4-2-2. Present scrap procurement of ANSDK

ANSDK consumed 98,000 tons of scrap in 1986, of which 35,000 tons was home return scrap and the remainder purchased scrap. When ANSDK is in full operation, it is expected that about 190,000 T/Y of scrap has to be purchased.

As the supply of domestic scrap is becoming tight, ANSDK is buying scrap actively from the public sector such as Ministry of Transport, Suez Canal Authority, etc. as well as scrapped materials of HADISOLB in addition to sources in the private market. However, the scrapped materials of HADISOLB which could be obtained in quantity so far cannot be considered as a stable supply source, and unless the recycling system of domestic scrap is established and developed, it is considered that in the long term view it becomes difficult for ANSDK to continue operation with domestic scrap alone without importing scrap.

4-2-3. Forecast of demand and supply of domestic scrap

It is expected that the demand for scrap in Egypt will expand repidly as a result of the full operation of ANSDK and expansions of steel mills.

On the other hand, the supply of domestic scrap cannot be expected to increase rapidly though it depends on progress and improvement of its recycling system.

The demand and supply of scrap in Egypt in the future is forecasted as shown in Table 4-8. As the result, the import requirement of scrap for the whale Egypt steel industry might be around 570,000T in 1990.

In case of importing scrap, USA will be a major supply source, and UK and USSR will be also possible sources in view of the distance from Egypt. For reference, the worldwide export and import of scrap are shown in Table 4-9 and Table 4-10. As a reference to the international price of scrap, the price trend of USA scrap on a CIF Japan basis is shown in Table 4-11 and Figure 4-1.

Table 4-8 Forecast of Demand and Supply of Scrap in Egypt

(Unit: Ton)

	1985	1986	1990	1995
(A) Demand of Scrap				
Existing steel mills	190,000	190,000	190,000	190,000
ANSDK (Existing Facilities)	---	60,000	190,000	190,000
Expansion project of EAF	---	---	460,000	950,000
Total	190,000	250,000	840,000	1,330,000
(B) Domestic Supply of Scrap	190,000	250,000	270,000	370,000
(A)-(B), shortage = import required	---	---	570,000	960,000

Note: The increase of supply is assumed at a rate of 7% a year.

4-2-4. World trade of steel scrap

World scap export in 1985 was about 30 million tons and the major exporting countries were U.S.A. (8.95 million tons) U.K. (4.52 million tons), France (3.96 million tons), West Germany (3.41 million tons) and U.S.S.R. (3.4 million tons). The total of scrap exported by the above 5 counties amounts to 24.24 million tons, accounting for a little more than 80% of the world scrap export. (See Table 4-9)

On the other hand, the major importing countries in 1985 were Spain (6.15 million tons), Italy (5.78 million tons), Republic of Korea (3.53 million tons) and Japan (3.25 million tons) and the total of their imports reached 18.71 million tons, accounting for a little less than 60% of the world total of scrap import. (See Table 4-10)

4-2-5. Scrap prices

Reflecting sluggish steel production in the world, the prices of scrap in the world is at a low level at present. For example, U.S.A.'s C&F prices to Japan for the past two or three years were $100-130/t, but since May 1986, it fell below the level of $100/t. (Table 4-11-1)

Also U.S.S.R.'s CIF prices to Japan are below $90/t recently. (Table 4-11-6)

The scrap prices in major European countries at the end of 1986 also, on respective currencies, showed drop as compared with the high prices during the 3 years from 1984-1986 as follows:

	1986		High price
U.K.	£50/t,	41% drop from	£85/t
W. Germany	DM170/t,	35% drop from	DM260/t
Belgium	BF2800/t,	53% drop from	BF6000/t
Italy	L.it100/t,	53% drop from	L.it190/t

(See Tables 4-11-2 through 4-11-5)

As seen above, though the world scrap prices are at low level at present, when ANSDK studies use of imported scrap in future, it should be kept in mind that scrap is basically merchandise subject to wide price fluctuation.

Recently (since spring of 1987) the price of U.S. scrap has an upwards tendency. (July, 1987: C&F Japan about $110/t)

Postscript:
As of March 1987 when the F/S was started, the price of scrap was very low worldwide, but its consumption began to recover rapidly from around May 1987 and U.S. scrap price in October and November 1987 is US$140-160/ton on CIF Japan.

Table 4-9 Scrap Exports in the World

(thousand metric tons)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Belgium/Luxembourg	527	501	531	550	537	578	498	682	774	736
Denmark	116	57	81	91	100	185	118	175	234	270
France	3,422	3,358	3,663	3,526	3,312	3,184	3,082	3,227	4,105	3,961
FR of Germany	2,597	2,481	2,765	2,998	3,077	3,407	2,867	2,977	3,268	3,407
Greece	0	1	0	0	0	1	1	1	1	1
Ireland	8	8	54	72	84	73	59	21	43	50
Italy	24	11	7	13	8	23	17	18	19	10
Netherlands	957	926	1,189	1,142	1,194	1,252	1,179	1,522	1,680	1,835
United Kingdom	599	938	1,565	1,338	2,805	3,367	3,073	3,794	4,316	4,520
EC Total	8,250	8,281	9,855	9,730	11,117	12,070	10,894	12,417	14,440	14,790
Austria	45	8	8	15	13	12	9	13	21	32
Finland	4	3	1	3	0	0	0	0	10	10
Norway	18	13	36	42	38	32	32	36	21	9
Portugal	3	4	10	5	5	5	9	10	9	16
Spain	0	0	1	0	1	1	1	1	4	1
Sweden	9	75	78	17	14	14	18	21	113	22
Switzerland	71	62	88	100	64	128	105	149	107	100
Turkey	0	0	0	0	0	0	0	0	3	4
Yugoslavia	20	42	79	47	45	69	63	70	142	173
Other Western Europe	170	207	301	229	180	261	237	300	430	367
Total Western Europe	8,420	8,488	10,156	9,959	11,297	12,331	11,131	12,717	14,870	15,157
Canada	1,013	697	874	1,033	785	573	628	875	795	878
United States	7,367	5,602	8,199	10,028	10,132	5,820	6,172	6,822	8,617	8,951
Japan	203	211	164	151	159	187	174	116	147	166
Australia	632	550	486	576	708	498	554	588	445	450
TOTAL INDUSTRIAL CTS.	17,635	15,548	19,879	21,747	23,081	19,409	18,659	21,118	24,874	25,602
Hong Kong	173	227	286	344	330	364	297	320	300	300
India (E from 1978)	157	209	20	5	5	5	5	5	5	5
Indonesia	0	0	6	0	1	0	0	1	0	0
Republic of Korea	19	1	8	13	10	25	141	285	124	54
Malaysia	16	5	5	5	10	12	6	5	5	5
Philippines	0	0	3	3	2	1	2	1	1	1
Singapore	3	7	4	2	5	2	8	119	109	100
Taiwan (ROC)	63	35	156	72	13	128	402	280	202	388
Thailand	3	0	0	0	1	1	8	1	0	0
TOTAL DEVELOPING CTS.	434	484	488	444	377	538	869	1,017	746	853
TOTAL WESTERN WORLD	18,069	16,032	20,367	22,191	23,458	19,947	19,528	22,135	25,620	26,455
Bulgaria	135	61	167	130	155	79	57	38	48	38
German Dem Rep	11	13	13	14	7	7	7	7	10	10
Hungary	37	71	42	37	31	32	53	50	79	27
Poland	92	1	0	0	0	0	0	0	0	0
USSR(E:1977,78,85)	1,837	1,800	1,800	1,988	2,505	2,681	2,859	3,370	3,407	3,400
Total Eastern Europe	2,112	1,946	2,022	2,169	2,698	2,799	2,976	3,465	3,544	3,475
WORLD TOTAL	20,181	17,978	22,389	24,360	26,156	22,746	22,504	25,600	29,164	29,930

Table 4-10 Scrap Imports in the World

(thousand metric tons)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Belgium/Luxembourg	586	493	979	970	859	956	887	1,045	1,672	1,490
Denmark	7	13	263	284	217	180	88	67	132	48
France	274	287	394	422	456	347	276	307	407	461
FR of Germany	1,556	1,435	1,560	1,619	1,511	1,343	1,296	1,298	1,765	1,621
Greece	80	93	198	230	239	288	434	520	328	313
Ireland	1	2	9	5	8	4	2	70	88	136
Italy	6,272	5,825	6,566	6,891	7,410	5,540	5,571	4,446	5,486	5,777
Netherlands	161	114	165	123	154	238	221	364	478	586
United Kingdom	694	100	43	44	25	21	37	11	34	50
EC Total	9,631	8,362	10,177	10,588	10,879	8,917	8,812	8,128	10,390	10,482
Austria	45	80	115	135	143	170	381	219	363	239
Finland	54	63	22	89	106	62	51	37	33	113
Norway	71	18	10	7	53	24	4	15	13	11
Portugal	29	95	663	146	149	85	125	108	120	105
Spain	2,658	1,993	2,550	3,452	4,386	4,005	4,762	4,742	5,018	6,147
Sweden	137	33	118	130	76	247	529	450	839	885
Switzerland	44	58	87	179	137	113	107	147	273	240
Turkey	236	300	323	362	346	525	748	1,074	1,038	1,148
Yugoslavia	342	409	402	265	396	479	508	738	781	729
Other Western Europe	3,616	3,049	4,290	4,765	5,792	5,710	7,215	7,530	8,478	9,617
Total Western Europe	13,247	11,411	14,467	15,353	16,671	14,627	16,027	15,658	18,868	20,099
Canada	823	584	954	1,045	1,015	838	501	669	1,137	884
United States	460	567	720	690	506	571	430	581	524	554
Japan	1,802	1,440	3,229	3,346	2,985	1,791	2,025	3,996	4,018	3,254
TOTAL INDUSTRIAL CTS.	16,332	14,002	19,370	20,438	21,178	17,827	18,983	20,814	24,547	24,791
Mexico (1978-1983:E)	526	356	500	740	1,050	820	350	380	454	660
Hong Kong	122	41	126	105	93	94	64	27	28	20
India	35	56	221	81	99	596	591	804	800	1,000 E
Indonesia	29	47	81	30	39	62	227	258	243	250 E
Republic of Korea	1,898	1,636	1,932	1,944	1,910	1,661	2,424	3,185	3,216	3,532
Malaysia	3	5	5	5	5	5	5	5	5	5 E
Philippines	106	62	79	95	9	9	25	0	2	2 E
Singapore	55	23	93	109	172	78	93	95	79	65
Taiwan (ROC)	297	571	622	761	1,232	881	651	736	578	362
Thailand	276	444	802	615	338	417	390	641	494	500 E
TOTAL DEVELOPING CTS.	3,347	3,241	4,461	4,485	4,947	4,623	4,820	6,131	5,899	6,396
TOTAL WESTERN WORLD	19,679	17,243	23,831	24,923	26,125	22,450	23,803	26,945	30,446	31,187
German Dem Rep	541	496	546	708	908	693	455	672	1,035	886
Hungary	9	2	3	6	4	144	14	28	20	14
Poland	47	34	9	6	227	53	5	5	7	5
Romania	0	0	8	10	56	0	0	0	0	0
Total Eastern Europe	597	532	566	730	1,195	890	474	705	1,062	905
WORLD TOTAL	20,276	17,775	24,397	25,653	27,320	23,340	24,277	27,650	31,508	32,092

Table 4-11-1 Change in Prices of Steel Scrap in U.S.A.

(Unit: US$/Ton)

Year	Month	1	2	3	4	5	6	7	8	9	10	11	12
1978	F O B	75.00	82.50	86.00	86.00	82.00	85.00	88.00	88.00	88.00	102.50	107.00	113.00
	COMPOSITE	70.33	71.50	74.16	76.08	72.09	73.50	77.83	76.49	72.92	73.25	82.96	89.91
	C & F *	92.00	99.50	103.00	104.00	102.00	106.00	108.50	109.50	110.50	125.00	130.50	136.50
1979	F O B	130.00	136.50	131.00	115.30	111.00	112.00	110.00	107.00	104.00	110.00	119.00	120.00
	COMPOSITE	96.08	108.08	118.76	101.66	98.83	110.83	96.91	90.83	88.09	86.91	91.76	93.41
	C & F *	152.50	159.50	157.00	143.50	145.00	150.00	147.00	142.00	139.30	147.20	156.50	158.00
1980	F O B	126.00	129.00	124.00	108.00	96.00	95.00	104.00	110.00	106.50	104.50	104.50	103.50
	COMPOSITE	99.10	105.00	102.08	95.91	78.56	69.33	75.10	84.41	94.00	95.92	98.50	102.08
	C & F *	161.00	167.00	163.00	152.00	140.00	187.20	146.00	149.50	145.50	145.50	148.00	146.50
1981	F O B	98.50	96.00	95.00	92.00	89.80	83.00	82.50	81.50	79.00	76.00	79.00	83.00
	COMPOSITE	98.29	99.50	105.09	102.57	95.42	89.17	90.17	95.33	91.33	82.57	75.66	76.23
	C & F *	137.00	135.00	133.00	127.00	125.80	119.00	115.00	111.50	108.00	106.00	105.50	108.00
1982	F O B	90.00	91.00	88.00	83.00	80.00	73.00	76.00	80.00	75.00	70.00	67.00	70.00
	COMPOSITE	84.33	82.17	77.75	71.70	62.67	58.33	56.16	55.74	56.23	52.90	51.25	52.30
	C & F *	115.00	113.00	113.00	111.00	108.00	98.00	98.00	98.00	93.00	80.00	88.00	91.00
1983	F O B	73.00	80.00	85.00	81.00	78.00	81.00	82.00	82.00	85.00	87.00	88.00	93.00
	COMPOSITE	59.92	67.91	73.49	71.00	67.00	70.76	71.75	75.03	77.17	77.66	80.09	86.70
	C & F *	98.00	105.00	110.00	108.00	103.00	105.00	102.00	102.00	105.00	108.00	110.00	115.00
1984	F.O B	100.00	105.00	100.00	97.00	98.00	97.00	96.00	97.00	100.00	97.00	93.00	93.00
	COMPOSITE	93.17	95.17	91.83	90.17	89.24	83.16	82.17	82.10	85.00	82.90	79.08	78.75
	C & F *	120.00	126.00	122.00	117.00	119.00	117.00	115.00	117.00	121.00	117.00	114.00	114.00
1985	F O B	94.00	94.00	93.00	89.00	81.00	80.00	85.00	85.00	84.00	85.00	85.00	86.00
	COMPOSITE	80.83	83.16	86.75	80.17	70.97	66.34	68.41	73.57	72.75	71.17	68.83	69.75
	C & F *	114.00	113.00	112.00	108.00	100.00	98.00	102.00	101.00	99.00	102.00	103.00	104.00
1986	F O B	88.00	88.00	88.00	87.00	82.00	82.00	83.00	84.00	83.00	80.00	86.00	81.00
	COMPOSITE	73.34	75.50	74.08	73.42	71.50	70.83	71.70	75.08	74.50	73.15	74.17	74.23
	C & F *	105.00	104.00	102.00	100.00	95.00	94.00	95.00	96.00	97.00	96.00	96.00	96.00

Remarks: NOIHMS $/LT
* C & F Price for Japan

Table 4-11-2 Change in Price of Steel Scrap in U.K.

