154 kV and 380 kV. Taking short distance from the power plants and the capacity of each power plant into consideration, 154 kV transmission lines are considered to be suitable for the Project. Judging from the transmission capacities, the number of circuits of each transmission line will be as follows:

(1) Olur - Ayvalı 154 kV Transmission line: Single circuit
(2) Ayvalı - Yusufeli 154 kV Transmission line: Double circuit

10.4.4 Distance and Conductor Size of Transmission Line

According to the survey on topographic maps, the transmission line distance of each transmission line are as follows:

(1) Olur - Ayvalı 154 kV Transmission line: approx. 13 km
(2) Ayvalı - Yusufeli 154 kV Transmission line: approx. 20 km

In accordance with the TEK's practice, the conductor of 154 kV transmission lines has been decided as follows:

- 636 MCM Aluminum Conductor Steel Reinforced (ACSR)

10.4.5 Interconnection with 380 kV Transmission System

The nearest terminal of 380 kV system from the Project is 380 kV Switching Station for Yusufeli Hydropower Plant to be completed before commissioning of the Oltu Project. The switchgear for the Oltu Project is of conventional outdoor type and to be installed in Yusufeli Switching Station since Yusufeli Switching Station is to be of a conventional outdoor switching station.

For stepping up the transmission voltage from 154 kV to 380 kV, it is necessary to install a step-up transformer at the Yusufeli Switching Station.

10.4.6 Power System Stability after Completion of the Project

Before completion of the Project, Yusufeli Hydropower Plant are to be completed and to be connected to the 380 kV transmission System. Yusufeli Power Plant has three units of 180 MW generators. During feasibility study of the Yusufeli Power Project, it has been confirmed that the 380 kV system is stable in even when the system disturbance occurred in the system during full load (540 MW) operation of Yusufeli Power Plant.

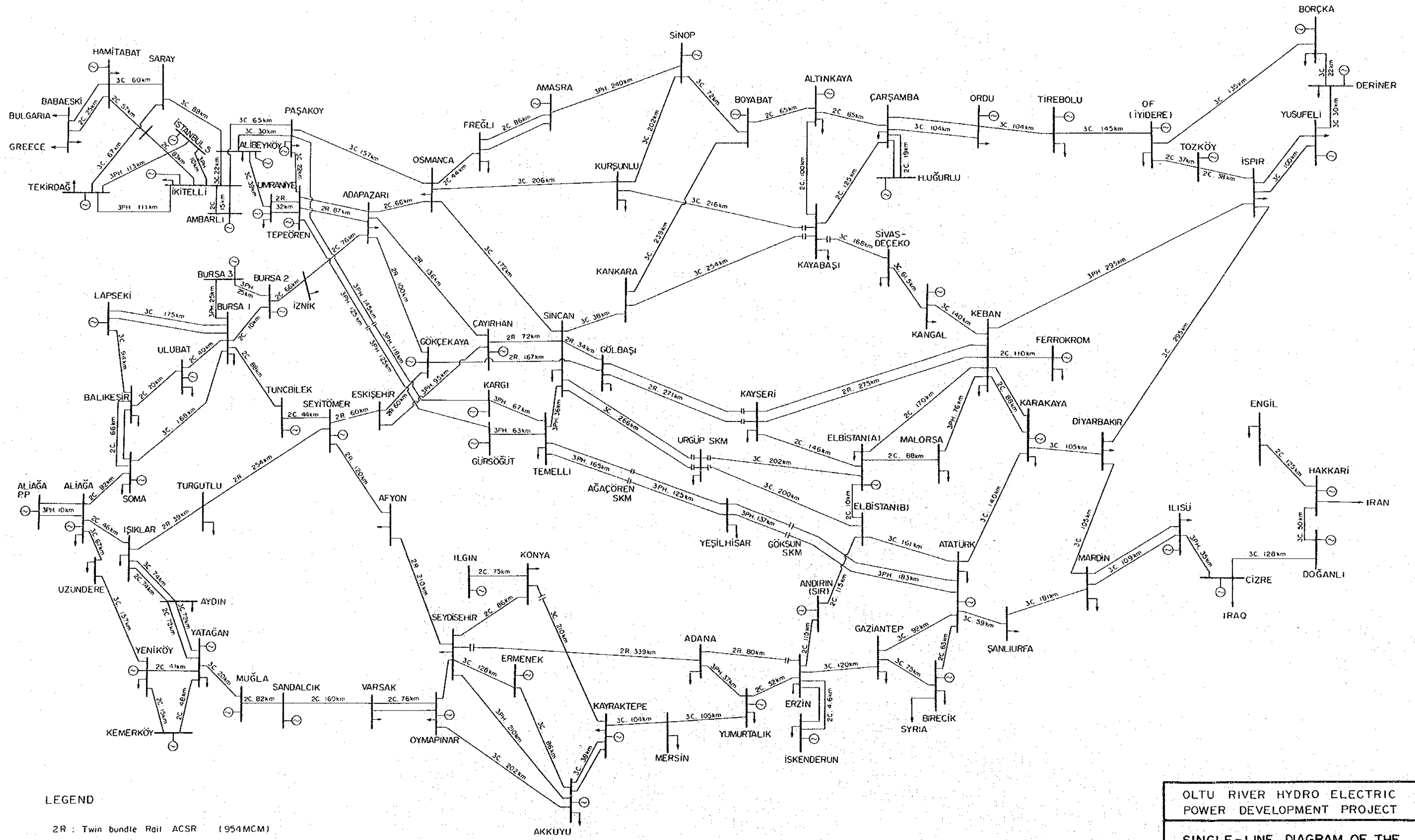
The power plants of the Oltu Project is to be connected to the 380 kV system at the Yusufeli Switching Station. Since the total capacity of two power plants (190 MW) is less than that of Yusufeli Power Plant, any disturbance on the 154 kV system of Oltu Project will not affect to 380 kV system seriously. Therefore, for the Oltu Project, the system analysis was made on the 154 kV system only.

10.4.7 Result of Power System Analysis

Short circuit current is the maximum at the time when three phase short circuit at the 154 kV bus of the Ayvalı Power Plant and the value is not more than 50 kA. Judging from the value, it is confirmed that the standard series of the circuit breakers is applicable for the Project.

For the steady state system stability, it should be confirmed that the Phase angle between the transmission line terminals, say sending end and receiving end, shall be within 60 degrees even if the line sending full power on the line. According to the analysis, the phase angle is within the criteria stated above and it is confirmed that the system is stable in the steady state operation.

For transient stability of the system, it shall be confirmed that the system is transiently stable under the most serious condition. The most serious condition will be the case that one circuit of the line between Ayvalı and Yusufeli Switchyard has three-phase ground fault near Ayvalı Power Plant during full load operation of two power plants and the fault be cleared by disconnecting the fault circuit by mean of the transmission line protective relaying system. As the result of the analysis, it is confirmed that the system is stable transiently and the both power plant can continue the operation.



LEGEND

2R : Twin bundle Rail ACSR (954MCM)

2C : Twin bundle Cardinal ACSR (954MCM)

3C : Triplet bundle Cardinal ACSR (954MCM)

3PH : Triplet bundle Pheasant ACSR (1272MCM)

OLTU RIVER HYDRO ELECTRIC POWER DEVELOPMENT PROJECT

SINGLE-LINE DIAGRAM OF THE 380kV NETWORK

-LONG TERM EXPANSION YEAR 2010

Fig. 10-1

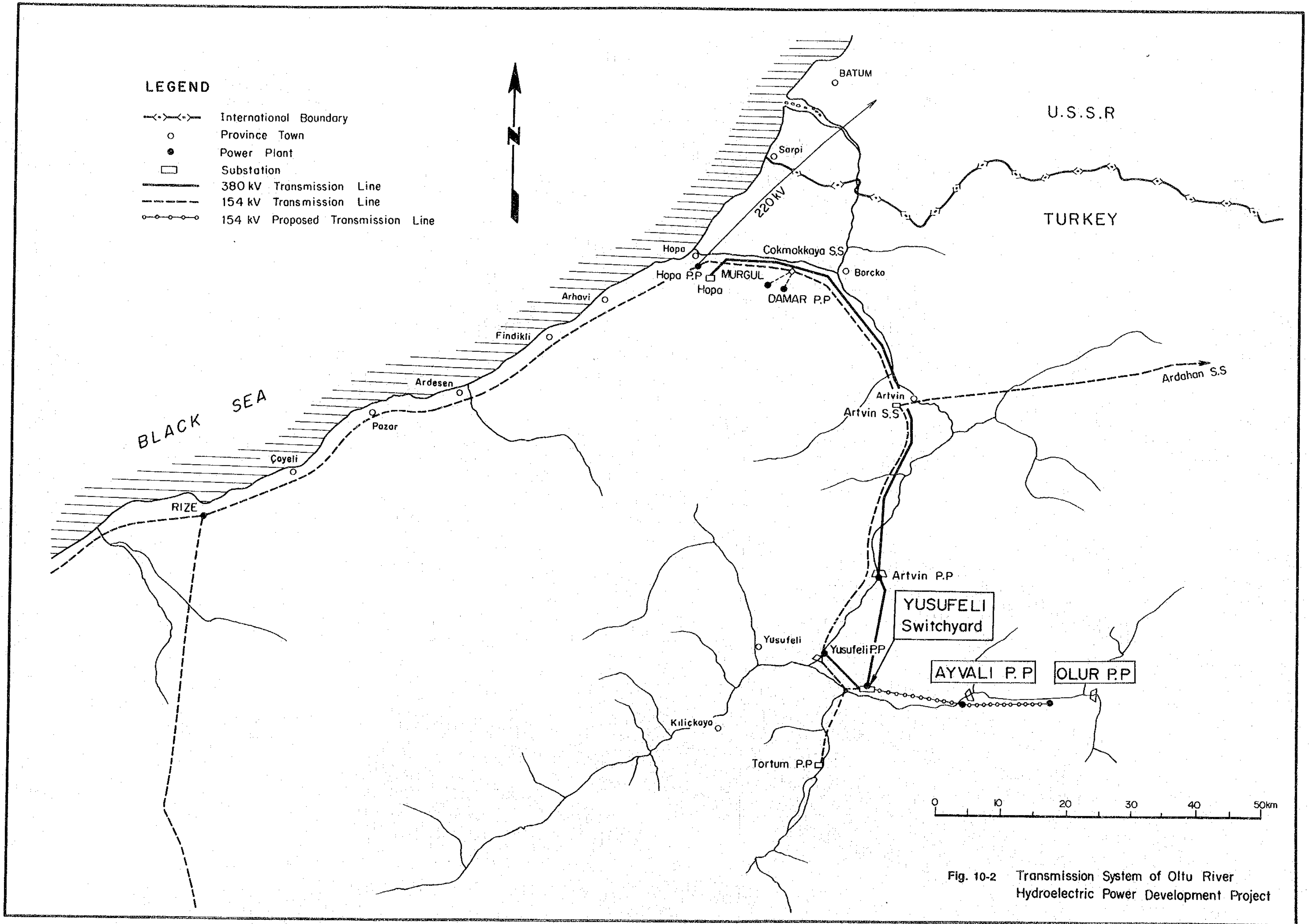


Fig. 10-2 Transmission System of Oltu River Hydroelectric Power Development Project

Chapter 11 FEASIBILITY DESIGN

Chapter 11

FEASIBILITY DESIGN

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Chapter 11 FEASIBILITY DESIGN

This Chapter describes the feasibility designs of civil structures, electro-mechanical equipments, transmission line, and temporary facilities for construction of the Olur and Ayvalı projects, respectively.

The results of studies of the designs of permanent facilities such as dam, spillway, intake, headrace tunnel, surge tank, penstock, powerhouse and tailrace tunnel which are situated as the main structures for the power plant are described including comparative designs of principal structures.

11.1 Olur Project

11.1.1 Dam and Auxiliary Structures

(1) Location and Outline

The projected damsite is located at the upstream part of the Oltu River, a tributary of the Çoruh River at the east side. Approximately 10 km downstream of the site for the Olur dam there is the Ayvalı dam which is included in this Oltu Project, and next downstream, the Yusufeli Project.

The topography at the site of Olur Dam is that of a V-shaped valley more or less symmetric right and left with slope gradients of about 30 to 35 deg. Regarding the dam axis, there is besides the present dam site a site of comparatively good quality as a dam axis from topographical and geological standpoints approximately 500 m downstream, and an investigation of this site had been carried out. Accordingly, an economic comparison was made of the two dam axes, upstream and downstream. As a result, the dam volume for the upstream proposal was 3.7×10^3 m^3, and that for the downstream proposal 5.3 x 10^3 m^3, so that the downstream proposal will have a volume 40% larger than the upstream proposal. The lengths of the diversion tunnels would be roughly equal. On the other hand, the excavation volume for the spillway would be 16% larger for the downstream proposal compared with the upstream proposal. Further, the distance between the two dams would be 500 m and it was found there would be hardly any difference in the amount of water storage, and it was judged reasonable to select the upstream proposal for which the construction cost would be cheaper.

The riverbed at the damsite has sand-gravel layers deposited to a thickness of approximately 45 m. It has been confirmed that gravel of maximum size 30 cm and fine-particled sand are deposited in stratified form in these sand-gravel layers. The stratigraphical sequence consists of a sand-gravel layer of 25 m at the top, a sand layer of 25 m, and then a sand-gravel layer of 5 m to reach the foundation rock.

The ground surface of both abutments has almost no top soil or trees, and weathered rock is exposed at the whole surfaces. The depths of weathering of the foundation rocks at both abutments are about 3 to 8 m. The foundation rocks at both abutments and the river bed are hard and large faults have not been confirmed. Therefore, the topographical and geological conditions make it possible to construct even a concrete dam as well as a rockfill dam.

(2) Selection of Dam Type

Various types are conceivable for the dam, but generally, a fill dam and a concrete dam can be cited. The main factors in dam design are the two points that the dam body including the foundation is stable and that the construction cost is economical.

The quality and quantities of materials available in the vicinity of the damsite have a strong influences on the selection of the dam type, and these are important factors from the standpoint of the economics also. The results of investigations and tests of the geology and materials in the surroundings of the damsite were examined taking these into account for Olur Dam.

The great feature of the surroundings of the Olur damsite of the abundantly existing river-bed sand-gravel and talus deposits was focused on, and utilization of these was studied.

According to the site investigations, the gradation of the river deposit materials is fair. If the oversized material can be eliminated, it may be judged that 75% of the materials can be amply used as the concrete aggregates and the filter materials which are on the coarse side.

When looking upon the river-bed sand-gravel as material, both quality and quantity are adequate, and from the standpoint of gradation, although there would be a necessity for consideration to be given in design and construction depending on the use and the range of the fluctuation of the grain size, it is thought possible for the selection of dam type to be made over a broad scope.

Factors to be considered in selection of the dam type, as shown in Table 11-1, directly are topography, geology, meteorology, hydrology, seismicity, dam scale and availability of dam material quality, quantity and place. Indirectly, there are also the influences of conditions of purpose of construction, construction period, technological capability, labor force, construction machinery, etc. And, the fundamental matter is for the most economical type to be selected upon securing the required degree of safety.

In the following, the features in type selection of concrete gravity dam and fill dam which are widely selected will be described.

1) A concrete gravity dam is the most general type, and whatever type may be finally selected, it is made an object of comparison study.

2) Hollow gravity dam and buttress dam are few in material-savings effects compared with their complexities in construction, and their advantages are becoming lessened.

3) In case of a fill dam, it is capable of adapting even where the geology is comparatively adverse. A fill dam is extremely weak against overtopping by flood on the other hand, and where the catchment area is large, it is necessary for a special study to be made of the method of controlling of flood.

   - A concrete or asphalt facing type fill dam has a weakness in the facing against settlement and earthquake motion, and it would be inadvisable to select this type unless there are conditions allowing the water level of the reservoir to be lowered for inspection and repair of the facing.

   - A zone-type fill dam is comparatively stable against settling compared with a homogeneous type fill dam so that the majority of dams are of this type. There are center core type and inclined core type depending on the location of the impervious core. Recently, the center core type has been adopted more often.

Table 11-1 General Factors for Dam Type Selection

Factor/Type	Concrete Dam	Rockfill Dam
Dam-site topography	A place where there is no extreme drop from upstream to downstream or no scraggly ridge. A narrow V-shaped valley in case of an arch dam.	Nothing in particular for the topography. The space of spillway should be considered.
Dam-site geology	Strength of foundation rock high, especially river bed and both abutments.	Selected often at sand-gravel foundations and rock foundations.
Meteorological conditions	No limitations in particular.	Limitations in core constructibility.
Dam height	No limitations in particular.	No limitations in particular.
Material conditions	When concrete aggregates obtainable.	When both core and rock materials obtainable.
Construction conditions	Depends on topography and scale but rapid construction possible.	Limitations in constructibility of core.

With the above taken into consideration, the dam type is considered capable of conforming with the siting characteristics of the Olur Dam and the recent technological trends are to be selected.