	Month	1	2	3	4	5	6	7	8	9	10	11	12
1984	£/t	63	63	57	62	62	69	64	70	72	72	68	71
	US$/t	88	94	82	87	86	94	84	92	89	88	81	82
1985	£/t	78	85	72	69	64	62	60	62	59	53	56	56
	US$/t	88	92	89	86	82	81	85	86	83	76	83	81
1986	£/t	62	54	54	52	51	47	46	55	48	47	47	50
	US$/t	88	78	80	81	75	72	69	82	69	66	67	74

Remark: High level of OA old heavy steel
Source: Metal Bulletin

Table 4-11-3 Change in price of Steel Scrap in W. Germany (Ruhr)

	Month	1	2	3	4	5	6	7	8	9	10	11	12
1984	DM/t	260	260	260	260	260	260	260	260	260	260	260	260
	US$/t	92	100	100	96	95	93	90	90	85	78	84	82
1985	DM/t	260	260	260	260	260	260	260	260	260	250	240	240
	US$/t	82	78	84	84	85	85	93	93	97	96	96	98
1986	DM/t	240	240	220	220	200	190	190	190	190	180	170	170
	US$/t	100	108	94	101	86	87	91	93	94	87	86	88

Remark: New Production Scrap Over 3mm
Source: Metal Bulletin

Table 4-11-4 Change in Price of Steel Scrap in Belugium

	Month	1	2	3	4	5	6	7	8	9	10	11	12
1984	BF/t	5500	5500	5500	5500	5600	5600	5900	5900	5800	5700	5700	5700
	US$/t	96	104	104	99	101	99	101	101	94	93	92	90
1985	BF/t	5800	5700	5900	6000	5900	5400	5400	5400	5200	4500	4500	4200
	US$/t	92	85	95	96	95	88	96	96	96	85	88	83
1986	BF/t	4800	4500	4500	4200	4100	4100	3700	3700	3600	3300	3200	2800
	US$/t	98	99	94	94	86	91	85	88	86	77	78	69

Remark: For Electric Furnace
Source: Metal Bulletin

Table 4-11-5 Change in Price of Steel Scrap in Italy

	Month	1	2	3	4	5	6	7	8	9	10	11	12
1984	1000Lit /t	150	145	140	150	155	165	165		150		170	
	US$/t	88	90	86	89	92	96	93	0	80	0	89	0
1985	1000Lit /t	185	190		190	185	170	170		170	165	165	165
	US$/t	95	92	0	96	94	87	86	0	94	93	97	98
1986	1000Lit /t	165	160	145	135	128	125	125		125	105	100	
	US$/t	101	106	92	90	81	83	87	0	90	74	73	0

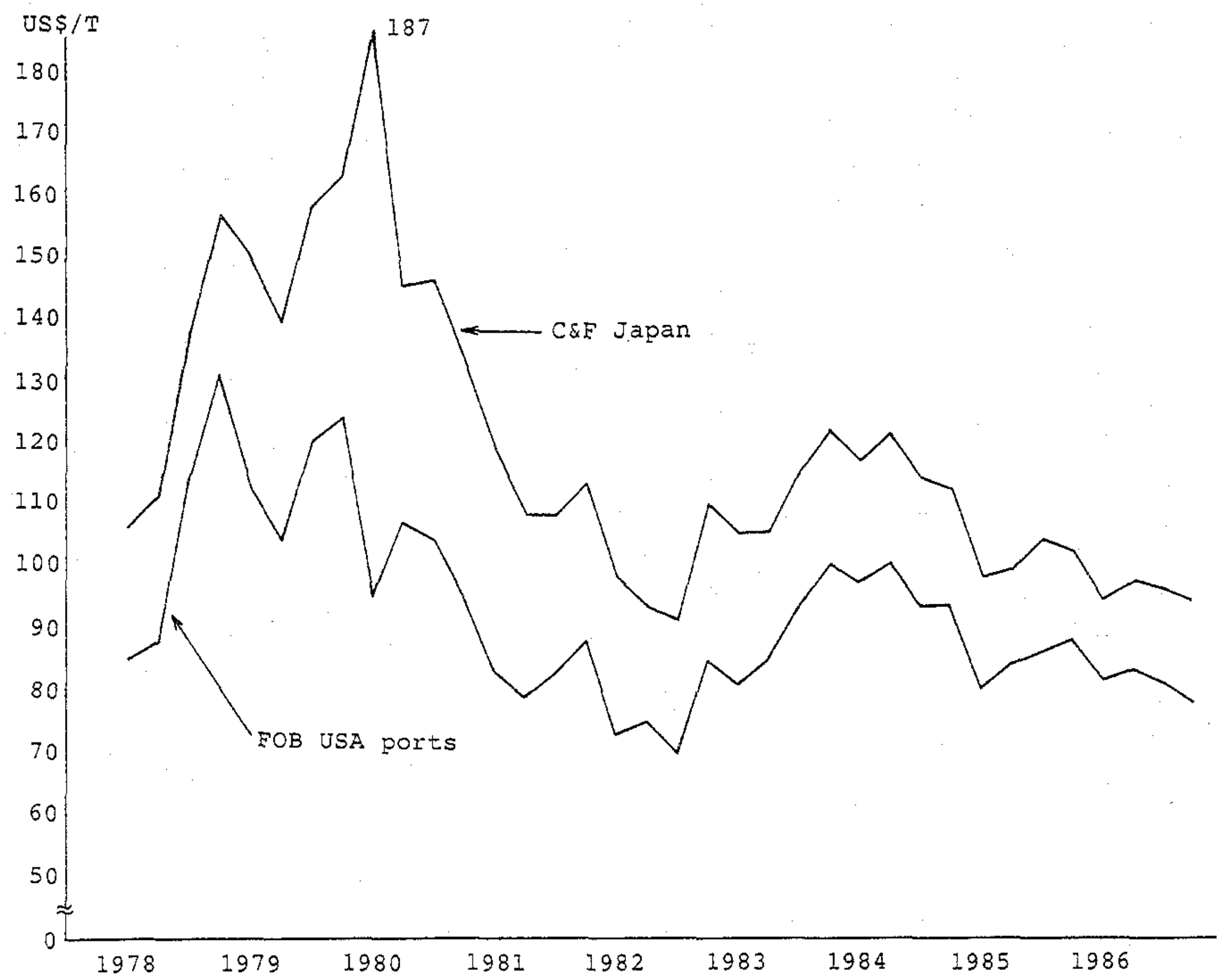
Remark: High Level of Heavy Melting Category 01
Source: Metal Bulletin

Table 4-11-6 Change in Price of Steel Scrap in USSR

	Month	1	2	3	4	5	6	7	8	9	10.	11	12
1984	US$/t	104	110	108	109	116	110	114	112	114	113	111	109
1985	US$/t	108	106	109	106	104	100	101	90	96	91	91	100
1986	US$/t	101	105	98	100	99	94	91	87	88	87	86	89

Remark: CIF Price for Japan

Figure 4-1 Price Trend of USA Steel Scrap (No.1 HMS)



4-3. Limestone

4-3-1. Present situation in Egypt

Egyptian production of limestone in the 1985/86 is 13 million m^3 and the production shows an increasing trend recently.

Incidentally, Egypt is blessed with abundant limestone reserves and does not import nor export limestone.

4-3-2. Present situation of ANSDK's purchasing

It is expected presently that ANSDK purchases 61,700 tons of limestone from SAMI SAAD CO. in 1987. SAMI SAAD CO. is located along the desert road connecting Alexandria and Cairo and a little close to Cairo, providing easy access to truck transport.

In order to avoid risk of depending on one supplier, ANSDK plans to stock 6,000 tons as a target.

Properties of limestone

ANSDK specifies the properties of limestone required to be compression strength not less than 250 kg/cm^2 and CaO content not less than 52.5%. ANSDK studied properties of limestone of other suppliers and confirmed that five brands are qualified.

Table 4-12 Production of Limestone in Egypt

(Unit: 1,000 m^3)

Year	Production
1976	5,000
1977	5,000
1978	6,000
1979	6,000
1980/81	5,000
1981/82	6,000
1982/83	7,000
1983/84	9,000
1984/85	11,000
1985/86	13,000

Source: CAPMAS

4-3-3. Present situation of burnt lime and outlook after the expansion of ANSDK

Limestone is burnt by calcining facilities and used as flux in EAFs in the form of burnt lime.

ANSDK has calcining facilities with a capacity of 52,800 T/Y. The capacity far exceeds the requirement of burnt lime for existing EAFs.

The requirement of burnt lime after the expansion will be 50,000 T/Y, which can be covered fully by the existing calcining facilities.

Table 4-13 Purchasing of Limestone by Steel Industry in Egypt

Year	Purchase (t)	Purchase (LE)	Unit Price (LE/t)
1980/81	580,972	2,352,758	4
1981/82	513,588	3,635,929	7
1982/83	516,973	4,508,985	9
1983/84	483,715	3,881,673	8
1984/85	582,384	5,754,677	10

Source: CAPMAS

Table 4-14 Purchasing of Burnt Lime by Steel Industry in Egypt

Year	Purchase (t)	Purchase (LE)	Unit Price (LE/t)
1980/81	4,522	56,581	13
1981/82	5,730	94,556	17
1982/83	4,347	80,000	18
1983/84	4,790	94,000	20
1984/85	4,981	117,000	24

Source: CAPMAS

4-4. Fluorspar

4-4-1. Present situation in Egypt

Nile Mining Co. and EL NASR Phosphate Co. are producing fluorspar in Egypt. The purity of fluorspar produced in Egypt is higher than about 75% which is required for steelmaking. Therefore, the price of fluorspare in Egypt is considered to be too high for the steel industry. It is assumed therefore that fluorspar is mainly shipped to chemical industry in Egypt.

In the meantime the amount of fluorspar purchased by the steel industry shows fluctuations from year to year. It was 983 tons in 1984/85 as shown in Table 4-15.

Table 4-15 Fluorspar Purchased by Steel Industry in Egypt

Year	Purchase		Unit Price (LE/t)
	(t)	(LE)	
1980/81	7,973	538,610	68
1981/82	2,714	183,998	68
1982/83	6,827	466,906	68
1983/84	2,755	192,074	70
1984/85	983	66,616	68

Source: CAPMAS

4-4-2. Present situation and outlook after the expansion of ANSDK

Fluorspar is one of additives used to improve fluidity of EAF slag.

At ANSDK fluorspar was used at the time of test operation of EAFs, but is was not used after the start-up of the furnaces, since slag fluidity is good. It is expected that the consumption of flourspar at ANSDK after the expansion will be small quantities. They will be purchased from domestic two companies and overseas suppliers.

4-5. Ferro-manganese

4-5-1. Present situation in Egypt

Ferro-manganese is not produced in Egypt and all of them are imported.

The Egyptian steel industry purchased 6,867 tons of ferro-manganese in 1984/85 at average unit price of LE437/T as shown in Table 4-16. In the meantime, start-up of Sinai Manganese Co. is planned, but its date of commissioning is unknown. The plan of Sinai Manganese Co. is to produce 80,000 T/Y of ferro-manganese utilizing manganese ore produced in the Sinai Peninsula.

4-5-2. Present situation of ANSDK's purchasing

In 1987 ANSDK is expected to purchase 8,600 tons and consume 7,570 tons.

At present, ANSDK has purchased a part of the above requirement from SFPO in France through tender and plans to purchase the remainder also through tender.

Table 4-16 Purchasing of Ferro-manganese by Steel Industry in Egypt

Year	Purchase		Unit Price (LE/t)
	(t)	(LE)	
1980/81	6,345	1,855,395	292
1981/82	4,651	1,645,277	353
1982/83	4,506	1,913,679	425
1983/84	4,711	1,895,966	403
1984/85	6,867	3,002,386	437

Source: CAPMAS

4-5-3. Outlook after the expansion of ANSDK

The Ferro-manganese requirement of ANSDK after the expansion is expected to be about 17,000 T/Y.

Supply sources of the material may be import and Sinai Manganese Co.

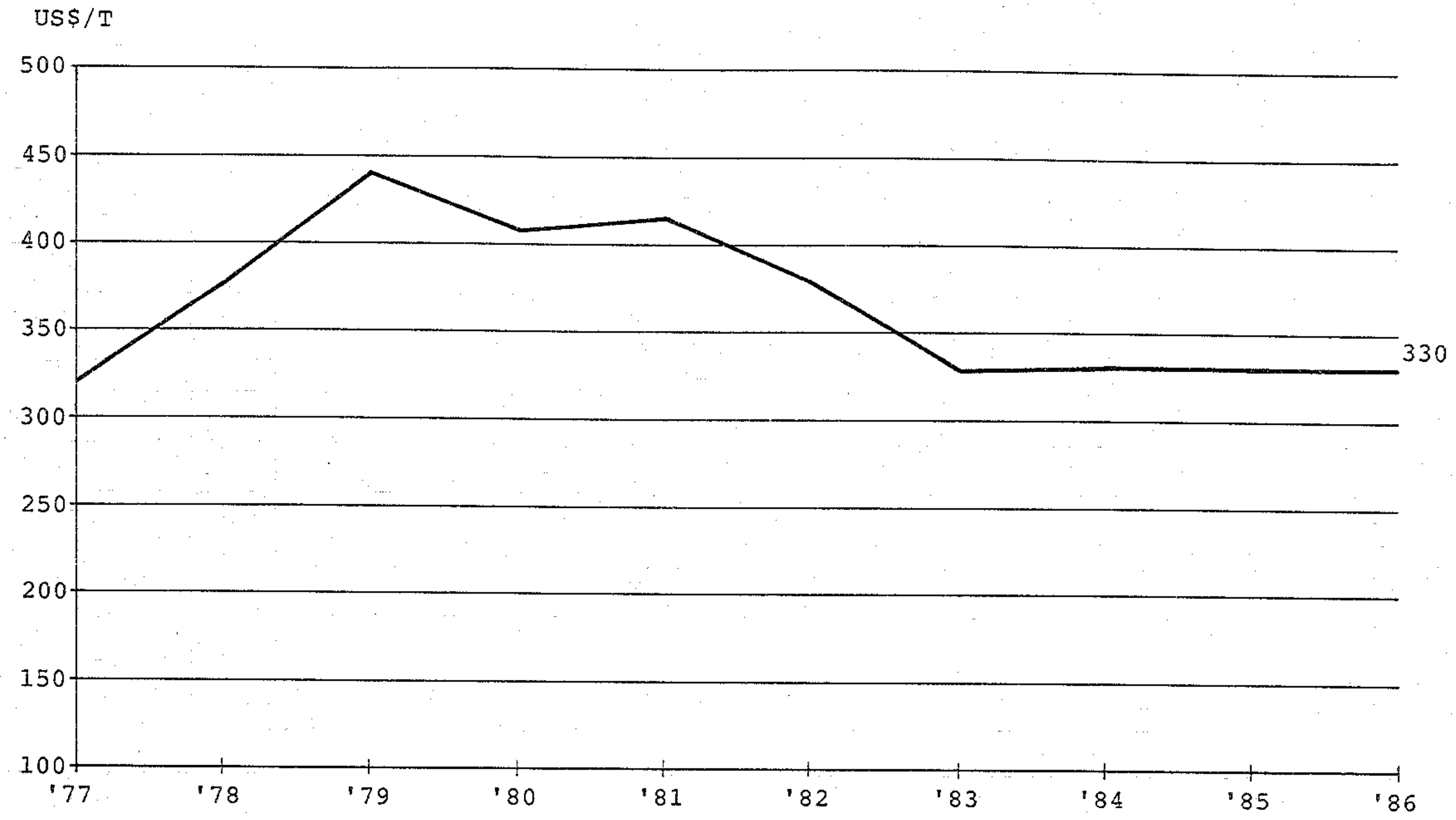
As shown in Table 4-17, the major supply sources of FeMn in the world are France and Norway. As a reference to the international price of FeMn, the price trend on a CIF USA is shown in Figure 4-2.

Table 4-17 Import and Exports of HC Ferro-manganese - 1985

(Thousand metric tons)

	DESTINATIONS												
	USA	Canada	W.Germany	France	Benelux	Italy	Holland	U.K.	Sweden	Austria	Japan	Others	TOTAL
ORIGIN Australia	10.0	---	---	---	---	---	---	---	---	---	---	15.0	25.0
Benelux	---	---	7.7	8.0	---	---	---	---	---	---	---	4.3	20.0
Brazil	10.4	---	---	---	---	---	---	---	---	---	0.8	21.8	33.0
France	104.5	2.1	39.4	---	24.6	27.0	9.2	4.3	4.3	0.2	---	2.1	217.7
W. Germany	4.5	4.9	---	3.5	2.8	5.0	1.0	0.6	0.1	7.0	---	2.6	32.0
India	---	---	---	---	---	---	---	---	---	---	4.9	0.4	5.3
Japan	---	---	---	---	---	---	---	---	---	---	---	16.0	16.0
Mexico	15.8	1.8	---	---	---	---	---	---	---	---	---	2.0	19.6
Norway	---	1.5	40.3	2.5	13.9	---	9.3	7.5	12.7	11.4	0.2	11.7	111.0
Portugal	5.3	---	1.0	2.2	---	5.1	---	1.5	---	---	---	3.1	14.1
South Africa	102.7	8.1	8.1	1.8	1.0	23.1	---	8.5	5.4	1.1	---	6.2	166.0
Spain	---	---	---	---	---	---	---	---	---	---	---	6.0	6.0
Others	30.3	0.9	0.6	7.0	3.2	7.8	0.4	0.2	0.1	1.9	0.1	---	60.6
TOTAL HC Fe Mn	283.5	27.4	93.0	25.0	45.5	68.0	19.9	22.6	22.6	21.6	6.0	91.2	786.3

Figure 4-2 FeMn-HC Delivered Price in USA



4-6. Ferro-silicon

4-6-1. Present situation in Egypt

At present, ferro-silicon is produced in Egypt only by KIMA Co., whose production in 1985/86 was 7,222 tons as shown in Table 4-18. A small quantity is imported, but the main supply is domestic production.

Table 4-18 Demand and Supply of Ferro-silicon in Egypt

(Unit: Ton)

Year	Production	Import	Consumption	Stocks End of Year
1976	4,540	--	5,265	1,085
1977	4,557	--	4,532	1,110
1978	5,009	--	4,535	1,584
1979	4,122	--	4,333	1,373
1980/81	4,587	--	4,935	820
1981/82	4,736	43	5,103	496
1982/83	2,662	3,827	6,973	12
1983/84	5,070	--	4,610	472
1984/85	5,904	362	6,359	379
1985/86	7,222	7	6,722	886

Source: CAPMAS

4-6-2. Present situation and outlook after the expansion of ANSDK

In 1987 ANSDK will purchase 3,710 tons of ferro-silicon from KIMA Co. and the purchase is expected to increase to about 6,000 T/Y after the expansion.

In addition to KIMA Co., EFACO (Egypt Ferroalloy Co.) may be considered as one of the suppliers of ferro-silicon after the expansion of ANSDK. Receiving technical cooperation of ELKEM in Norway, EFACO already completed a plant having an annual capacity of 50,000 tons. Although this plant of EFACO is located at Edfu, upstream of Luxor, and is planned to receive power from Aswan Power Station, the power receiving facilities are not completed and therefore the plant is not in operation yet.

EFACO plans export of ferro-silicon and their product is expected to have a reliable quality.

Therefore it can be expected that the domestic supply of ferro-silicon is adequate, in quantity and in quality, even after the expansion of ANSDK.

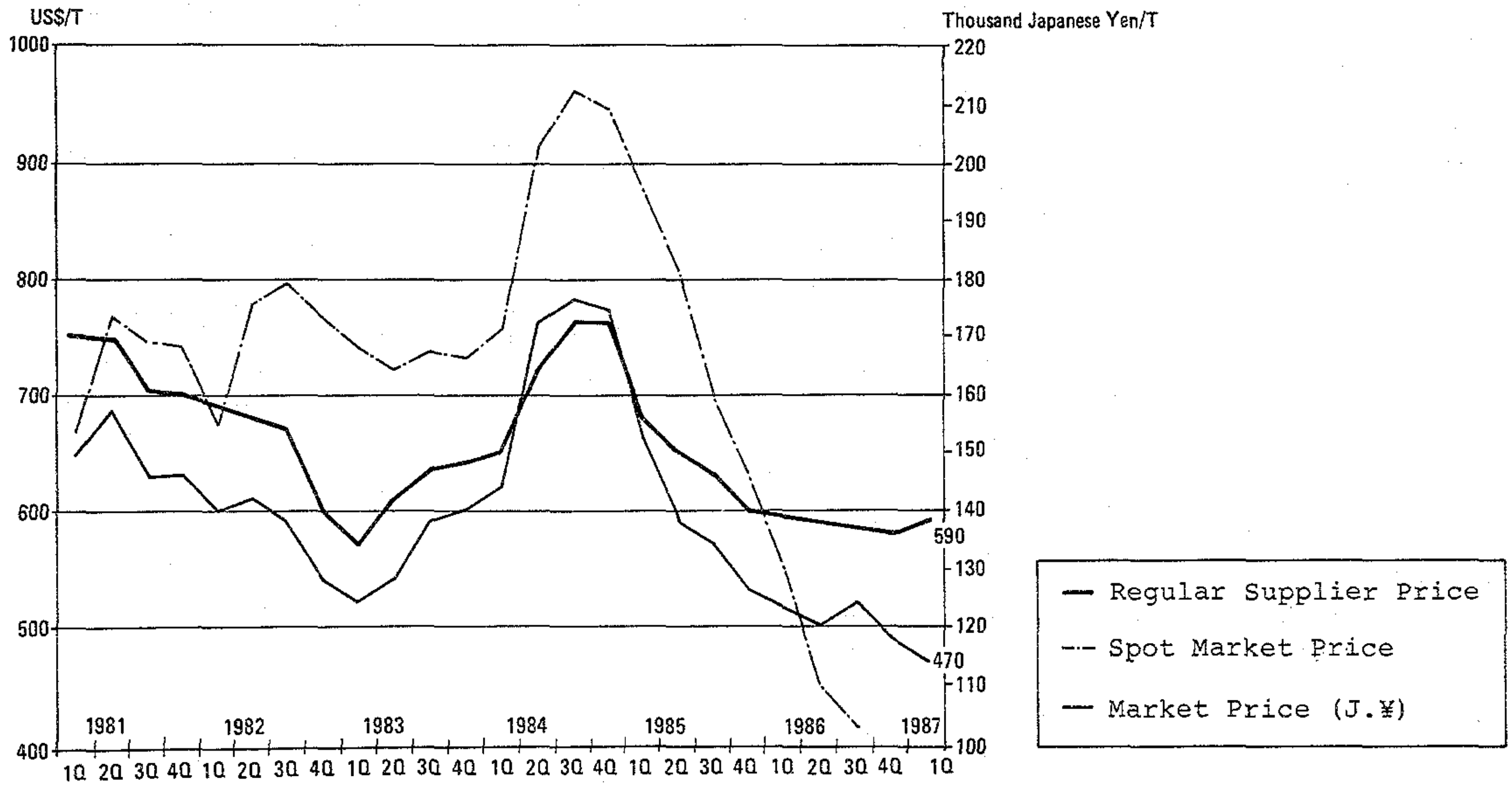
For reference, the world production & trade of FeSi and its international price trend are shown in Table 4-19 and Figure 4-3.

Table 4-19 World Production and Trade of Ferro-silicon (1984)

(FeSi 75% base, thousand T)

Area	Production	Export	Import
East Europe, USSR	985	27	--
North Europe	479	403	--
West Europe	298	28	234
Middle East/Asia	428	--	350
Africa	116	54	--
Oceania	28	5	5
South America	245	132	--
North America	405	19	79
TOTAL	2,985	668	668

Figure 4-3 Price Trend of Ferro-Silicon (CIF Japan)



4-7. Aluminium

4-7-1. Production of aluminium in Egypt

There is only one aluminium refinery in Egypt, namely, Egypt Aluminium Company. It imports alumina and refines it. Production of primary aluminium in 1985/86 was 174,630 tons as shown in Table 4-20.

4-7-2. Present purchase and consumption in ANSDK

ANSDK purchases 43 T/Y of aluminium at the price of LE 1,610/T in the form of 8-kg ingot from General Metal Co., an aluminium rolling company.

Aluminium is used only as an additive into a ladle prior to continuous casting and not used for injection into EAFs, and therefore aluminium consumption remains small.

Table 4-20 Production of Aluminium in Egypt

(Unit: Tons)

Year	Production	Stocks End of Year
1976	54,231	NA
1977	89,182	NA
1978	101,032	NA
1979	101,895	NA
1980/81	133,812	NA
1981/82	140,543	18,915
1982/83	139,295	16,633
1983/84	169,663	19,590
1984/85	174,696	24,349
1985/86	174,630	17,404

Source: CAPMAS

4-7-3. Outlook after the expansion of ANSDK

As the aluminium consumption at ANSDK is expected to be as low as about 120 T/Y even after the expansion and in view of the present scale of domestic production, it can be expected that ANSDK enjoys a stable supply of aluminium in future also.

4-8. Coke breeze

4-8-1. Production of coke in Egypt

In Egypt coke is produced by only one company, EL NASR Coke Co. It is supplied to HADISOLB as well as chemical companies. EL NASR Coke Co. has a plan to expand its coking capacity, and after the plan is materialized, supply of coke breeze will increase.

4-8-2. Purchase of coke breeze by ANSDK

ANSDK is to purchase 3,350 T/Y of coke breeze from MISR Chemical Co., a chemical company located nearby. ANSDK is expected to consume 2,640 tons in 1987.

MISR Chemical Co. buys coke from EL NASR Coke Co. and supplies coke breeze under screen to ANSDK.

ANSDK entered into a 3-year supply contract with MISR Chemical Co. The contract includes a price escalation clause of 5% per year and is to be extended automatically.

4-8-3. Purchasing of coke breeze after the expansion of ANSDK

Under the full operation after the expansion, ANSDK will require about 1,600 T/Y of coke breeze.

To satisfy the coke breeze requirement, it is necessary for ANSDK to diversify supply sources in addition to MISR Chemical. As one of such sources, EL NASR Coke Co. may be available as it has a plan to expand its coking capacity. Coke breeze consumption of after expansion will be less than 1987. It is result that all scrap operation, start-up time, use coke breeze more than DRI operation.

4-9. Graphite Electrodes

4-9-1. Present situation in Egypt

At present, graphite electrodes are not produced in Egypt and are all imported.

4-9-2. Present situation of ANSDK's purchasing

In 1987 ANSDK is expected to consume 2,640 tons, of which 2,300 tons are to be purchased with a loan from the World Bank.

Due to the tender process of the World Bank loan ANSDK must purchase electrodes from one company for one tender, but it is considered desirable to purchase them from three or so companies in order ensure the stable supply.

4-9-3. Outlook after the expansion of ANSDK

It is expected that the consumption of electrodes at ANSDK after the expansion will increase to about 5,000 T/Y, but they will have to be all imported from W. Germany, U.S.A. and Japan.

4-10. Refractories

4-10-1. Present situation of ANSDK

Presently ANSDK imports most of refractories mainly from Japan, West Germany and Ireland. However, ANSDK purchases from domestic sources some quantity of refractories, mainly castables, to be applied to places which do not require severe specifications.

4-10-2. Specifications of refractories of ANSDK

ANSDK places an emphasis on quality in purchasing refractories because refractories of poor quality decrease the number of heat and lower the operating rate, resulting in cost increase.

Therefore, ANSDK has set up its own standards for the refractories by which minimum requirements according to different places of application are specified.

4-10-3. Outlook after the expansion of ANSDK

After the expansion, ANSDK will also have to import most of required refractories from the above mentioned countries. However, there is a joint venture plan to construct a refractories in the suburbs of Alexandria between Egyptian Company Refractories Works, a public sector company, and A.P. Green, a U.S. refractories company who provides the J/V with a technical assistance. When the plan is materialized, purchase from domestic source may be increased.

4-11. Dolomite

4-11-1. Present Situation in Egypt

The production of dolomite in 1985/86 in Egypt was 103,693 tons as shown in Table 4-21.

Dolomite is relatively abundant in Egypt and its supply can be said stable.

The amount purchased by the steel industry remained at the level of about 80,000 - 100,000 tons a year in recent years.

4-11-2. Present Situation of ANSDK

ANSDK purchases calcined dolomite from two companies, HADISOLB and Egyptian Copper Works.

Dolomit is used as EAF's castable refractries.

ANSDK's purchase in 1987 is expected to be 2,587 tons.

4-11-3. Outlook after expansion of ANSDK

ANSDK's dolomite purchase after the expansion is expected to be about 4,000 T/Y, which can be obtained stably considering the production in Egypt.

Table 4-21 Production, Consumption & Stock of Dolomite in Egypt

(Unit: Ton)

Year	Production	Consumption	Stocks End of Year
1976	120,246	119,846	759
1977	91,940	92,340	359
1978	56,796	55,182	1,973
1979	147,155	148,612	516
1980/81	154,238	72,168	82,840
1981/82	120,730	121,733	81,837
1982/83	63,548	61,379	84,006
1983/84	160,687	164,065	80,628
1984/85	156,277	141,811	95,094
1985/86	103,693	28,047	170,740

Source: CAPMAS

Chapter V. PRESENT STATUS OF EL DIKHEILA IRON AND STEEL WORKS

5. Present Status of El Dikheila Iron and Steel Works

5-1. Outline of ANSDK

5-1-1. Brief history

The Alexandria National Iron and Steel Company (ANSDK) was established in July 1982 for the purpose of production and sale of concrete reinforcing bar and wire rod. The Head office sits in the compound of El Dikheila Steel Works in Alexandria and it has a branch office in Cairo.

Construction of production facilities of El Dikheila Works began in 1983 and the facilities were completed one after another beginning in 1986 and the Works was completed as an integrated steel mill in April 1987. Its production capacity is about 745,000 t/y of rolled steel products.

The idea of El Dikheila Works originated when natural gas fields was found in Abu Qir in the suburb of Alexandria and it was proposed to produce DRI using this gas.