Firstly, with regard to fill dams, an interior core type is conceivable from the various conditions above. Concerning core materials, there is a deposit along the road at Kaledibi site on the left bank, approximately 3 km upstream from the dam, which can be utilized as core material in large quantity. As coarse-particled sizes are somewhat high in content, it is thought to be effective for this to be used in blending with some amount of fine-grained material which is confirmed at the Yolboyu site. But there will be no problem in securing a quantity of about 600,000 m^3.

As for rock materials, there is a quarry site, approximately 1 km upstream in a gully on the right-bank side immediately downstream of the dam, from which large-scale collection will be possible.

Regarding both abutments at the damsite, it has been confirmed as a result of investigations that fresh foundation rock can be obtained by excavation of 3 to 8 m. The river bed consists of deposits of thickness as much as 45 m, and methods such as removal by excavation and by grouting or cut-off slurry walling method are conceivable. But since the dam height exceeds 130 m, the safest method is removal by excavation of the core portion alluvium.

Regarding the foundation of the dam, it is normally considered that there will be risk of liquefaction in the following cases:

- When a sand layer exists within 15 m from the ground surface

- When N-value in the standard penetration test is under 15. (In case of fines content 15 to 35%)

- When purely a sand layer consisting of medium-grained sand of uniform particle size and silt and clay content is less than 10%.

- When a sandy soil of content of fines (74 μ and under) is less than 35%.

Regarding the sand layer existing at the foundation of Olur Dam, according to the results of investigations made so far, since it has been found that the thickness from the ground surface is approximately 25 m, and N-value from additional boring was higher than 15, it is considered that liquefaction of the dam foundation will not occur. In the aspect of design, waiting zones were provided at the cofferdams upstream and downstream of the dam giving consideration to stability of the tops of the slopes. However, in further detailed designing, it will be necessary for confirmations to be made of the distribution of sand layers over a wide area and of grain-size distributions through additional investigations.

In case of selecting a rockfill dam, the spillway is to be made a chute type of width 46.5 m at the right-bank side because of the topography, in order to safely release the design flood discharge of 4,750 m^3/s (PMF). The energy dissipating device at the bottom part is to be made a flip bucket type.

On the other hand, a concrete dam would require further investigations to be made such as of bedrock strength. But a straight gravity dam of a general type of cross section is to be considered.

In case of a concrete dam there would be advantageous aspects compared with a fill dam with respect to flood disposal and the liquefaction of the foundation mentioned previously. Further, when considering this type of dam, it would be necessary for investigation to be made of items such as foundation rock strength, but a concrete arch dam which is possible to an extent was also made an object of comparison. Further, in case of a concrete dam, a large quantity of good-quality cement would be required, and Kars which is comparatively close by, may be considered as the candidate production site. In this case, the transportation distance would be approximately 170 km, while road conditions are favorable.

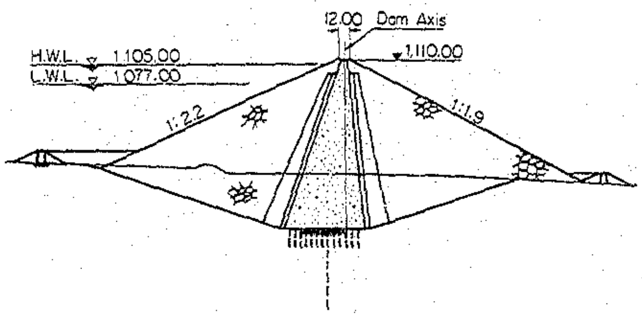
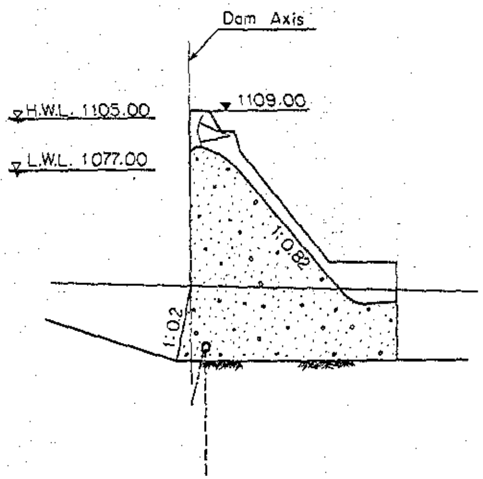
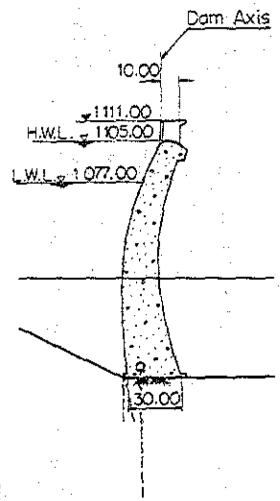
With the above as the objects, basic designs were made of the individual types, and the results of comparing the economic natures are as shown in Table 11-2 and Table 11-3.

From the above results, a rockfill dam may be considered to be advantageous with respect to the economics, and for the Olur site, although depending to an extent on the results of further investigations, a rockfill dam is to be adopted in this study.

Table 11-2 Comparison of Dam Type, Olur (1)

Specification/Type	Rockfill	Concrete Gravity	Concrete Arch
High water level (m)	1,105	1,105	1,105
Dam height (m)	136	137	146
Spillway type	Chute	Center overflow	Center free fall weir
Gate	Radial	Radial	---
W x H (m)	13.5 x 16.5	13.5 x 16.5	---
Specifications			
Diversion tunnel length (m)	530	502	696
Inside diameter (m)	6.0	6.0	6.0
Dam excavation (10^3 m^3)	651	1,396	1,686
Dam volume (10^3 m^3)	3,818	1,045	874
Spillway excavation (10^3 m^3)	546	---	---

Table 11-3 Comparison of Dam Type, Olur (2)

Item		Rockfill Type	Concrete Gravity Type	Concrete Arch Type
Typical Section				
Slope	Upstream	1 : 2.2	(1 : 0.2)	-
	Downstream	1 : 1.9	1 : 0.82	-
Dam Volume		3,817,900 m^3	1,045,100 m^3	874,100 m^3
Construction Cost		182,102 x 10^6 TL	276,568 x 10^6 TL	260,753 x 10^6 TL
Ratio of Construction Cost		100	151.9	143.2

(3) Designs of Structures

1) Dam

As stated up to the preceding clause, a rockfill type is selected for the Olur Dam. The topography and geology of the damsite are as previously described, and with nothing to pose a problem, this is a site suited to this type of dam. Regarding the type of the impervious core, recent high rockfill dams (more than 100 m) in the world have almost all been center core type, and since there is no topographical condition at this site for an inclined type to be adopted in particular, a center core type was selected. Concerning the width of the core, a core having a thickness of 30 to 50% of water pressure is considered to be safe even under fairly adverse conditions regardless of the soil and dam height. The core material for Olur Dam is available at the left bank 3 km upstream, and this has a high content of coarse particles, but quantity can be secured with comparative ease. Because of this, the core was made some-what thick and about 50% of water pressure from the viewpoints of permeability and securing of quantity. Regarding dam configuration, a horizontal seismic coefficient of 0.15 was adopted, the examples of similar sites in Turkey were referred to, and the upstream slope was made 1:2.2 and the downstream slope 1:1.9. Regarding stability of the dam, the result that there will be no special problem has been obtained also in stability calculations including the dam foundation. (See Table 11-4)

Regarding dam materials such as for the filter and rock zones, the abundant river-bed deposits and muck from excavation for structures are to be diverted as much as possible, and a zone type is to be adopted.

A quarry is to be provided at the right bank downstream of the dam.

Table 11-4 Stability Analysis of Olur Dam

Condition	Hydrostatic Pressure		Pore Pressure	Seismic coefficient	Minimum Safety Factor	
	Upstream Side	Downstream Side			Up-st. Side	Dn-st. Side
End of Construction • Normal	Water Level 1,026.00	Water Level 1,026.00	Value at the end of Construction	---	1.9	2.0
End of Construction • Earthquake	Water Level 1,026.00	Water Level 1,026.00	Value at the end of construction	k=0.10	1.3	1.5
Steady Seepage • Normal H.W.L	H.W.L. 1,105.00	Water Level 1,026.00	Based on steady seepage at H.W.L.	---	2.2	2.0
Steady Seepage • Earthquake H.W.L	H.W.L. 1,105.00	Water Level 1,026.00	Based on steady seepage at H.W.L.	k=0.15	1.6	1.3

2) Spillway

It will be necessary for the spillway to be capable of safely releasing the design flood discharge of 4,750 m^3/s (PMF). From the standpoints of topography and geology, it would be possible for the spillway to be provided at either bank, right or left, but when the plan configuration such as the flow direction and excavation volume are considered, the right-bank side would be suitable. Accordingly, a chute-type spillway of width 46.5 m with 3 gates is to be provided on the right bank. The energy dissipating device at the bottom part is to be made a flip bucket type since the right bank on the downstream side happens to be the outlet of a large gully, the fan deposit is deep, and provision of a large-capacity stilling basin is difficult topographically. Moreover, there are no houses in the vicinity.

3) Care of River

Care of river for the dam would consist of upstream cofferdam, diversion tunnel, and downstream cofferdam. The upstream cofferdam is for the purpose of preventing inflow of river water to the work area during construction of the main dam, and diverting the river water to the diversion tunnel.

The location of the upstream cofferdam was arranged further upstream from the toe of the main dam in order to facilitate excavation of the thick river-bed deposit at the core section and to provide a extra banking for the counterweight between the main dam and the cofferdam taking into account the fact that the foundation of the rock zone contains sand and silt layers. The height of the cofferdam was set for a design flood discharge (332 m^3/s) of 25 years return period flood. But to increase safety, it was designed so that when the water storage effect was considered there would be no overtopping even with a 50 year return period flood (376 m^3/s).

The height of the cofferdam is 22 m and is to be such that overtopping will not occur in the flood season and the cofferdam is to be completed during the non-flood season. The diversion tunnel is to have a discharge cross section (D = 6.0 m, L = 530 m) with which it would be possible for the design flood discharge to be released completely downstream without overtopping the cofferdam in the flood season, and in a manner that the construction cost including the cofferdam would be cheapest. The height of downstream cofferdam was determined as 6.5 m that the downstream water level would not overtop, during the flood season.

4) Outlet Works

Outlet Works are to be provided for the purposes of irrigation downstream at the time of initial water impoundment and emergency dewatering. The outlet works is to be provided by the conversion of the diversion tunnel to a valve chamber; but since the diversion is planned with a single tunnel, it is to be of a construction possible for branching to be done at the section of the diversion tunnel for plugging of the diversion tunnel.

The outlet works would consist of a high pressure valve and a high-pressure slide gate for emergency purposes.

The inner diameter and the length of the outlet works are 4.0 m and 148 m respectively, and the diameter of the high pressure valve is 1.5 m. Outlet Works is consisted of a main valve and an emergency high pressure gate.

The inlet structure of the outlet works is to be of reinforced concrete and provided at the diversion tunnel inlet, the elevation being set at the vicinity of the planned sedimentation level of the reservoir. The capacity is set for it to be possible for a design discharge of 44 m^3/s to be released at high water level of the reservoir. Furthermore, besides the emergency outlet valve, a facility for irrigation is to be provided.

11.1.2 Waterway and Powerhouse

(1) Location and Outline

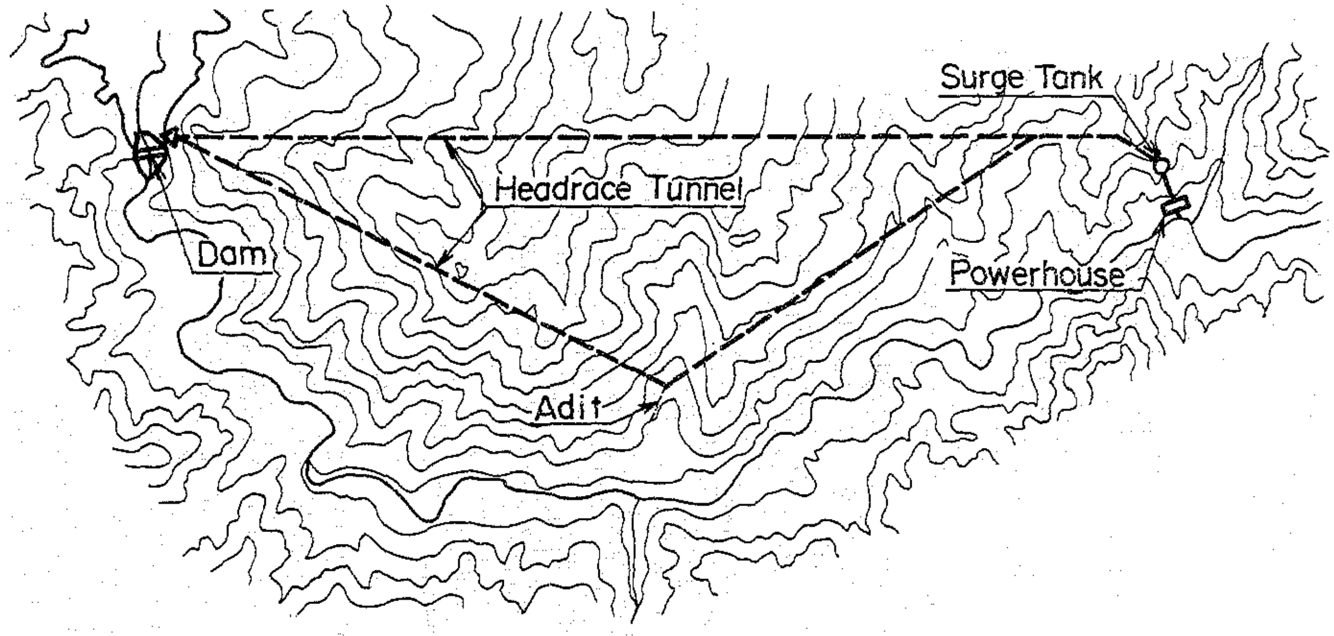
The headrace of the Olur Project is to consist of a tunnel of approximately 10 km from an intake provided at the left bank of the reservoir and taking advantage of the meandering of the river to obtain a head of 180 m.

The geology of the route of the tunnel is as described in 7.3.1(3), and although faults and sheared zones to be especially problematic geologically in tunnel excavation have not been recognized, there is a part near the end of the headrace where deposits are thick.

(2) Study of Waterway Route

For the headrace route, what is first conceivable is the shortest path connecting the intake and powerhouse. In this proposal, the waterway length is approximately 9,660 m, while it is impossible to provide work adits along the way because of the topographical conditions. In tunnel excavation in general, in case of the conventional method, it is effective to provide a work adit at about every 3,000 to 5,000 m when considering work efficiency. Therefore, comparison studies were made of the three alternatives of a case of excavation of the shortest route by the conventional method, a case of excavation by TBM (Tunnel Boring Machine), and a case of excavation by the conventional method but providing a work adit at an intermediate point as shown in Table 11-5. As a result, it was found that the excavation of the shortest route by the conventional method would be the cheapest, but

Table 11-5 Comparison of Waterway, Olur

Item	Straight by NATM	Straight by TBM	Alternative by NATM
General Plan			
Total Length of Headrace Tunnel	9,660 m	9,660 m	11,000 m
Construction Cost of Headrace Tunnel	$121,407 \times 10^6$ TL	$166,325 \times 10^6$ TL	$137,875 \times 10^6$ TL
Ratio of Construction Cost	100	137.0	113.6
Construction Period	70 months	34 months	48 months

approximately 70 months would be required for the construction period. The TBM method would shorten the construction period to 34 months but the construction cost would be increased approximately 37%. In the case of providing a work adit, it would shorten the construction period to 48 months but the construction cost would be approximately 14% higher while there also would be loss in kWh production due to increased tunnel length. Accordingly, the construction period in case of the shortest route by the conventional method would be problematic. But when the dam construction period including care of river works such as the diversion tunnel are taken into consideration, it could be judged that the overall construction schedule would not be impeded if tunnel excavation were to be commenced at an early stage. The original plan for the conventional method with the construction cost the lowest was adopted.

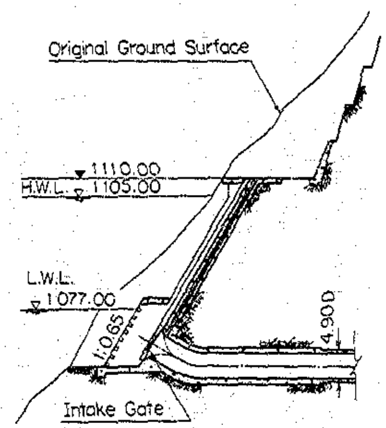
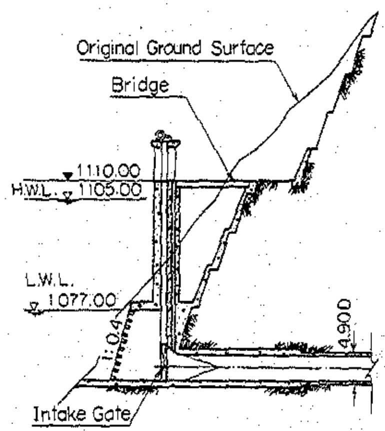
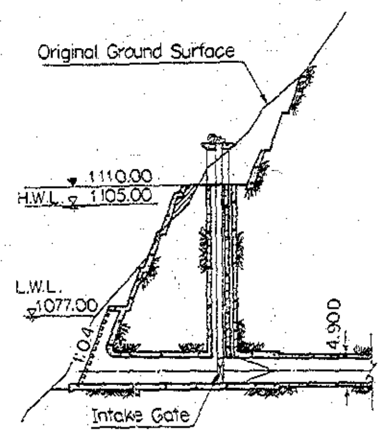
(3) Designs of Structures

1) Intake

The intake is to be provided at a gully at the left bank approximately 170 m upstream from the dam axis in consideration of the tunnel route, the topographical and geological conditions, and the plan for an access road.