This idea was materialized between Egypt and the World Bank and it was decided the project would be implemented by joint venture method. In early 1977, nine companies in Japan, U.S.A., W. Germany and U.K. participated in the international tender for selecting technical partner in the project and in 1979, two years later, Japanese consortium (JC) consisting of Nippon Kokan K.K., Kobe Steel, Ltd. and Toyo Menka Kaisha, Ltd. was officially selected as the partner. Prior to that, IFC also decided to invest capital in the project and thus the project was to be implemented as a joint project of Egypt, World Bank and JC.

The present capital of ANSDK is 235 million Egyptian pounds, which is shared as follows.

Shareholders:

Egyptian government agencies and state companies*	87%
International Financing Corporation	3%
Japanese Consortium (JC)	10%

*Members of the Egyptian shareholders

Egyptian General Petroleum Corporation (EGPC)

Executive Organization for Industrial & Mining Complexes (IMC)

Egyptian Iron and Steel Co. (HADISOLB)

Delta Steel Mill

National Metal Industries Co.

Egyptian Copper Works

National Bank of Egypt

Bank of Alexandria

Bank Misr

National Investment Bank

Misr Insurance

5-1-2. Company organization

1) Organization chart and functions

Organization chart of the company is shown in the Table 5.1.2-1. The organization comprises 9 departments and 26 sections including the head office of secretary sec. and public relations dept.

2) Management

The number of employees at the time of completion of Stage I is planned to be about 1,900, of which 155 are Japanese staff. The Japanese staff are dispatched under the management agreement entered into between ANSDK and JC and assume important positions such as general manager (GM), deputy general manager (DGM), department manager (DM), section manager (SM) and assistant section manager (ASM). The company is to be managed by the

Japanese staff and Egyptian counterparts and during 5 years of start-up, technology transfer is to be made.

Since the start-up of steelmaking plant in May 1986, the start-up operation has been smooth. With adequate consideration given to environmental control and safety, it could confirmed by the field survey that the management system of the company is well functioning.

Management policy and measures of ANSDK are determined by the board of directors consisting of representatives of shareholders (11 members from Egyptian side and one each from JC and IFC) and two representatives of ANSDK.

The top management consists of Chairman and Managing Director, Joint Managing Director (both being Egyptians), General Manager (Japanese) and Deputy General Managers (one Egyptian and one Japanese).

Each position of DM and SM is occupied by a pair of a Japanes and an Egyptian so that early transfer of technology can be attained. Functions of officers are as follows:

(1) Chairman and Managing Director (C/MD)

- To represent the company,
- To have general authority to ensure smooth relation between national policy, implementation of the project and management of the company, and
- To execute and oversee measures determined at the Board of Directors

(2) Joint Managing Director (JMD)

- Supervision of daily management condition of the company,
- Execution of business assigned by C/MD,
- Report of the above to C/MD, and
- To act for C/MD

(3) General Manager (GM)

- To have authority assigned by C/MD or JMD over all employees for the purpose of attaining company's objectives,
- To take responsibility for C/MD and JMD as to daily management of the company,
- To report to C/MD and JMD,
- To act for JMD,
- To attend Directors' meeting (without the vote), and
- To coordinate work of DMs

(4) Deputy General Manager (DGM)

- To assist GM as staff (Specific assignment of DGM determined by GM),
- To act for GM when absent, provided, however, that any decision is made by GM (GM should designate his acting DGM during his absence), and
- To study and report specific assigned work according to the instruction of GM

(5) Department Manager (DM)

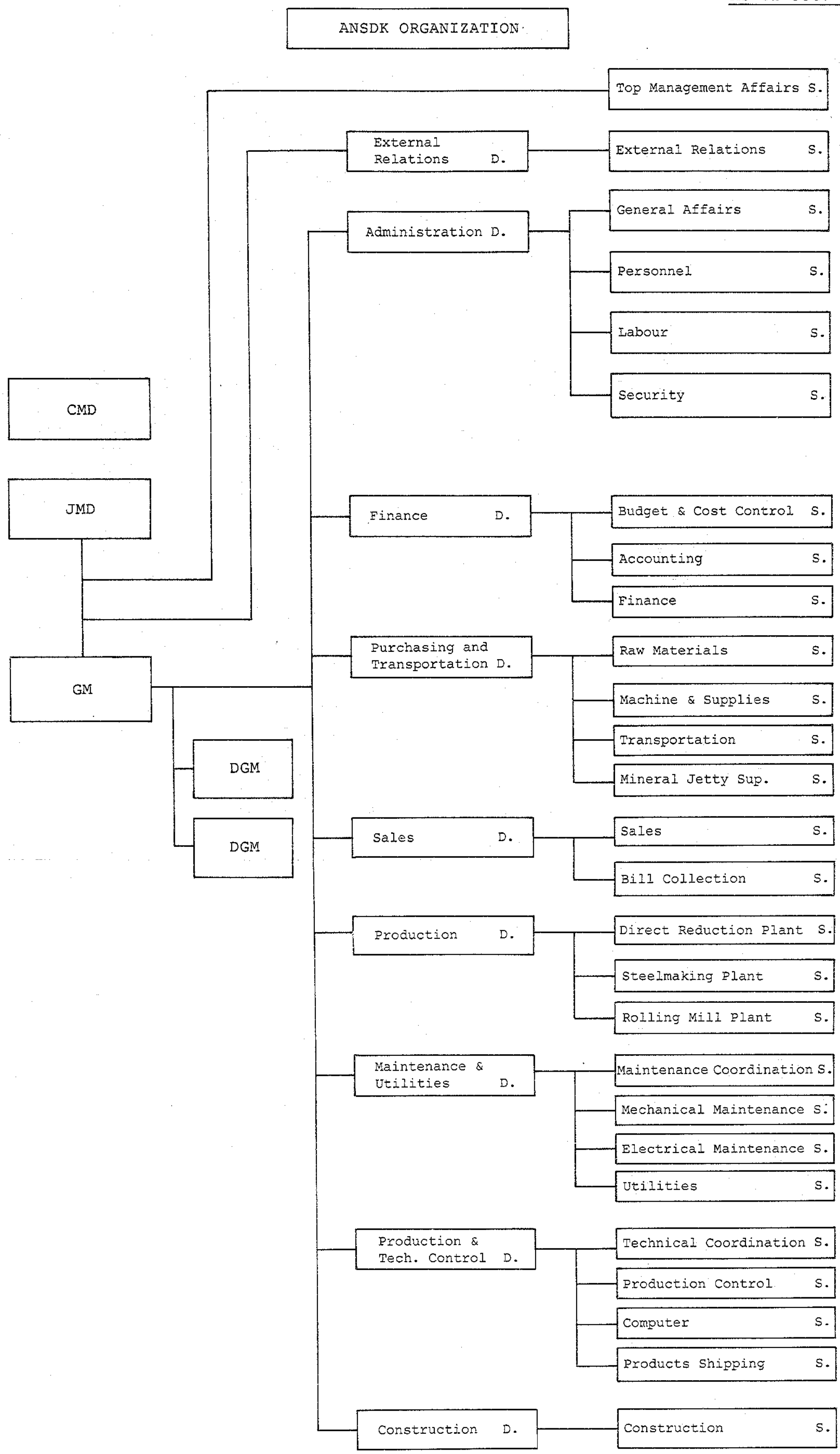
- To make decision within assigned authority,
- To supervise and coordinate work of section managers (SM),
- To supervise SM and fellow section manager (FSM),
- To report the result of work to GM,
- To allocate study of specific matters among fellow department manager (FDM),
- To educate and train FDM

(6) Fellow Department Manager

- As counterpart of DM, to participate in discussion

Table 5.1.2-1 Organization chart of ANSDK

As of Oct. 1, 1986



5-1-3. Education and training of employees

1) Employment

School education system of Egypt is basically of so-called 6-3-3-4 system and the percentage of school attendance is comparatively high. As the Egyptian economy in general is slow at present, employment of able workers is relatively easy. It is said that under such circumstances, ANSDK also could obtain generally satisfactory manpower.

In employing plant workers, mainly young people who have capability required for performing jobs in future are engaged and as for clerical and technical employees, mainly those who have experiences are employed.

2) Education and training

Education and training of employees at ANSDK is divided into special training conducted by JC under Training Services Agreement and On-the-Job Training in which employees learn technique by doing jobs. The special training is to have Egyptian employees acquire ability which enables them to control and operate plants and have them succeed the management of the plants from the Japanese staff at an earliest day. The special training is divided into 3-month basic education at ANSDK and OJT in Japan or in Qatar for about three months.

(1) Basic education

Basic education is given mainly by indoor lectures and employees of engineer and assistant foreman class are divided into 11 groups by plant and job and educated about outline of respective plant and facilities and their operation process, quality and cost control and safety measures. The education lasts two months and so far about 300 persons received this education.

(2) Overseas education

a) In-service training

About 220 employees selected from among those who had received the basic education were given in-service education for 2.5 - 3 months at steel mills overseas--- Japan and Qatar.

b) Management education

This is a course to receive managment education conducted by AOTS of Japan and is mainly for DM class. In 1986 6 persons received the training and 7 more persons are planned to attend the course in future.

c) Trainer training education

This is an education course to train trainers so that education and training by ANSDK itself can last and the candidates for the trainer were picked up among those who received overseas education. The education terminated in June 1987 and from now on, in-house education will be given by those trainers or instructors in accordance with the system established in advance.

3) Welfare

Regarding welfare, satisfactory measures are in effect in conformity to the Labor Law and it is contemplated to expand the facilities in the fields of housing and medical care. The performance in welfare activity can be said excellent with working condition favorable in labor safety and hygiene and under proper guidance of the persons in charge.

5-2. El Dikheila Iron and Steel Works

5-2-1. Location conditions

Alexandria City where the Works is located faces the Mediterranean Sea and is the second largest city next to Cairo and has a population of about 2.5 million. It is also famous as a port city like Port Said.

El Dikheila area selected as the site for this project is located about 15 km west of Alexandria City and an area which is looked upon with much expectations as one of the key points in the industrialization plan of Egypt. The site sits between the shoreline formed by Dikheila Bay on the Mediterranean Sea and the Lake Maryut and there was a limestone quarry in the past. It is reputed as a site which fulfills adequately requirements of a steel mill and the field survey confirmed it. Location condition of the site is enumerated in the following.

(1) The site is connected with New Dikheila Port by belt conveyor, which facilitates unloading and transportation of raw materials.

(2) Facilities of natural gas, main fuel, and industrial water are complete.

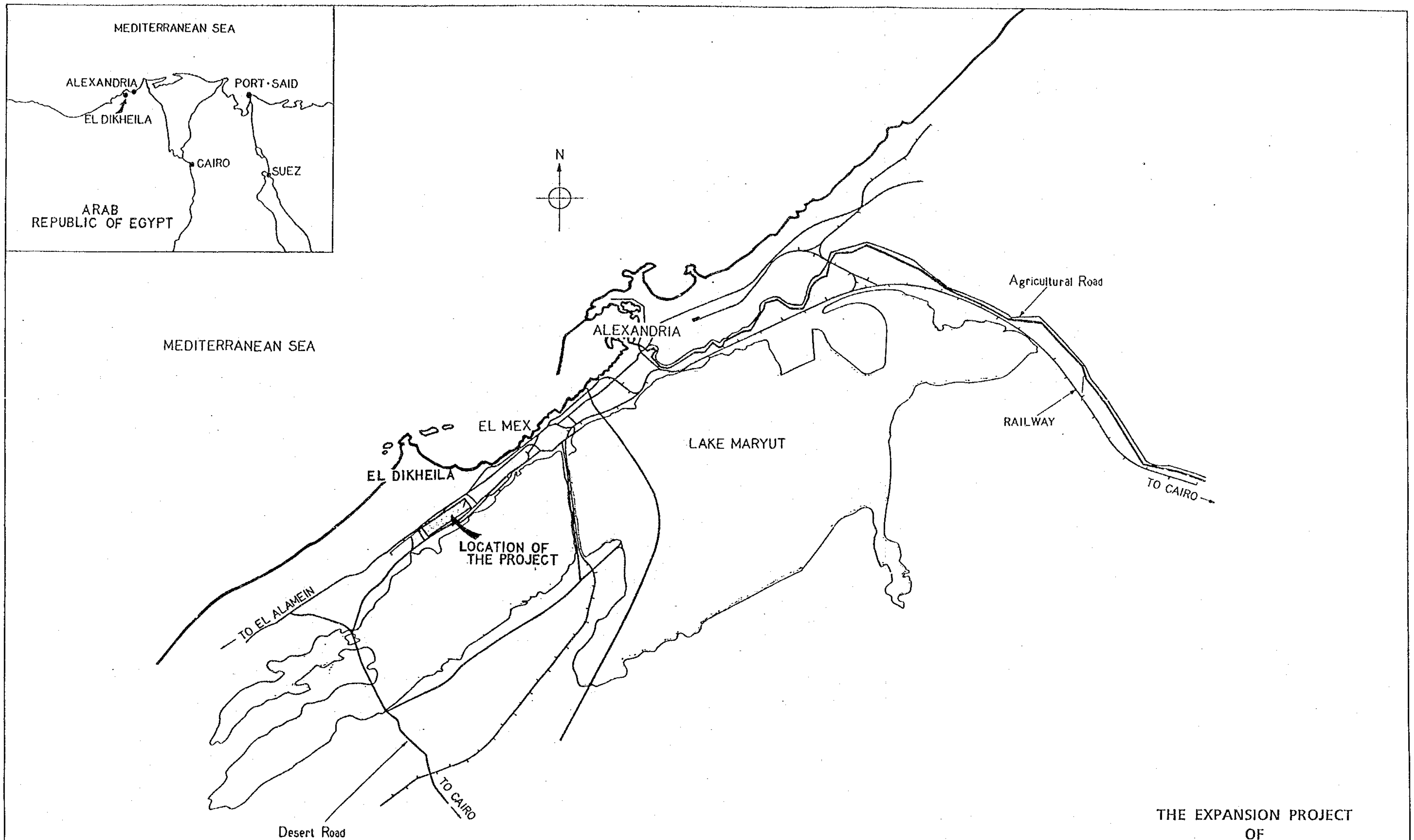
(3) Soil condition is good and suited for construction of heavy structures.

(4) Climate is mild and living condition is superior.

(5) It is close to steel consuming centers and has easy access to the existing trunk road network.

(6) Power is available from power stations at Abu Qir and Kafr El Dawar through substation at El Dikheila.

Location of El Dikheila Works and access to the port facilities are shown in DWG JICA G-001 and G-002.