The topography and geology of this site are as described in 7.3.1(2). There is no problem regarding the foundation for the intake structure. However, the topography is that of a steep slope of approximately 40 deg. and if open excavation for the intake structure were to be done excessively, it is thought it would be disadvantageous both economically and in the aspect of slope stability during construction. The type of intake structure was considered making a

Table 11-6 Comparison of Power Intake Type, Olur

Item	Inclined Type	Intake Tower	Gate Shaft
Typical Section			
Excavation Volume	26,300 m^3	12,200 m^3	12,500 m^3
Concrete Volume	5,300 m^3	7,200 m^3	4,600 m^3
Construction	Good	Fair	Good
Ratio of Construction Cost	100	113.8	115.2

comparison study of the construction costs for the three conceivable types. As a result, an inclined type was judged to be optimum with respect to the economics and constructibility. The alternatives are shown in Table 11-6.

The elevation of the basement of the intake structure was decided at elevation 1,067 m, to take into consideration the future sedimentation, and also the elevation can avoid the vortex for the conduit system.

2) Headrace

The topography and geology of the headrace tunnel route are as described in 7.3.1(3), and there are no serious problems posed in particular. Of the tunnel route, there is a part of thin overburden near the end of the tunnel. This has been confirmed by results of seismic prospecting, so it was considered to install the steel lining about 250 m of this part.

The elevation of the center of the headrace tunnel was decided at elevation 1,056.5 m to take into consideration passing the thin overburden part, and the down surging of the sudden load reduction of the power.

The inner diameter of the tunnel, as a result of the economic comparisons shown in Fig. 11-1, was decided to be made 4.9 m. Considering the fact that the geological conditions of the tunnel route are generally favorable, it is thought there would be ample safety against the anticipated internal and external pressures with a lining thickness of 0.4 m.

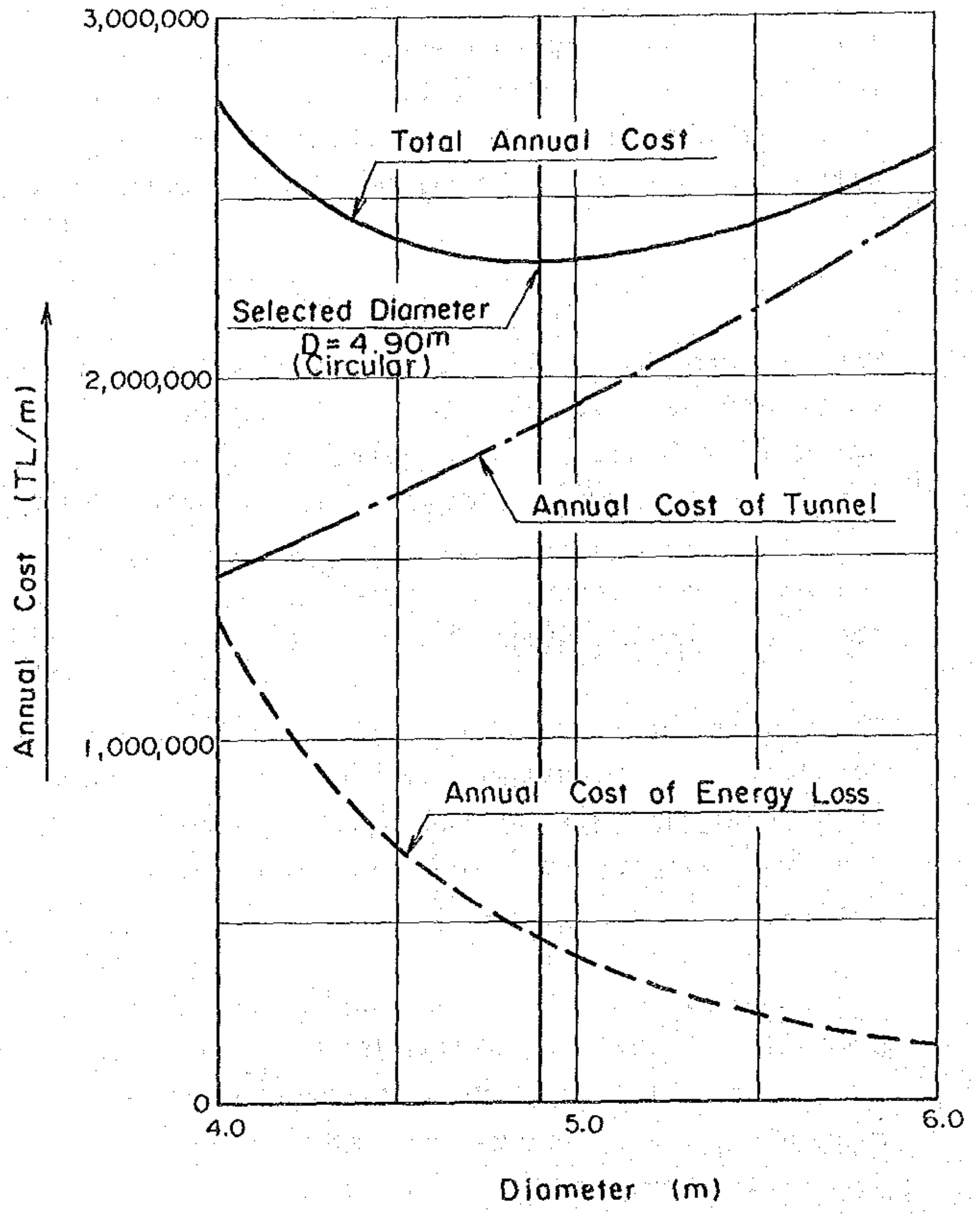


Fig. 11-1 Estimation of Optimum Diameter of Headrace Tunnel, Olur

3) Surge Tank

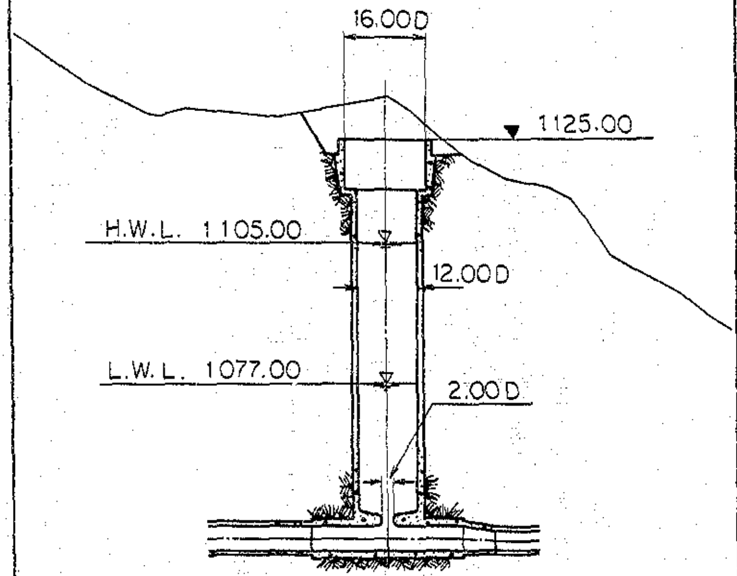
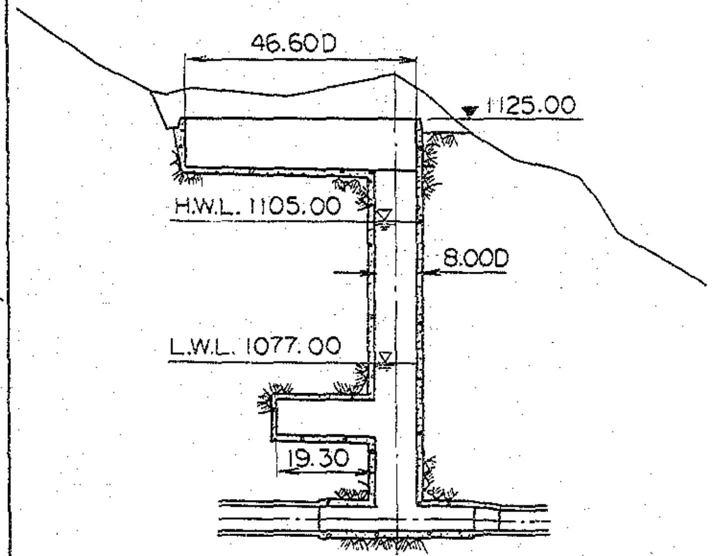
The length of the headrace in the Olur Project is long at approximately 10 km, and a surge tank will be needed in the headrace to adjust available water in accordance with sudden increase in load at the power station and to absorb water-hammer action when the sudden load reduction occurs. The surge tank is to be provided at the upper part of a ridge at the left bank immediately downstream of the village. The topography of the surroundings is complex with almost no topsoil, and slopes are steep and rock masses are outcropped. But an access road can be provided with comparative ease from the upstream side. No problem geologically has been pointed out in particular.

The two types of restricted orifice type and water chamber type were examined for the type of the surge tank in view of the topography. The results of the examinations are shown in Table 11-7. As a result, it was found that the restricted orifice type excelled with respect to the economics, and that it would also be superior in constructibility. The inside diameter of the vertical shaft was decided on at 12 m based on the conditions for static and dynamic stability of the water surface.

4) Penstock

The penstock is to be located roughly down the middle of the ridge connecting the powerhouse to be provided at the river-bed, immediately downstream of the village and the surge tank, and has a plan configuration of a more or less straight line from the surge tank to the powerhouse (OPK Alternative).

Table 11-7 Comparison of Surging Handling, Olur

Item	Orifice Type	Chamber Type
Typical Section		
Excavation Volume	Open 10,000 m^3 Shaft, Tunnel 14,300 m^3 Total 24,300 m^3	Open 21,800 m^3 Shaft, Tunnel 27,600 m^3 Total 49,400 m^3
Concrete Volume	4,200 m^3	5,100 m^3
Ratio of Construction Cost	100	133.2

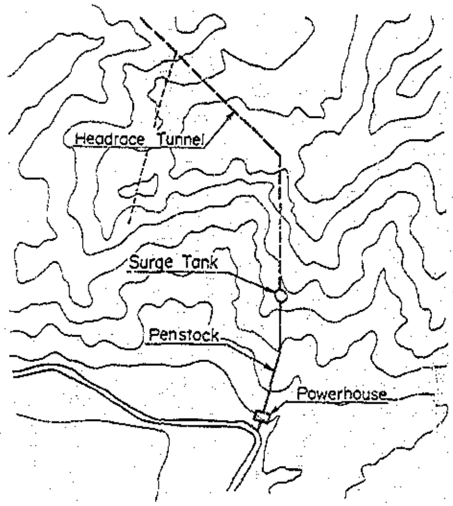
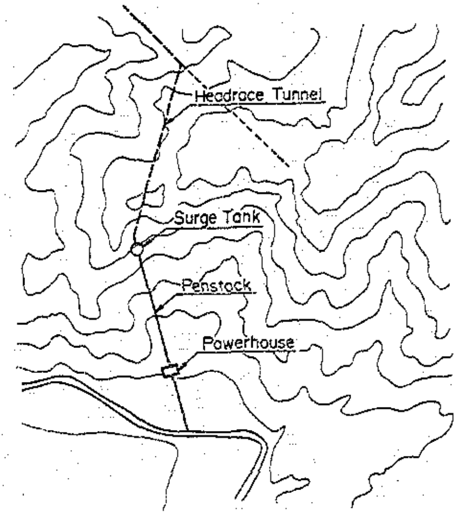
This site is slightly rugged in the vicinity of the surge tank, but the geology is favorable, as indicated in 7.3.1(4), and it is suitable for a surface-type penstock which would be easier to construct.

Further, for an alternative penstock, several upstream locations were studied for rough economic comparisons, and field reconnaissances were made, and as a result, a site approximately 300 m upstream (OPT Alternative) was selected. In the event this alternative is adopted, the thalweg of the river would become distanced from the headrace, and since there are river deposits in terraced form in the vicinity of the river bed, a layout providing the powerhouse immediately below the penstock and leading to the river with a culvert tailrace would be provided. Concerning the foundations of the powerhouse and tailrace in OPT Proposal, the depths of the basement rocks are 60 m which have been confirmed through exploratory drilling and seismic prospecting.

The results of studies on the two cases above are given in Table 11-8. As a result, it was judged that the OPK Proposal is superior in the economics and hydraulic characteristics would be advantageous.

The penstock would have a length of 436 m and a maximum static head of 181 m, and design and construction of steel pipe can be amply done based on domestic procurement in Turkey. The average diameter would be 3.6 m, fairly large-diameter for a surface penstock. Therefore, the turbine center elevation was studied so that even when there is load variation at the turbine when the dam water level is lowered, negative pressure will not occur in vicinity of the upper bend, and EL. 1,046 m was adopted.

Table 11-8 Comparison of Penstock Layout, Olur

Item	OPK	OPT
General Plan		
Length of Waterway and Powerhouse	Headrace 9,661 m, Penstock 436 m, Powerhouse and Outlet 44 m	Headrace 9,361 m, Penstock 341 m, Powerhoue and Outlet 44 m Tailrace Culvert 283 m
Construction Cost of Waterway and Powerhouse (Excluding Dam)	$152,229 \times 10^6$ TL	$162,976 \times 10^6$ TL
Ratio of Construction Cost	100	107.1
Total Head of Power Generator	166.67 m	165.67 m

5) Powerhouse and Switchyard

The powerhouse would be located at the left bank where the Oltu River, near a village 7.5 km downstream from the damsite, bends roughly at a right angle. The topography and geology are as described in 7.3.1(4). The ridge at the left bank, to be the penstock route, forms a steep cliff near the river edge. Immediately below the penstock, there is a part where taluses from the ridge are deposited so that the penstock route will be located shifting slightly to the upstream side where outcropping of basement rock has been confirmed.

It is possible for a ground surface type powerhouse to be provided at this site from a topographical standpoint and a tailrace would be unnecessary, so that a comparatively compact power station can be provided, while an access road and an equipment delivery road can be readily connected.

The elevation of the powerhouse at the ground surface is selected at EL. 934 m from the standpoint of equipment layout. The design flood discharge at the powerhouse site is taken to be 500 m^3/s (200 year return period flood), and the water level in this case would be at elevation 930 m.

Consequently, this powerhouse would have a reasonable height allowance even during flood, and it may be said there would be no risk of inundation.

Regarding the switchyard, there is a flat river terrace area at a point 100 m upstream and it would be possible for the switchyard to be provided with only a small amount of excavation. On the other hand, as for an alternative, a site approximately 300 m upstream (OPT Alternative) is conceivable as mentioned under the clause on the penstock. This powerhouse site would be provided more toward the mountain than the riverbank terrace due to the topography, and therefore, would require a tailrace of approximately 250 m.

11.1.3 Electro-mechanical Equipment

(1) Selection of Number of Units

The installed capacities of both Olur and Ayvalı projects are 65 MW and 125 MW, respectively.

Keeping the installed capacity as the same, there are many conceivable combinations of number of units and unit capacity, but the fewer the number of units is, the more economical the construction cost becomes.

The relatively high turbine efficiency will be obtained in the case of a one unit compared with a two unit case, and thus result in the increase of annual energy production. The following hydroelectric power generation plans in the downstream area of Çoruh river are scheduled to be constructed and connected to 154 kV or 380 kV network, to which both Olur and Ayvalı power stations are also incorporated.

Yusufeli	180	MW x 3 units
Artvin	160	MW x 2 units
Deriner	167.5	MW x 4 units
Borçka	150	MW x 2 units
Muratlı	57.5	MW x 2 units

On account of operation of those power stations as a group, selection of any operable unit in the group including the Olur and Ayvali power stations does not raise any objection as each unit has a similar unit capacity or is interchangeable, i.e. when one is selected for the number of units for both Olur and Ayvalı power stations.

Even in the case of unit shut down of the Olur or Ayvalı power station by failure, there is no undesirable affect on the power system stability in one unit case.

The transportation road up to the Yusufeli site will be constructed in advance of this project, and the upstream portion from the Yusufeli site to this project site is to be extended during construction of this project.

The downstream portion of the transportation road is sufficient to transport bulky items of this project as the unit dimensions and weight of this project are less than those of Yusufeli project, and also obvious increase of construction cost for the upstream portion will not occur, even in the one unit case for both power stations.

Taking all those above mentioned, the number of units for both Olur and Ayvalı power stations will be one each.

(2) Type and Ratings of Major Equipment

From the maximum discharge and effective head,vertical shaft Francis is judged as appropriate.

The generator is directly coupled to the turbine shaft, vertical shaft, three phase, alternating current, synchronous generator.