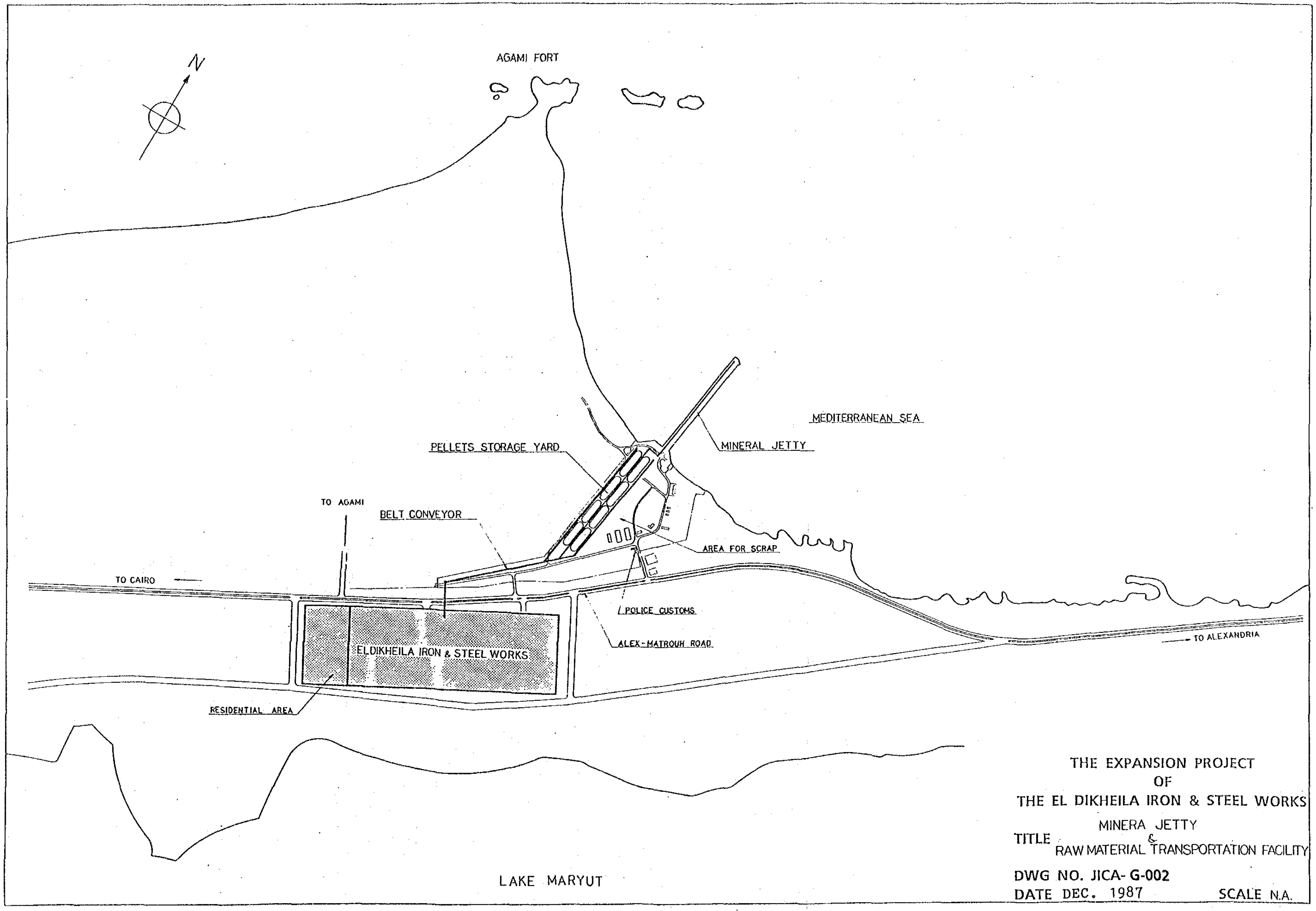


THE EXPANSION PROJECT
OF
THE EL DIKHEILA IRON & STEEL WORKS

TITLE LOCATION OF EL DIKHILA IRON & STEEL WORKS

DWG NO. JICA- G-001

DATE DEC. 1987 SCALE N.A.



THE EXPANSION PROJECT
OF
THE EL DIKHEILA IRON & STEEL WORKS

TITLE MINERA JETTY & RAW MATERIAL TRANSPORTATION FACILITY

DWG NO. JICA- G-002
DATE DEC. 1987 SCALE N.A.

5-2-2. Outline of El Dikheila Iron and Steel Works

1) Major facilities

El Dikheila Steel Works produces bars and rods on DRI process and electric arc furnace (EAF) - continuous casting (CC) process and the major facilities are as outlined in the following.

(1) Direct-reduced iron (DRI) plant (DRP)

600 module x 1 unit
DRI 716,000 t/y
Start-up in November 1986

(2) Steelmaking plant (SMP)

EAF	70 t/heat x 4 units	
	Liquid steel	840,000 t/y
CC	4-strand x 3 units	
	Billet	798,000 t/y

(3) Bar mill plant (BMP)

Bars 425,000 t/y

(4) Rod mill plant (RMP)

Rods 320,000 t/y

In addition to the above major facilities, the Works has lime calcining facilities, utilities facilities, power receiving and distributing facilities, intraworks transportation facilities, inspection & analysis facilities and control facilities.

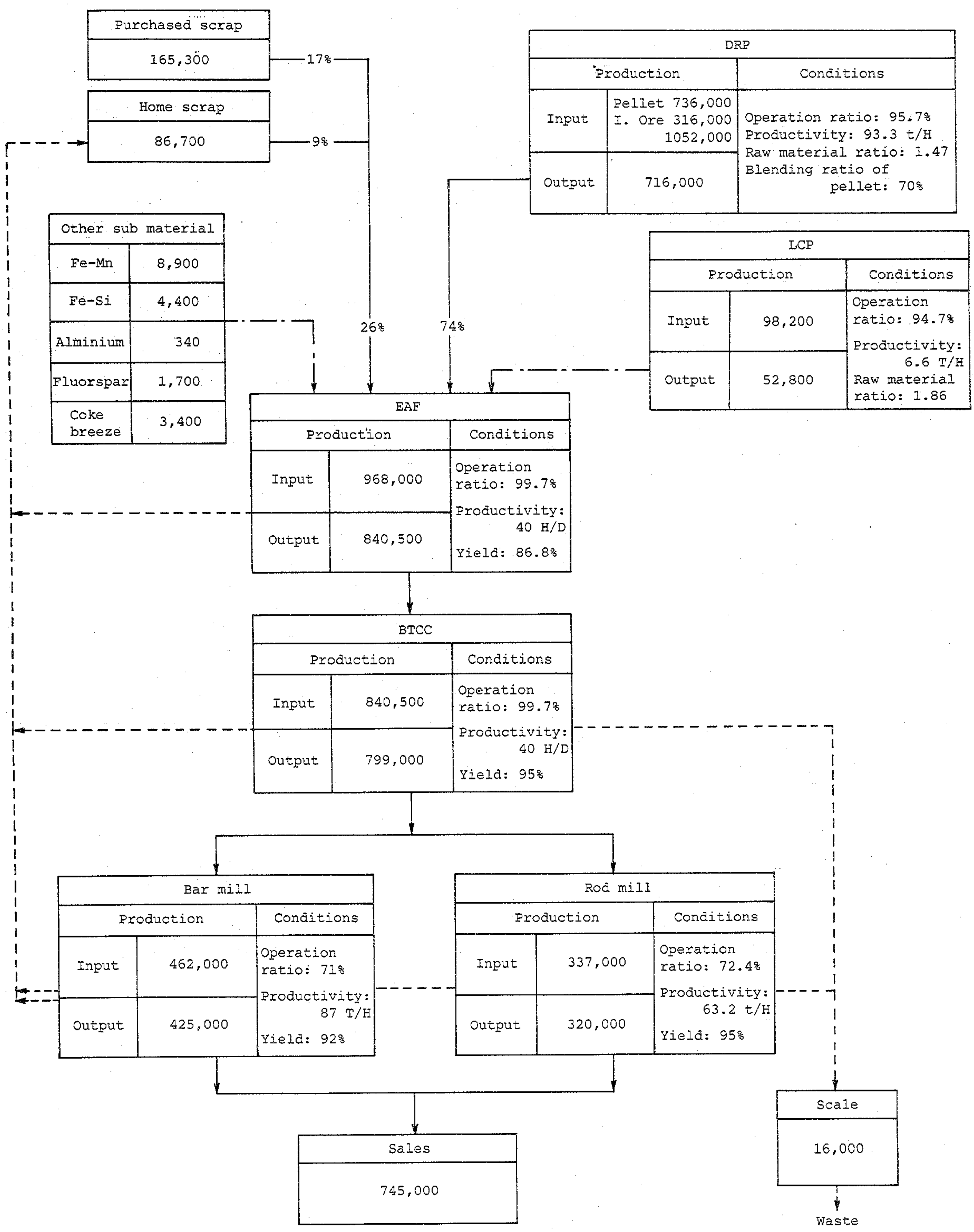
The site of the Works is about one million m^2 and all the facilities are laid out rationally in straight line from receiving raw materials to shipping products. Besides, as the El Dikheila area is a resort, special consideration has been given to prevention of environmental pollution.

2) Material balance sheet

Material balance sheet in the Works is shown in Fig. 5.5.2-1.

Fig. 5.2.2-1 PROCESS AND MATERIAL FLOW CHART

Unit: t/year



5-2-3. DR plant

1) Outline

ANSDK has installed a DR plant of MIDREX process with annual capacity of 716,000 tons. This plant was supplied by Kobe Steel, Ltd. and is one of the largest in the world as to the production by one unit.

Contract was signed in March 1984 and became effective in October that year, and its erection works was commenced in September 1985 and the plant was completed in October 1986 and started up in November that year. It took only 24 months from the contract becoming effective to the start-up of the plant, which is indeed an exceptionally short construction period for a DR plant.

The DR plant is at present in a satisfactory operation and the hourly production alreay cleared the nominal capacity of 93.3 t/h.

2) DR process

The DR plant at Stage I uses natural gas produced at Abu Qir gas field in the suburb of Alexandria. At the time of tender, MIDREX process and HYL III process competed, but MIDREX process was adopted because of its reliability.

As well known, about 30 units of MIDREX process have been constructed throughout the world and, of all known types of DR process, MIDREX has proved most successful commercially and the MIDREX type DR plant of ANSDK also is in a smooth operation.

3) Capacity

The DR plant at Stage I has nominal capacity of 716,000 t/y, which is the largest in the world in terms of production per module. The number of working days a year is designed to be 320 days, and with daily production of 2,240 tons and 24-hour continuous operation a day, hourly production capacity is 93.3 tons.

After its start-up at the end of November 1986, the production of 93.3 t/h was already achieved in April 1987.

Though the performance guarantee test is yet to be made, production of 93.3 t/h and 716,000 t/y is considered practicable in view of the present operation condition.

4) Raw materials used

DR plant supply contract specified that LKAB pellet of Sweden, CVRD pellet of Brazil and also Mutuca lump ore in Brazil are to be used, but at present ANSDK is using Samarco pellet alone.

Though it seems that occurrence of fine DRI is higher than usual, the production capacity of the plant was attained by such single use of Samarco pellet. Raw material purchasing specification of ANSDK and specification of the material from each supplier are shown in Table 5.2.3-1. Except that Samarco pellet contains more fines in size of 0-6.3 mm, the specification presented by Samarco satisfies the raw material purchasing specification of ANSDK.

Table 5.2.3-1 Specifications of Pellets and Lumpy Ore

Pellets

Supplier	Chemical Composition		Size	Tumble Strength	Compression Strength
(ANSDK required)	Fe	67.5 % min.	6-20 mm (nominal)	+ 5 mm 95% min.	average 250 Kg
	$SiO_2+Al_2O_3$	2.0 % max.	9-16 mm 95% min.	-28 mesh 4% max.	-50 Kg 2 % max.
	P	0.030% max.	0- 5 mm 3% max.		
	S	0.010% max.			
	Cu	0.01 % max.			
	TiO_2	0.15 % max.			
SAMARCO	Fe	67.5 % min.	6-20 mm (nominal)	+ 6.3 mm 94% min.	average 250 Kg
	$SiO_2+Al_2O_3$	2.2 % max.	9-16 mm 95% min.	-28 mesh 4% max.	-50 kg 2 % max.
	P	0.03 % max.	0-6.3mm 5% max.		
	S	0.010% max.			
	Cu	0.01 % max.			
	TiO_2	0.15 % max.			
CVRD	Fe	67.5 % min.	8-18 mm 90% min.	+ 5 mm 95% min.	average 250 Kg
	$SiO_2+Al_2O_3$	2.0 % max.	0- 5 mm 5% max.	-28 mesh 4% max.	-50 Kg 2 % max.
	P	0.03 % max.			
	S	0.010% max.			
	Cu	0.01 % max.			
	TiO_2	0.15 % max.			
LKAB	Fe	67.0 % min.	6-20 mm (nominal)	+ 6.3 mm 95% min.	average 270 Kg typical
	$SiO_2+Al_2O_3$	2.0 % max.	9-16 mm 95% min.	- 0.5 mm 4% max.	-50 Kg 2 % max.
	P	0.03 % max.	0- 5 mm 3% max.		
	S	0.01 % max.			
	Cu	0.01 % max.			
	TiO_2	0.3 % typical			

Lumpy Ore

Supplier	Chemical Composition		Size	Tumble Strength	Compression Strength
(ANSDK required)	Fe	67.0 % min.	10-25 mm (nominal)	+ 5 mm 90% min.	Not mentioned
	$SiO_2+Al_2O_3$	2.0 % max.	0- 5 mm 5% max.	-28 mesh 7% max.	

(Cont'd)

Supplier	Chemical Composition	Size	Tumble Strength	Compression Stength
(ANSDK required)	P 0.040% max. S 0.015% max. TiO_2 0.03 % max.			
MBR	Fe 67.0 min. $SiO_2+Al_2O_3$ 2.5 % max. P 0.03 % max. S 0.010% max. Cu 0.01 % max. TiO_2 0.15 % max.	6.35-31.75 mm - 6.35 mm 10% max. +31.75 mm 5% max.	Not mentioned	Not mentioned

Pellets

Supplier	Reduction Characteristics (Midrex Linder 760 °C)		Hot Load Test (815 °C)	
(ANSDK required)	Metallization Degradation (-3 mm)	93% min. 2% max.	Tumble Strength (+3 mm) Average Compression Clustering	95 % min. 100 Kg min. None
SAMARCO	Metallization Degradation (-3 mm)	93% min. 2% max.	Tumble Strength (+3 mm) Average Compression Clustering	95 % min. 100 Kg min. None
CVRD	Metallization Degradation (-3 mm)	90% min. 3% max.	Not mentioned	
LKAB	Not mentioned		Not mentioned	

Lumpy Ore

Supplier	Reduction Characteristics (Midrex Linder 760 °C)		Hot Load Test (815 °C)	
(ANSDK required)	Metallization Degradation (-3 mm)	92% min. 5% max.	Tumble Strength (+3 mm) Clustering	90 % min. None
MBR	Not mentioned		Not mentioned	

5) Operation condition and base consumption units

The DR plant is operated with Samarco pellet alone and in a smooth operation achieving desired quality of DRI.

Table 5.2.3-2 gives operation data of the plant from its start-up to February 1987.

Average production per hour is 69.4 t/h, which is about 74% of the nominal capacity 93.3 t/h. This is because the production was lowered as DRI demand was low with one line of rolling plant being under construction.

Important quality of product, metallization, is considerably higher than 92% being the standard and averages about 96.3%. It was said that though this reflected partly low production, the metallization was held at a high level as a little time passed since the start-up of DR plant and steelmaking shop just began use of DRI.

Carbon content is a little higher than the standard of 1.5%. But this is considered resulted from the fact that the reducing gas temperature at the ports of the DR furnace is kept a little lower due to low production level and that Samarco pellet is susceptible to carburization.

The both above are quality favorable for steelmaking shop. But when the plants including DR plant are in operation of nominal capacity in future, the above metallization and carbon content of DRI are expected to approach the standard values.

Table 5.2.3-3 shows actual results of unit consumption of materials. Though consumption of raw materials is somewhat higher than normal level, it is considered due to the use of Samarco pellet.

Due to the low production level, unit consumption of natural gas and power is high, but once the production rises to the nominal capacity level, they are expected to fall to the designed level.

Water and nitrogen gas is lower than desinged base.

Unit consumption of air is high, but it is considered that this is because air is consumed much at various places and due to low production level because of little time passed since the start-up of the plant. It is expected to fall gradually as the production level rises and operation period gains.

Table 5.2.3-2 Operation Data of Stage I DR Plant

	Monthly Data				Average
	Nov.'86	Dec.'86	Jan.'87	Feb.'87	
Production (Ton/month)	640	29,945	27,155	26,892	27,927
Operation days (Day/month)	1	22	20	21	21
Production hours (Hour/month)	10.5	435.52	379.00	396.00	403.5
Productivity (Ton/hour)	60.9	68.8	71.6	67.9	69.4
Product quality:					
T.Fe (%)	93.12	93.44	93.22	93.09	93.2
Metallization (%)	96.78	96.14	96.26	96.64	96.3
Carbon (%)	1.97	1.90	1.60	1.92	1.81

Note: Data of Nov.'86 are not included in the average.

Table 5.2.3-3 Base Consumption Units of Stage I DR Plant

Unit Consumption	Monthly Data				Average
	Nov.'86	Dec.'86	Jan.'87	Feb.'87	
Oxide material (Ton/ton-DRI)	7.38	1.50	1.45	1.59	1.51
Natural gas (Nm^3/ton-DRI)	1,878	306	297	312	305
Electric power (kWh/ton-DRI)	4,972	136	140	147	141
Water (m^3/ton-DRI)	31	1.33	1.26	1.40	1.33
Air (Nm^3/ton-DRI)	0.05	6.93	15.30	17.94	13.39
Nitrogen (Nm^3/ton-DRI)	7.8	0.54	0.05	1.08	0.56

Note: Data of Nov.'86 are not included in the average.

6) Plant layout

The layout of Stage I DR plant is shown in Fig. 5.2.3-1. The site of DR plant is a 230 m x 230 m lot including space for future expansion. It is divided into Core area cntering on Reduction furnace and Reformer, Water area for water treatment facilities and Material handling area for transport of raw materials and DRI product.

On the south of Water area, the site for expansion of DR plant is secured and prepared. In this area will be installed Core area equipment and Water area facilities. Material handling area facilities are to be installed at the present Material handling area.

In the Core area, reduction furnace, rotary equipment such as process gas compressor, reformer, recuperator and stack are arranged in that order from the west.

On the western end of Water area, control building was built and on the east of the building are clarifier, cooling tower, pump and dehydrator.

At Material handling area, facilities are arranged in such manner that raw materials and product flow from north to south, and on the northern end was installed oxide storage bins which stock raw materials brought from raw material yard. Product storage bins which stock DRI discharged from the reduction furnace sits almost at the center of Material handling area and DRI transfer system is arranged in the direction to Steelmaking shop.

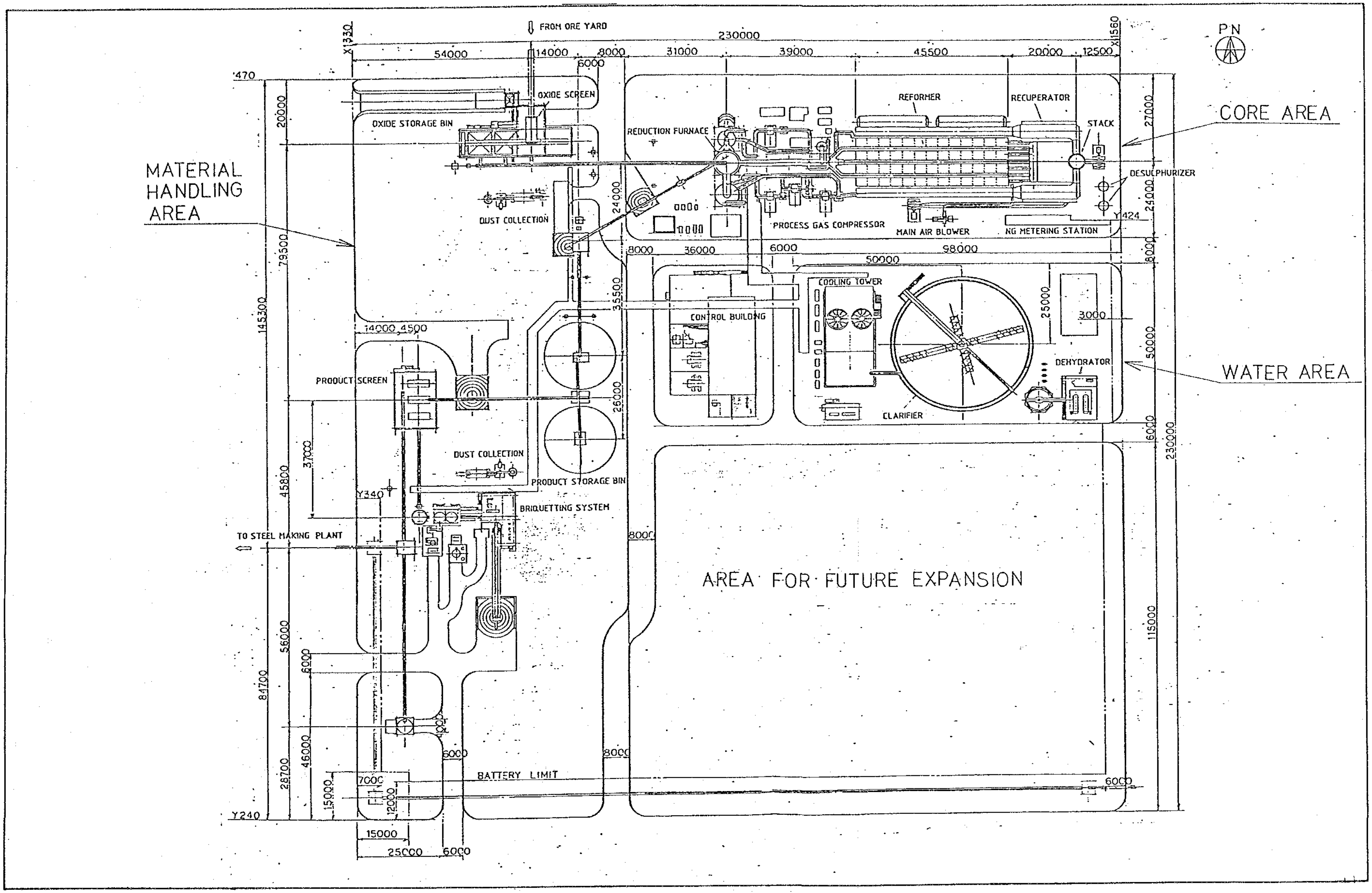


Fig. 5.2.3-1 DR PLANT

7) Process/plant description

PROCESS AND PLANT DESCRIPTION

The MIDREX Direct Reduction Process converts iron oxide in either pellet or lump form to highly metallized iron for steelmaking.

The following is a description of the process chemistry, process flow and plant equipment used in MIDREX Direct Reduction Plant.

(1) DESCRIPTION OF MIDREX PROCESS

The most significant features of the MIDREX Direct Reduction Process are:

- a continuous system utilizing an uninterrupted flow of reducing gases for the removal of oxygen from the iron oxide feed material and for carburizing the reduced iron;

- maximum energy efficiency by recycling the top gas from the shaft furnace into the process;

- the unique gas reforming system which used primarity carbon dioxide, produced during the reduction of the iron oxide, for the catalytic conversion of the natural gas without formation of soot. This obviates the necessity of an external source of oxygen for the conversion of methane of carbon monoxide and hydrogen.

The two principal components of a MIDREX Plant are the gas reformer for the production of the reducing gases and the shaft furnace as a reactor in which the reduction process takes place. Apart from these, there are the transportation and handling systems within the Plant. All transportation systems for oxide materials, gas, water and metallized product are operated automatically and are mainly controlled from a central control room.

The MIDREX Plant design employs two independent gas loops, i.e., process gas and cooling gas. The process gas is withdrawn from the top of the reduction furnace and passed through the top gas scurbber. The cleaned, cooled gas is pumped to the reformer by the process gas compressors where it is mixed with preheated natural gas, the mixture (feed gas) is then preheated and subsequently reformed. The reformed gas is then introduced into the reduction furnace at the bustle and flows upward through the metallizing zone to the top of the furnace. A separate closed loop of cooling gas is recycled through the cooling gas scrubber and the lower section of the reduction furnace cooling zone to cool the product before discharge.

Iron oxide material is fed automatically into the feed hopper of the furnace in response to weight control devices. The oxide feed flows into the furnace through a number of charging tubes.

(2) FUNDAMENTAL CHEMISTRY

a) REDUCTION

Most naturally occurring iron oxide has the chemical composition Fe_2O_3 and contains about 30% oxygen by weight. In the MIDREX Process, oxygen in the iron oxide reacts with carbon monoxide (CO) and hydrogen (H_2) in the reducing gas to form metallic iron (Fe), carbon dioxide (CO_2), and water vapor (H_2O). The overall reduction reactions are:

$$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$$

$$Fe_2O_3 + 3H_2 \longrightarrow 2Fe + 3H_2O$$

An important property of the reducing gas is the reductant/oxidant ratio. This ratio is a measure of the ability of the gas to reduce iron oxide.

The reductant/oxidant ratio is defined as the mole ratio of reductants in the gas to the oxidants in the gas:

$$\text{Reductant/oxidant ratio} = \frac{\text{moles } (CO_2 + H\ )}{\text{moles } (CO_2 + H_2O)}$$

The quantity and quality of reducing gas affects the degree of metallization and productivity. The degree of metallization quantities the oxygen removal from the iron oxide during reduction:

$$\text{Degree of metallization, \%} = \frac{\text{kg Metallic Iron}}{\text{kg Total Iron}} \times 100\%$$

The MIDREX Plant production rating is based on a degree of metallization of 92% to 95% metallized product based on the special requirements of the steelmaker. The technical and economic optimization of direct reduction/electric arc furnace (DR/EAF) operation is usually achieved using a 92% metallized product.

b) Reforming

In the MIDREX Reformer, natural gas is reacted with CO_2 and H_2O produce a reducing gas rich in CO_2 and H_2. The important reforming reactions are:

$$CH_4 + CO_2 \longrightarrow 2CO + 2H_2$$

$$CH_4 + H_2O \longrightarrow CO + 3H_2$$

These reactions are endothermic and thus require heat input. The reactions are also catalyzed in order to speed up the reaction rates and maximize reformer efficiency.

Two major features distinguish the MIDREX Reforming Process from conventional steam reforming processes:

- Most steam reforming processes use excessive amounts of steam to reform hydrocarbons.
  Steam reforming processes usually have no top gas recycle. In contrast, the MIDREX Process recycles top gas to the reformer. This allows efficient recovery of reductants still present in the reduction furnace top gas. About one half of the total amount of CO plus H_2 in the reducing gas comes from the recycled top gas, and thus only about one half of the reductants needs to be freshly produced by reforming natural gas.

- Steam reformer H_2O feed gas concentrations are usually between two and three times that necessary for complete hydrocarbon conversion. H_2O feed gas concentration in the MIDREX Process is, in contrast, much closer to the minimum stoichiometric amount. Unburdened by the large presence of water vapor, the reducing gas exiting in the MIDREX reformer can be used directly in the reduction furnace without a water removing quench step and subsequent preheating step. This, of course, adds to the efficiency of the process.

c) <u>Carburization</u>

Carburization is the controlled reaction of carbon with iron to form iron carbide (Fe_3C). In the MIDREX Process, carburization occurs by one or more of these reactions:

$$3Fe + CH_4 \longrightarrow Fe_3C + 2H_2$$
$$3Fe + 2CO \longrightarrow Fe_3C + CO_2$$
$$3Fe + CO + H_2 \longrightarrow Fe_3C + H_2O$$

Most iron and steelmaking process require some carbon in the raw iron feed material. The control of MIDREX iron carbon content has been well developed and is easily controlled within 0.3% of the desired value.

(3) PROCESS FLOW

The reduction furnace operates at moderate pressure with the reduction and cooling gases retained within the furnace system by means of dynamic gas seal at both top and bottom of the reduction furnace.

The raw material entering and product discharged through the seal legs provide a resistance to gas flow. Inert seal gas generated from the flue gas of the reformer is introduced at elevated pressure into the seal legs. Small volumes of inert seal gases are vented from the reduction furnace discharge.

The top gas leaving the furnace is recycled to recover its unreacted CO and H_2 for further use. This is done by first cooling and scrubbing the gas in the top gas scrubber to condense water vapours and remove dust particles before the gases are compressed and recirculated. A part of top gas is vented to the reformer burners to relieve the volume expansion accompanying reforming. The remaining becomes process gas, which is mixed with fresh (make-up) natural gas and preheated by flue gas from the reformer. The feed gas pre-heater, part of the recuperator, is a typical addition to MIDREX plants. Such a heat recuperator improves energy efficiency in the MIDREX plants.

The preheated mixture is reformed in 468 heat-resisting alloy tubes containing catalysts expressly developed to reform methane with CO_2 and some H_2O.

The reforming of natural gas with CO_2 without the formation of soot is a unique feature of the MIDREX Process.

The reducing gas quality and the temperature of the reformer are automatically controlled. The reformer is fired by multiple burners using perheated air and burning a mixture of top gas fuel and natural gas. About 85% of the required heat is obtained from burning the top gas fuel. Combustion air is preheated to about 600°C by recuperation of heat from the flue gas leaving the reformer.

The discharge of the cooled reduced material from the furnace takes place continuously by means of a discharge feeder which in turn discharges the material onto a short conveyor for further transport to the product storage.

The water system of the plant consists basically of two closed loop water circuits which handle the process and the machinery water respectively. The machinery water circuit serves the indirect machinery cooling.

The process water circuit includes dust collection scrubbers, top gas and cooling gas scrubbers, reformed gas, seal gas coolers, classifier, slurry dehydrator and clarifier. In order to minimize water losses, the machinery water is indirectly cooled by the process water and the water from the process water circuit will be cooled in a cooling tower.

For dust collection in the oxide handling system and the product handling system, wet scrubbers are provided and, at the furnace discharge and the product handling system, a combination of dry cyclones and wet scrubbers.