Generator voltage is stepped up to the transmission voltage by main transformer.

The type of main transformer will be three phase, oil-immersed, as the capacity is not so large, and weight and dimensions less than transportation limitation, accordingly.

154 kV transmission line will be terminated at outdoor switchyard to send power generated at Olur power station to Ayvalı switchyard.

The type of switchyard is that of Aluminum pipe bus as of TEK's standard for the time being, but GIS type may be considered as an alternative to catch up with technological aspects.

The ratings of major electro-mechanical equipment are as follows;

Water Turbine

Type	Vertical shaft,Francis
Number of units	1
Normal effective head	157.2 m
Maximum discharge	48 m^3/s
Turbine output	66500 kW
Revolving speed	333 rpm

Generator

Type	Three phase, Alternating current,synchronous
Number of units	1
Output	74000 kVA
Power factor	0.9 lagging
Voltage	11 kV
Frequency	50 Hz
Revolving speed	333 rpm

Main Transformer

Type	Outdoor,three phase
Number of units	1
Capacity	74000 kVA

Voltage	primary:	11 kV
	secondary:	154 kV

Outdoor Switchyard

Bus system	single bus + transfer Bus (future)
Bus	Aluminum pipe
Number of transmission lines connected	154 kV 1 for Ayvali
	34.5 kV 1

(3) Main Circuit Equipment

As the powerhouse is a ground surface type, the main transformer is equipped at outdoor switchyard near the powerhouse and generator lead and main transformer are connected by 11kV power cable or segregated phase bus.

A parallel-in circuit breaker is equipped at low tension side of main transformer and used for synchronizing generator to the power system.

The number of 154 kV transmission lines which take off from the outdoor switchyard is only one for the Ayvalı switchyard at the time of commissioning, and the single bus system is applied, accordingly.

Another one 154 kV transmission line is planned for future extension, and the space for the outdoor switchyard will be such that one transfer bus can be added. It is TEK's practice to provide a transfer bus to enable the inspection of circuit breaker for transmission line with the line alive and by-passed through the transfer bus.

One feeder is branched from the single bus to a step-down transformer and connected to one 34.5 kV transmission line and one 6.6 kV station service circuit.

To secure station service power in any failure of transmission line or switchyard equipment, emergency power source of a diesel engine-generator set will be equipped in this power station.

Fig. 11-11 and Fig. 11-12 indicate the single line diagram of the power station and switchyard plan, respectively.

(4) Telecommunication Equipment

Power line carrier system (earth return) is provided for composing telecommunication circuits for power generation and dam operation.

11.2 Ayvalı Project

11.2.1 Dam and Auxiliary Structures

(1) Location and Outline

The projected damsite is located approximately 20 km downstream of the Olur Dam, and the end of the backwater of the projected Yusufeli Reservoir would be reached approximately 10 km further downstream.

The topography at the damsite is that of a V-shaped valley of gradients of the right and left banks approximately 40 deg. and roughly symmetrical, and although the slopes of the two banks are slightly steeper compared with the upstream of the Olur damsite, the valley width is larger. The projected damsite is a location topographically advantageous since the length of the diversion tunnel can be made short by utilizing the meandering of the river. From topographical and geological viewpoints, there is no favorable damsite seen in the vicinity which can serve as an alternative. The river-bed at the project site is covered by alluvium of a thickness of 60 m, but according to the results of investigations by drilling up to now, thick sand layers have not been confirmed. Further, since N-values in standard penetration tests on the river-bed deposits are 17 to 50 and higher, it is thought there is little possibility of liquefaction occurring at the Ayvalı site.

The geology of the damsite, as described in the part on geology, has almost no tree growth or topsoil, and weathering has occurred to about 3 to 5 m. The basement rock is hard and large faults have not been confirmed to exist.

(2) Selection of Dam Type

Regarding the procedure followed in selection of the dam type, it has been described in detail in the part on the Olur dam so it will be omitted here.

The Ayvalı damsite is a comparatively good location where it will be possible topographically and geologically for either a fill-type dam or a concrete dam to be constructed. However, the valley width is large at approximately 500 m, while dam height would be 180 m or more from the foundation rock, and especially, the right-bank side is a rock mass having numerous cracks. Because of this, a hard and dense bedrock required as the foundation for an arch dam cannot be hoped for, and it is thought difficult from the standpoints of safety and economy for an arch dam to be adopted. Therefore, comparative designs were made of the two cases of rockfill dam and concrete gravity dam.

The materials available at the damsite, similarly to the case of the Olur Dam, were the abundantly existing river-bed sand-gravel and talus deposits in the vicinity of the damsite, and test results were examined to judge whether they would be usable. The particle-size distribution of the river-bed sand-gravel is fairly good. So, if can be selected, the over sized gravel can be selected, it may be judged that more than 70% of the river deposits are amply usable as concrete aggregates and also as filter materials for the fill type dam.

On the other hand, considered from the aspect of materials in case of adopting a fill-type dam, it is considered possible to borrow core materials from deposits at both banks in the Bulanik Valley 8 km downstream of the dam and the Tavusker Valley 8 km upstream. There is a considerable amount of scatter in gradations at the Bulanik candidate site. The material of the Tavusker candidate site does not have as much scatter as that of the Bulanik candidate site, while the gradation is fine so that it is quite possible for this to be used. The two candidate sites in connection with Ayvalı Dam do not necessarily have large quantities, but the problems of quality and quantity can be solved by using the materials of the two sites independently or combining the materials of the two.

As mentioned before for filter material, it is thought that the river-bed sand-gravel in the surroundings can be amply used both in quality and quantity. Regarding rock materials, it has been ascertained that good-quality material exists in large quantity at the left bank upstream of the dam. As stated up to this point, it is possible for either a concrete dam or a fill dam to be constructed as seen from the aspects of topography, geology, and materials, and therefore, designing was done for the respective types considering materials and work execution and a comparison study was made of the economics.

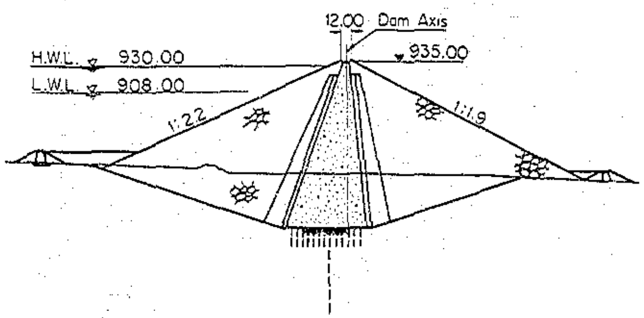
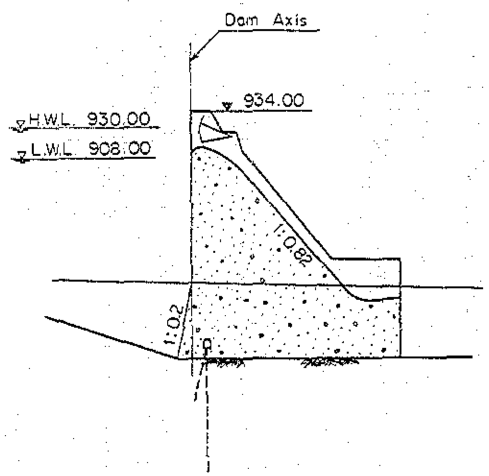
The results of studies are as shown in Table 11-9 and Table 11-10.

According to the above results, it is considered that a rockfill dam would be advantageous with regard to economics in comparison with a concrete gravity dam, and it is thought the rockfill dam proposal would be optimum at the Ayvalı site.

Table 11-9 Comparison of Dam Type, Ayvalı (1)

Specification/Type	Rockfill	Gravity
High water level (m)	930	930
Dam height (m)	175	177
Spillway type	Chute	Central free fall weir
Gate	Radial	Radial
W x H (m)	13.5 x 17.5	13.5 x 17.5
Specifications		
Diversion tunnel length (m)	659	536
Inside diameter (m)	6.0	6.0
Dam excavation (10^3 m^3)	1,112	2,392
Dam volume (10^3 m^3)	9,268	2,423
Spillway excavation (10^3 m^3)	1,105	---

Table 11-10 Comparison of Dam Type, Ayvalı (2)

Item		Rockfill Type	Concrete Gravity Type
Typical Section			
Slope	Upstream	1 : 2.2	(1 : 0.2)
	Downstream	1 : 1.9	1 : 0.82
Dam Volume		9,268,100 m^3	2,423,100 m^3
Construction Cost		344,970 x 10^6 TL	581,169 x 10^6 TL
Ratio of Construction Cost		100	168.5

(3) Designs of Structures

1) Dam

With regard to the dam type, as a result of thorough field investigations of topography, geology, and dam materials, and study of the economics, a fill-type dam with center core type was selected, the same as for the Olur Dam. But because of the problem concerning available quantity of core material, the core was made slightly thinner than for the Olur Dam and about 45% of the maximum water pressure was made the measure. The dam configuration, because the embankment materials would be about the same as for the Olur Dam, and the design conditions regarding geology and earthquake were also the same, the upstream slope gradient was made 1:2.2 and the downstream slope gradient 1:1.9. Regarding stability of the dam, as shown in Table 11-11, the result that there will be no problem in particular has been obtained in stability calculations including the dam foundation. With respect to dam materials such as filter and rock out of the embankment materials, the river deposits, abundantly available in the vicinity, and material from a quarry at the left bank immediately upstream are to be used. For core materials, the deposits in the Bulanik Valley 8 km downstream and the Tavusker Valley 8 km upstream are to be used independently or upon blending together. And, the excavation muck from the spillway, underground powerhouse, and other structures are to be diverted to rock material as much as possible.