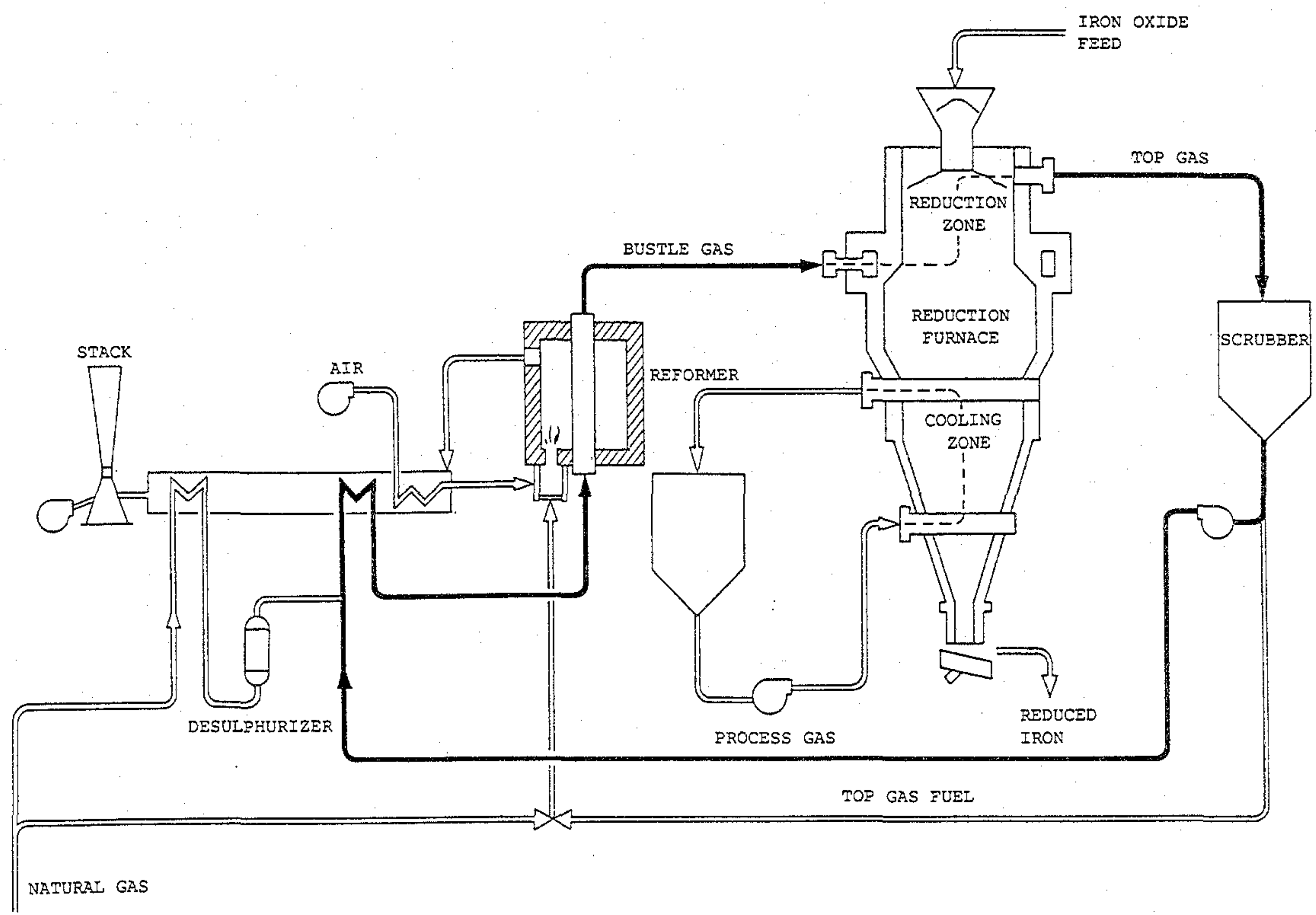


Fig. 5.2.3-2 FLOWSHEET OF MIDREX DR PROCESS

(4) DESCRIPTION OF THE PLANT

a) OXIDE HANDLING SYSTEM

The iron oxide materials are transported from ore yard onto the 6 mm oxide screen and screened. Oxide materials +50 mm and foreign materials which should not be charged into the shaft furnace are eliminated prior to transportation from the oxide stock yard to the above oxide screen. The +6 mm oxide materials are fed onto the shuttle conveyor which distributes oxide materials to one of three oxide storage bins. The -6 mm oxide fines are fed to the 3 mm oxide screen through a chute. The fractions 6-3 mm and -3 mm are stored in the middle fines bin and the oxide fines bin, respectively.

The +6 mm oxide materials are discharged from the oxide storage bins onto the furnace feed conveyor at a controlled rate by means of constant weigh feeders. The furnace feed conveyor elevates the oxide feed to the top of the reduction furnace and discharges the oxide materials into the feed bin. the addition of the oxide fines -6 mm to +3 mm is controlled by the quantity of screened oxide materials going to the reduction furnace.

The quantity of -6 mm fines depends on the type and quality of the oxide material (pellets, lump ores). It could be economical to screen out the -3 mm oxide fines, as these fines mainly result in excess dust in the top gas and cooling gas and are finally concentrated in the slurry. It is recommended to make use of the -3 mm oxide fines in a sintering plant or cement plant.

b) REDUCTION SHAFT FURNACE

The reduction shaft furnace includes all equipment from the point at which oxide feed is discharged into the feed bin above the furnace to the discharge of the metallized product from the furnace discharge feeder.

Within the shaft furnace, which consists of the reduction zone and the cooling zone, the oxide pellets flow by gravity.

The iron oxide feed bin at the top of the furnace is equipped with weight detector for level control and alarm devices to regulate the flow of material supplied to the bin.

Feed material from the feed bin passes through a vertical pipe which serves as the "top seal leg" of the reduction furnace. By blowing inert gas into feed pipe, this dynamic gas seal allows a continuous flow of the iron oxide into the furnace at all times and, at the same time, effectively prevents the escape of process gas into the atmosphere.

The incoming feed to the reduction furnace is distributed through a multiple arrangement of feed pipes (oxide material distributor) which minimize segregation of particle sizes.

The MIDREX furnace with 5.5 meter diameter by 9.5 meter high reduction zone allows about 5-hours of retention time for iron oxide feed exposure to the reducing gases. Reducing gases enter the furnace through a series of ports around the bottom periphery of the furnace reduction zone. Flowing upward through the bed of descending iron oxide material, these gases react with the iron oxide to form metallized product.

Spent reducing gases are withdrawn at the top of the furnace, dooled and scrubbed to remove entrained dust, compressed, and then returned to the reformer for recycling. The reduction reactions are as described in paragraph 2) a).

For the production of one ton of metallized material, about 1.4 tons of dry, screened high grade iron oxide raw material are required.

In the lower portion of the reduction furnace, product cooling is carried out. In this cooling zone, the relatively reactive metallized product is cooled to minimize reactivity by a separate closed loop recirculated gas stream to near ambient temperatures while remaining in a protective atmosphere. The cooling gases are introduced through a tapered inverted cone (cooling gas distributor), concentric with the convergence of the shaft of the cooling zone (cooling gas off-take), cooled and scrubbed in a direct contract packed tower (cooling gas scrubber) using water flowing countercurrently and then recycled into the shaft furnace via a compressor.

The bottom cone of the reduction furnace terminates in a discharge seal leg, a discharge tube similar to the top seal leg charging tube, terminating with a discharge feeder. Both the discharge seal leg and the top seal leg contain hydraulically operated closure gates (top and bottom slide gates) should an emergency or long shutdown require a mechanical seal.

The cooled metallized products are discharged from the furnace through the bottom seal leg continuously over a variable speed vibrating feeder (furnace discharge feeder)

c) PRODUCT HANDLING SYSTEM

The metallized product will be discharged from the furnace by means of the discharge feeder onto a furnace discharge conveyor at a temperature of about 40 - 50°C. Hot material, if it should occur, can be discharged by means of belt tilting device on the semi-product pile. The metallized product is dedusted at the discharge point of the reduction furnace.

+50 mm over-size material is discharged on the cluster pile by means of a grizzly. A sampler is installed to take samples of the metallized material which is transported via a belt conveyor to the product storage bins. The conveyor and the product diverting system (consisting of pneumatically operated diverter gate and transfer conveyor) charge the product into the product storage bins.

The two storage bins have capacity of 7,500t each and are provided with rock ladders, to prevent free fall and degradation of the material. Vibrofeeders with rack and pinion type shut-off gates are provided to discharge the material from the bins. To prevent air from stacking through the bins and possible reacting with the product, seal gas is introduced at the bin discharges. A remotely operated swing valve is located between head chute of conveyor and silo to seal the silo. The bins also contain sounding and inspection ports for inventory control measurements. The vibrofeeder discharges the product from the bin onto a belt conveyor to the product screening station.

The product screen eliminate -3 mm product fines, which are transportated into the product fines bin via a belt conveyor and a bucket elevator, the fines are used in the briquetting facility. The oversize product is transported via conveyors to the metallized product delivery point to the steel-making plant and to the truck loadout station.

When initially starting up the process, and upon occasion when a significant process upset has occurred which prevents the product from meeting specifications, the material is diverted from the furnace discharge conveyor to a semi-product pile. This material can be recycled to the process by transportation (front-end-loader and/or dump truck) to the semi-product hopper which is installed over the belt conveyor for the middle fines charging onto the furnace feed conveyor.

d) METALLIZED FINES BRIQUETTING

An important development in the handling and storage of the metallized product as well as in fines utilization is the cold briquetting system which directly uses metallized product fines to provide a briquette which can be stored outdoors and handled by conventional means, including front-end-loaders and conveying equipment.

Fines which as formed in the direct reduction furnace are uniformly distributed in the charge and do not affect furnace performance as long as the pressure drop does not exceed safe limits.

In the dedusting system (a combination of a dry cyclone and wet scrubber), the metallized dry dust collected by the cyclone is transferred to briquetting facility.

The metallized fines, screened off at -3 mm and the metallized dry dust, are mixed with 2 kinds of binders in the cold briquetting plant to produce briquettes. One is hydrated lime which is made from calcined lime in this briquetting plant. The other is molasses which is available in Egypt.

The briquetting system utilizes a roll type briquetting machine in conjunction with a system of dry and liquid binders to produce pillow-shaped briquettes not subject to wet oxidation of dry re-oxidation.

The briquettes possess excellent strength suitable for handling with conventional equipment. The binder system allows operation of the briquetting machines at low briquetting force, high productivity and low roll wear.

e) <u>GAS REFORMER</u>

The gas reformer is of the floor fired, updraft type and consists of a radiation fire-box by reason of the high process temperatures.

Due to this fact the flue gases leave the reformer at very high temperature, about 1100°C. The waste heat is recovered for the process in a downstream recuperator. The vertical catalyst-filled reformer tubes are arranged in the fire-box in 6 parallel rows. 36 tubes from a so-called "bay" Mechanical design and construction of steel structure, arrangement of burners and flue gas ducts correspond with these "bays" i.e. the bay forms a module of the reformer. A reformer of required capacity shall be designed as an arrangement of several identical bays along the longitudinal axis of the reformer. For the capacity range of the 716,000 tons per year DR-Plant, the reformer box consists of 13 bays.

The reformer tubes are of the bottom-to-top flow design. Each longitudinal row of tubes has its own inlet distributor below the reformer bottom. The tubes has its own inlet distributor below the reformer bottom. The tubes of two parallel rows are connected to a common reformed gas outlet headers above the reformer arch.

Connection of the feed gas distributors to the lower reformer tube ends is received by flexible hoses made of corrugated stainless steel.

Connection between reformer tube outlets and reformed gas headers are provided by stiff, internally insulated T-pieces that are welded to the reformer tubes and flanged to the headers and incorporate a catalyst filling and topping nozzle each.

The fixed point of the reformer tube is the center line of the inlet nozzle to the reformed gas header with additional adjusted spring supports. Thermal expansion of outlet T-pieces and tubes go downwards. For better tube life a part of the vertical load on the tubes is supported by means of block-and-tackle devices with counter weights made of concrete. This supporting system is located underneath the reformer. For process reasons, better efficiency and improved tube life, the reformer box is gas tight to avoid cold air leakage into the fire box. the outside casing is completely welded or - as far as panel design may be used - sealed. The openings for the catalyst tubes in the fire-box arch and bottom are sealed against the tubes using expansion of lined woven asbestoes. Observation holes are equipped with temperature resistant panels of glass.

Thermal insulation and lining of the reformer walls are of conventional design, consisting of insulating fire-bricks backed by block insulation. Sufficient horizontal and vertical expansion joints are provided in the brick lining for long life time of the walls. All joints have a z-form to avoid hot spots on the furnace casing. To reduce combustion noise and weight of lining, reformer arch and floor are designed with a special lining: roof is lined with layers of fibre. The floor is insulated by block insulation and insulating fire bricks covered with a layer of granulated brick.

The three reformed gas beaders as well as the entire reformed gas line to the reduction shaft furnace are inside-lined with insulating material.

Two different systems of burners are installed in the reformer floor-main burners and auxiliary burners. The main burners are located in rows between all tube rows and between the outer tube rows and the longitudinal walls, the latter burners with smaller capacity.

These burners are fired with top gas fuel. This gas contains enough combustibles (H_2, CO) to meet the major part of the reformer heat requirements. Reformer box temperature control is realized by mixing natural gas to the top gas fuel. The auxiliary burners are arranged only in four rows. They are installed in the rows between the outer tube rows and the longitudinal walls and between tube rows 2 and 3, as well as 4 and 5, respectively. The auxiliary burners are fired with natural gas. Number and capacity of the auxiliary burners are determined by their tasks. During normal operation they are used as pilot burners, fed with a constant quantity of natural gas fuel.

Further, during start-up, the reformer shall be heated up to nearly operating temperature by the auxiliary burners. And, during plant operation, when it is necessary to stop gas flow through the reformer tubes and shaft furnace ("IDLING"), the auxiliary burners keep the reformer at a temperature slightly below operating temperature to avoid stresses on reformer tubes and lining caused by temperature changes.

Both burner systems are of the forced draft type with air supply from the main air blower and from the auxiliary air blower respectively. Combustion air for the main burners is preheated in the recuperator. The auxiliary burners are supplied with cold air.

Flue gas is withdrawn from the reformer box by two flue gas headers arranged along the upper parts of both longitudinal walls of the reformer. To ensure uniform heat distribution along the reformer length, each reformer bay has a separate flue gas port to each of the flue gas headers. these flue gas ports are located in the sidewall sections of every bay directly below the reformer arch.

The flue gas headers are refractory lined. For compensation of thermal expansion, expansion joints are provided between the single sections of the headers.

The flue gas leaving the reformer box at a temperature of about 1100°C is fed to the recuperator for waste heat recovery. Flue gases from the recuper-acor are exhausted to the atmosphere through the power stack.

f) WASTE HEAT RECUPERATOR AND FLUE GAS SYSTEM

In the reformer box only radiation heat of flames and flue gas can be used due to the high combustion temperatures. So flue gases leave the reformer box with a temperature of about 1100°C.

The remaining heat is recovered in the recuperator system for preheating purposes. In sequence of downstream flow of the flue gas there are preheated (1) combustion air for the main burners, (2) feed gas to the reformer tubes, (3) natural gas to be desulphurized and mixed to the process gas for process make-up, and (4) cold combustion air for the main burner to be further preheated in (1).

To limit size and weight of prefabricated parts the recuperator is split into two paralled trains, each of them directly connected to one of the two reformer flue gas headers. The recuperators are designed as tube bundles arranged in a flue gas duct of rectangular cross section with cross-flow of the flue gases.

In the first recuperator tube bundle section, combustion air is preheated to about 600°C. In this section, combustion air in the tubes goes co-current to the flue gas flow, so that partially preheated air is in heat exchange with the hottest flue gas.