Table 11-11 Stability Analysis of Ayvalı Dam

Condition	Hydrostatic Pressure		Pore Pressure	Seismic coefficient	Minimum Safety Factor	
	Upstream Side	Downstream Side			Up-st. Side	Dn-st. Side
End of Construction • Normal	Water Level 810.00	Water Level 810.00	Value at the end of Construction	---	2.2	2.0
End of Construction • Earthquake	Water Level 810.00	Water Level 810.00	Value at the end of construction	k=0.10	1.6	1.3
Steady Seepage • Normal H.W.L	H.W.L. 930.00	Water Level 810.00	Based on steady seepage at H.W.L.	---	2.2	2.0
Steady Seepage • Earthquake H.W.L	H.W.L. 930.00	Water Level 810.00	Based on steady seepage at H.W.L.	k=0.15	1.1	1.3

2) Spillway

The spillway is to be provided at the right bank of the dam in consideration of topography, geology, and downstream water-flow direction. The design flood discharge is 5,270 m^3/s (PMF). To safely release this at maximum water level and during a flood, a spillway 46.5 m in width is to be provided and three radial gates of height 17.5 m and width 13.5 m are to be installed. The spillway is to be a chute type and energy dissipation downstream is to be by flip bucket.

3) Care of River

The river is to be diverted prior to the work on the dam proper providing cofferdams at upstream and downstream of the work area, and excavating a diversion tunnel. Regarding the locations of the cofferdams, they are to be 400 m upstream and downstream of the dam axis since sufficient distance is required in order not to hinder excavation of the thick river-bed sand-gravel. The height of the upstream cofferdam (24.5 m) was set based on a design flood discharge at the damsite of a 25 year return period flood (376 m^3/s), but the height was made one at which a 50 year return period flood (425 m^2/s) would not overtop the dam considering the water storage effect upstream of the cofferdam. And in a manner that the construction cost of the diversion tunnel (D = 6.0 m, L = 659 m) including the cofferdam would be cheapest. Further, the height of the downstream cofferdam (4.5 m) was decided so that the downstream water level at the time of flood would not overtop the cofferdam.

4) Outlet Works

For initial water impoundment of the dam and for emergency dewatering, the outlet works are to be provided utilizing the diversion tunnel. Since the diversion tunnel would be a single one, the construction is to be for branching at the section of the outlet valve in order to be able to carry out plugging of the diversion tunnel. The inner diameter and the length of the outlet works are 4.0 m and 156 m respectively, and the diameter of the high pressure valve is 1.5 m.

The inlet of the outlet valve is to be of reinforced concrete and provided at the inlet structure of the diversion tunnel, and the elevation made near the planned sedimentation level of the reservoir. The design capacity of the outlet valve made one with which it would be possible to discharge 53 m^3/s at high water level of the reservoir. Furthermore, besides the emergency outlet value, a facility for irrigation is to be provided.

11.2.2 Waterway and Powerhouse

(1) Location and Outline

The Ayvalı Project is a dam-and-waterway type power generation project utilizing the head between the Olur Project at the middle stretch of the Olur River and the backwater end of the Yusufeli Reservoir planned downstream of the Olur Project. The course of the Olur River downstream of the planned Olur Power Station meanders in a westerly direction and merges with the Çoruh River. It has been confirmed in studies of the project made up to the present that it will be advantageous to utilize to the maximum the head of 230 m between the Ayvalı Dam located 20 km downstream of the Olur Dam, conducting water by a tunnel at the left-bank side to the Yusufeli Reservoir, taking advantage of the meandering of the river.

The topography and geology of the waterway route are as described in 7.3.2(3).

(2) Study of Waterway Route

The waterway route for the Ayvalı Project needs to pass Anzav Gully at the left-bank side near the Yusufeli Reservoir, so that it is difficult from the standpoint of the topography close to the end of the Yusufeli Reservoir to conduct directly to the reservoir at a high elevation, and it is also economically disadvantageous.

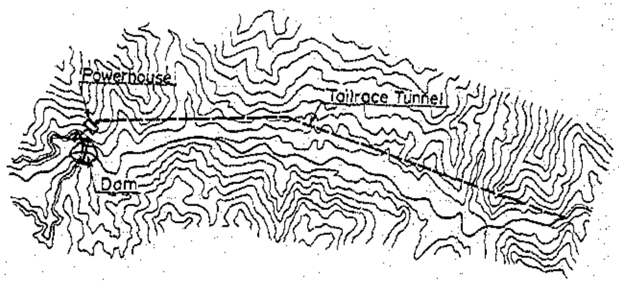
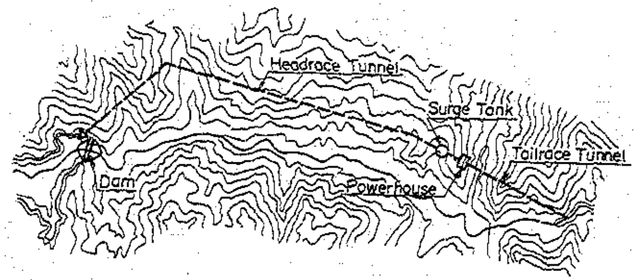
However, when attempting to utilize the head between the Ayvali dam and the Yusufeli reservoir to the maximum, there is no suitable site for a ground surface-type powerhouse which would be most economical. Therefore, a comparison study was made of two alternatives, that of providing an underground powerhouse immediately downstream of the dam and discharging downstream by the shortest route on the river side, and that of conducting water downstream by a headrace from the dam, providing an underground powerhouse in the vicinity of Anzav Gully, and discharging into the Yusufeli reservoir by a tailrace. The features of the respective alternatives are given in Table 11-12 below.

Table 11-12 General Factors for Waterway Route

Element/Type	Headrace Route	Tailrace Route
Topography & Geology	Adequately thick cover obtainable.	Cover thin compared with headrace route.
	Ayvali volcanic rocks	Ayvalı volcanic rocks.
Construction conditions	Necessary for long period for construction of approach road.	Near river and work adit easy to provide.
	Necessary detour tributary.	Possible to shorten construction period.
Waterway shape	Circular pressure tunnel.	Horseshoe shape, non-pressure tunnel.

Upon consideration of the above elements, comparisons of the designs were made, and the economic natures were examined. The results of the examination are shown in Table 11-13.

Table 11-13 Comparison of Waterway, Ayvalı

Item	APU	APL
General Plan		
Total Length of Waterway	9,600 m	10,250 m
Construction Cost (Excluding Dam)	$159,925 \times 10^6$ TL	$197,988 \times 10^6$ TL
Ratio of Construction Cost	100	123.8

According to the above results, the tailrace alternative is advantageous from the aspect of the economics. Although the geology of the waterway route in the case of the headrace alternative is one where earth cover is thick, and it is thought there would be no problem geology-wise, cover of a minimum of 100 m can be obtained and there will be no problem in executing work. On the other hand, the geologies of the underground powerhouse sites are more or less equal, and there is not much difference between the two. Consequently, for the waterway route of the Ayvalı Project, the tailrace alternative is to be adopted from the point of view of the economics.

(3) Design of Structures

1) Intake

The intake is to be provided at the left-bank side approximately 100 m upstream from the dam considering the topography, geology, and access road situation of the tunnel route and its surroundings.

The topography and geology at this site are as described in 7.3.2(2). Geology, there is no problem as a foundation for the intake structure. However, since the topography is rugged, if open excavation were to be done excessively, it would be economically disadvantageous. The type is an inclined type similar to the intake of the Olur Project

Additionally, the elevation of the basement of intake structure was decided at elevation 898 m to counter measure the maximum sedimentation volume and avoiding the vortex for the conduit system.