The next in the sequence is the feed gas preheater(2). Arriving from the scrubber, where furnace off-gas (top gas) has been cooled down, cleaned and saturated with water, the compressed process gas is mixed with the process make-up natural gas to attain the reformer feed gas. The make-up natural gas first is preheated to about 380°C in the preheater (3), and than desulphurized. The feed gas is preheated to about 450°C in the feed gas preheater.

In the natural gas preheater (3), all natural gas to be mixed to the process gas is preheated.

The flue gases shall leave the recuperator after heat exchanging with cold air (4). Thus heat in the flue gas is recovered to the economical limit.

Both recuperator trains are connected to a power stack where the injected air to an ejector nozzle from a power stack fan forms suction pressure for the reformer and recuperators.

g) BLOWERS, SCRUBBERS AND OTHER PROCESS EQUIPMENT

Process and Cooling Gas Compressors

The process and cooling gas compressors are positive displacement, rotary lobe machines incorporating features designed and proven specifically for the MIDREX Process. The compressor configuration and arrangement are chosen to allow use of identical compressors to facilitate Plant operation and replacements.

The process gas compressors are arranged with two machines operating in parallel in the first stage and a single machine in the second stage of compression. Each compressor has an integrally designed water spray system to continuously clean the machine and absorb the heat of compression.

The cooling gas compressor is designed to operate in a single stage. A spray system is also incorporated in the cooling gas compressor design.

Top Gas and Cooling Gas Scrubber, Reformed Gas Cooler

The top gas and cooling gas shrubbers receive hot, dust-laden gases from reduction and cooling zones of the reduction furnace respectively. The gases are cooled, scrubbed and demisted in the scrubber system, then compressed and recirculated through their respective circuits.

Cooling and cleaning of gases is accomplished in three integral stages within the scrubber vessel. The gases first flow through a venturi scrubber, then a packed section and finally through a mist eliminator.

The gases leaving the top gas venturi are divided into two streams which are passes through two different packed towers within the scrubber, followed by a mist eliminator or process gas after-cooler.

Dust-laden effluent water with a high solids content from the bottom of the scrubbers is routed to the clarifiers over a classifier. The rest of the effluent water from the scrubbers is led directly to the clarifier.

A part of the reformed gas is cooled in the reformed gas cooler for temperature control. This cooler functions by passing the gas through the packing.

h) <u>WATER SYSTEM</u>

The cooling water system has been designed to function in a closed loop and is divided into two system - the machinery cooling water (indirect cooling water) system and the process water (direct cooling water) system.

For the cooling of water, plate type indirect heat exchangers are used for the machinery water system and a cooling tower is used for the process water system.

The closed loop circuit enables the water losses to be kept to a minimum. In the closed loop the water passes through the system performing its cooling and/or dust scrubbing function and undergoes the following treatments in the process water system/ chemical additive treatment, clarification, cooling and is again recirculated continuously through the system.

Machinery Water system

The machinery water system functions by indirect cooling via a plate heat exchanger in a separate loop providing clean cooling water to various process machines, such as compressors and fans. The machinery water system also cools the hydraulic oil, the indirect inert gas aftercooler, the refrigerating medium of the inert gas cooling system and gas sampling probes.

This water cools indirectly the burden feeders in the reduction furnace. For emergency purpose, a water storage tank is provided.

If losses should occur in the indirect cooling water system, they are supplemented by fresh make-up water from water receiving station.

Process Water System

Water in this system shall be in direct contact with the reformed gas in the reformed gas cooler, with the flue gas in the inert gas cooler and in the emergency inert gas generator, with dust-laden gases in the top gas and cooling gas scrubbers and the dust collecting scrubbers.

The water with a higher solids content from the bottom of the top gas and cooling gas scrubbers shall be passed through a classifier and then overflowed and agitator tank to the collecting basin prior to the clarifier. The rest of the warm process water shall flow directly to this basin of the clarifier. The returning warm water from the reformed gas cooler, the seal gas cooler, the emergency inert gas generator and the condensate from the indirect inert gas cooling are collected and shall be pumped directly to the warm water basin of the cooling tower. The overflow from the clarifier shall be collected also in the common warm water sump of the cooling tower and from there pumped into the induced draft cooling tower to be cooled down and then recirculated.

The discharge of the slurry from the clarifier is filtrated by a filter press to recover water from the slurry and to make sludge cake easy disposal.

In the process water system, water is produced from the reduction process. An equalization system is provided to balance the water consuming and water producing systems.

Make-up water is added to the cold water sump. Flocculatns and pH controller are added to the process water system. The blowdown of the process water circuit is drained from the clarifier basin to the drainage system.

8) Equipment list

Major equipment of Stage I DR plant are shown in the list of equipment in Table 5.2.3-4.

They are classified by the following categories.

Oxide handling system

Reduction furnace & reformer

Blower area, scrubber & other process equipment

Product handling system

Water system

Table 5.2.3-4 Equipment list of DR plant

EQUIPMENT LIST PLANT: DIRECT REDUCTION PLANT

NO.	EQUIPMENT	Q'TY	MAIN SPECIFICATION
	OXIDE HANDLING SYSTEM		
DR-001	Shuttle Conveyor	1	Type : Belt type, 30°, 3-roller Capacity : 700 t/h Belt width: 1,050 mm Horizontal length : Approx. 17 m Lift : 0 m
DR-002	Day Bins	3	Type : Reinforced concrete construction with fabricated steel cone Capacity : 1,200 t, each
DR-003	Oxide Discharge Feeders	3	Type : Constant weigh feeder Capacity : 150 t/h
DR-004	Oxide Screen	1	Type : Single deck; standard heavy duty type Capacity : 500 t/h, each Size : 2,400 mm x 6,100 mm
DR-005	Furnace Feed Conveyor	1	Type : Pocket belt type Capacity : 200 t/h Belt width: 750 mm Horizontal length : Approx. 75 m Lift : Approx. 60 m
	REDUCTION FURNACE & REFORMER		
DR-101	Reduction Furnace	1	Type : Continuous charge/discharge type, shaft furnace, reducing in upper section, cooling in lower section Capacity : 93.3 t/h (Metallized product basis) Size : Furnace diameter, inside refractory: 5.5 m Consist of: Furnace charge hopper, upper seal gate, burden deeders, lower seal gate, hydraulic units, continuous discharger, refractories, structures, and miscellaneous materials

NO.	EQUIPMENT	Q'TY	MAIN SPECIFICATION
DR-130	Reformer	1	Type : Vertical tube filled with catalyst, refractory-lined, gas tight, welded steel structure Capacity : Natural gas basis, Normal 160,000 Nm^3/h Size : 200 mm in diameter reformer tubes Consist of: Reformer tubes, catalyst, burners, refractories, structure and miscellaneous materials
	BLOWER AREA, SCRUBBER & OTHER PROCESS EQUIPMENT		
DR-201	Top Gas Scrubber	1	Type : Direct water cooled, packed tower type
DR-202	Cooling Gas Scrubber	1	Type : Direct water cooled, packed tower type
DR-210	Process Gas Compressors	3	Type : Positive displacement, rotary lobe type Consist of: Speed reducers, oil pump units and pulsation dampers
DR-211	Process Gas Mist Eliminator	1	Type : Cyclone type
DR-220	Cooling Gas Compressor	1	Type : Positive displacement, rotary lobe type Consist of: Speed reducers, oil pump units and pulsation damper
DR-221	Cooling Gas Mist Eliminator	1	Type : Cyclone type
DR-241	Recuperators	2	Type : Shell and tube type with refractory-lined shell
DR-242	Power Stack	1	Type : Steel shell with refractory and air let positioner Consist of: Stack and fan
DR-250	Main Air Blower	1	Type : Centrifugal type, with silencer and lubrication oil pump unit

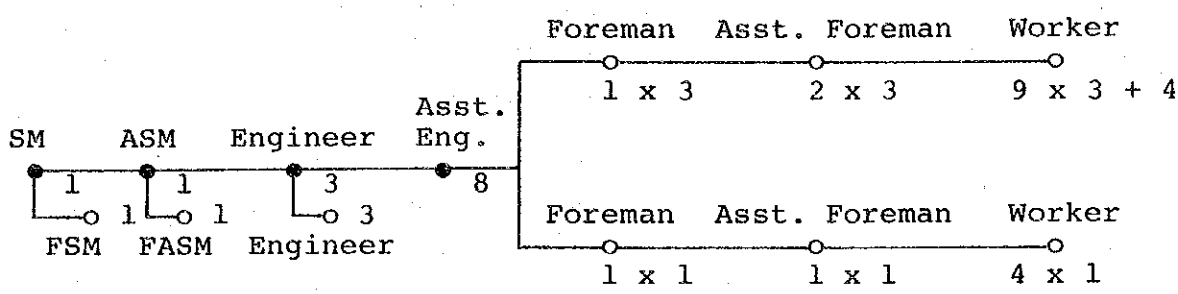
NO.	EQUIPMENT	Q'TY	MAIN SPECIFICATION
DR-251	Auxiliary Air Blower	1	Type : Centrifugal type, with inlet filter
DR-260	Reformed Gas Cooler	1	Type : Direct water cooled, packed tower type
DR-261	Process Gas Mixer	1	Type : Bending duct type
DR-262	Seal Gas Facility	1set	Type : Utilizing flue gas generated in reformer Consist of: Cooler, compressor, dryer, scrubber, inert gas generator, mist eliminator and miscellaneous
	PRODUCT HANDLING SYSTEM		
DR-301	Furnace Discharge Conveyor	1	Type : Belt type, 30°, 3-roller Capacity : 130 t/h Belt width: 600 mm Horizontal length : Approx. 50 m Lift : Approx. 6 m
DR-302	Semi-Product Diverter	1	Type : Manual operated Capacity : 130 t/h
DR-303	Product Belt Scals	1	Type : Load cell type Capacity : 130 t/h normal 150 t/h max. 30 t/h min.
DR-304	Product Storage Bin Feed Conveyor	1	Type : Pocket belt type Capacity : 110 t/h Belt width: 600 mm Horizontal length : Approx. 40 m Lift : Approx. 30 m
DR-305	Product Storage Bins	2	Type : Fabricated steel with slide gate Capacity : 7,500 t, each
DR-311	Storage Bin Discharge Feeders	2	Type : Lower deck magnet vibrator, rod suspension type Capacity : 270 t/h, each

NO.	EQUIPMENT	Q'TY	MAIN SPECIFICATION
DR-312	Product Bin Discharge Conveyor	1	Type : Belt type, 30°, 3-roller Capacity : 270 t/h Belt width: 750 mm Horizontal length : Approx. 13 m Lift : Approx. 2 m
DR-313	Screen Feed Conveyor	1	Type : Belt type, 30°, 3-roller Capacity : 270 t/h Belt width: 750 mm Horizontal length : Approx. 48 m Lift : Approx. 9 m
DR-314	Product Screen	1 + 1	Type : Single deck, standard heavy duty type Capacity : 270 t/h Size : 2,440 mm x 6,100 mm
DR-315	Product Fines Conveyor	1	Type : Belt type, 30°, 3-roller Capacity : 20 t/h Belt width: 600 mm Horizontal length : Approx. 33 m Lift : 3 m
DR-320	Briquetting Facility	1	Type : Metallized fine, cold briquetting Capacity : 15 t/h Consist of: Feeders, Conveyor, Bucket elevators, Briquetting machine, Storage bin, Miscellaneous
DR-331	Product Transfer Conveyor	1	Type : Belt type, 30°, 3-roller Capacity : 250 t/h Belt width: 750 mm Horizontal length : Approx. 56 m Lift : Approx. 11 m
DR-332	Product Diverter	1	Type : Remote controlled type Capacity : 250 t/h

NO.	EQUIPMENT	Q'TY	MAIN SPECIFICATION
DR-333	Truck Bin	1	Type : Steel fabrication Capacity : 100 t Accessory : 1 - Cut gate
DR-340	Oxide Dust Collector	1	Type : Cyclone & scrubber Capacity : Approx. 54,000 m^3/h @50°C Consist of: Cyclone, venturi scrubber, fan, dust storage bin and duct
DR-341	Product Dust Collector	1	Type : Cyclone & scrubber Capacity : Approx. 54,000 m^3/h @50°C Consist of: Cyclone, venturi scrubber, fan and duct
	WATER SYSTEM		
DR-401	Clarifier	1	Type : Conorete basin with rake Size : 40 m dia.
DR-402	Cooling Tower	1	Type : Mechanical induced draft cross flow Capacity : 2,600 m^3/h
DR-403	Pump	1set	Type : Vertical turbine type Consist of: Contaminated water pump, machinery cooling water pump, and miscellaneous pump
DR-404	Sump and Tank	1set	Consist of: Thickner tank, mixing tank, miscellaneous sump and tank
DR-405	Miscellaneous Equipment for Water System	1set	Consist of: Chemical injection system, piping, materials, structure, etc.

9) Personnel

Present operation personnel are as shown below.



SM : Section Manager
FSM : Fellow Section Manager
ASM : Assistant Section Manager
FASM: Fellow Assistant Section Manager
● : Japanese
o : Egyptian

The personnel consist of staff departments of those who are engineers or higher ranking officers and operation departments including assistant engineers or lower class personnel.

The staff department is so arranged that Japanese who were sent under Management Agreement and Egyptian who are counterparts are positioned in parallel. After the technology transfer, those Japanese will return to Japan and the staff will be all Egyptians. At that time, the Japanese management dispatched as Asst. Engineers will also return to Japan.

5-2-4. Steelmaking plant

1) Outline

The steelmaking plant is planned to tap 840,500 t/y of molten steel with 4 70-t EAFs using DRI and scrap and cast 798,500 t/y of billets with 3 CCMs. In 13 months from the start of erection of cranes in April 1985, the plant began operation with 100% scrap charge on May 3, 1986, as scheduled prior to the start-up of DR plant.

The operation of the plant since its start-up has been satisfactory, and as shown in Fig. 5.2.4-1, the production exceeded the planned start-up production and the production of molten steel in February 1987 was 39,759 tons, which was 130% of the planned start-up production.

Billets produced in the steelmaking plant are of medium and low carbon ordinary steel for concrete reinforcing bar of 37 kg and 52 kg classes.

Facilities related to EAFs were supplied by Nippon Kokan and those related to CCMs by Kobe Steel.

2) Outline of facilities

(1) Layout

The layout of the plant is shown in Fig. 5.2.4-2, and the facilities are arranged from east to west so that operation discussed below can be performed smoothly.

Of raw materials, DRI is transported by belt conveyor from the storage bins at DR plant to the storage hopper in the steelmaking plant, from which DRI is charged into EAFs with help of computer control. On the other hand, scrap is loaded by crane with lifting magnet into bucket at indoor scrap yard and the bucket is carried by flat-car to the EAF yard. The scrap is then charged by charging crane into EAFs.

Molten steel melted and refined in EAF is, after ferro-alloys are added by ferro-alloy facilities, tapped into a ladle on a ladle car and after stirred by a stirrer to ensure uniform steel temperature and composition, the ladle is loaded on the turret, from which molten steel is cast into CCM.

Cast billets are piled by crane with lifting magnet on a billet transfer car and sent to rolling plants.

(2) Major facilities

Table 5.2.4-1 shows outline of the major facilities.

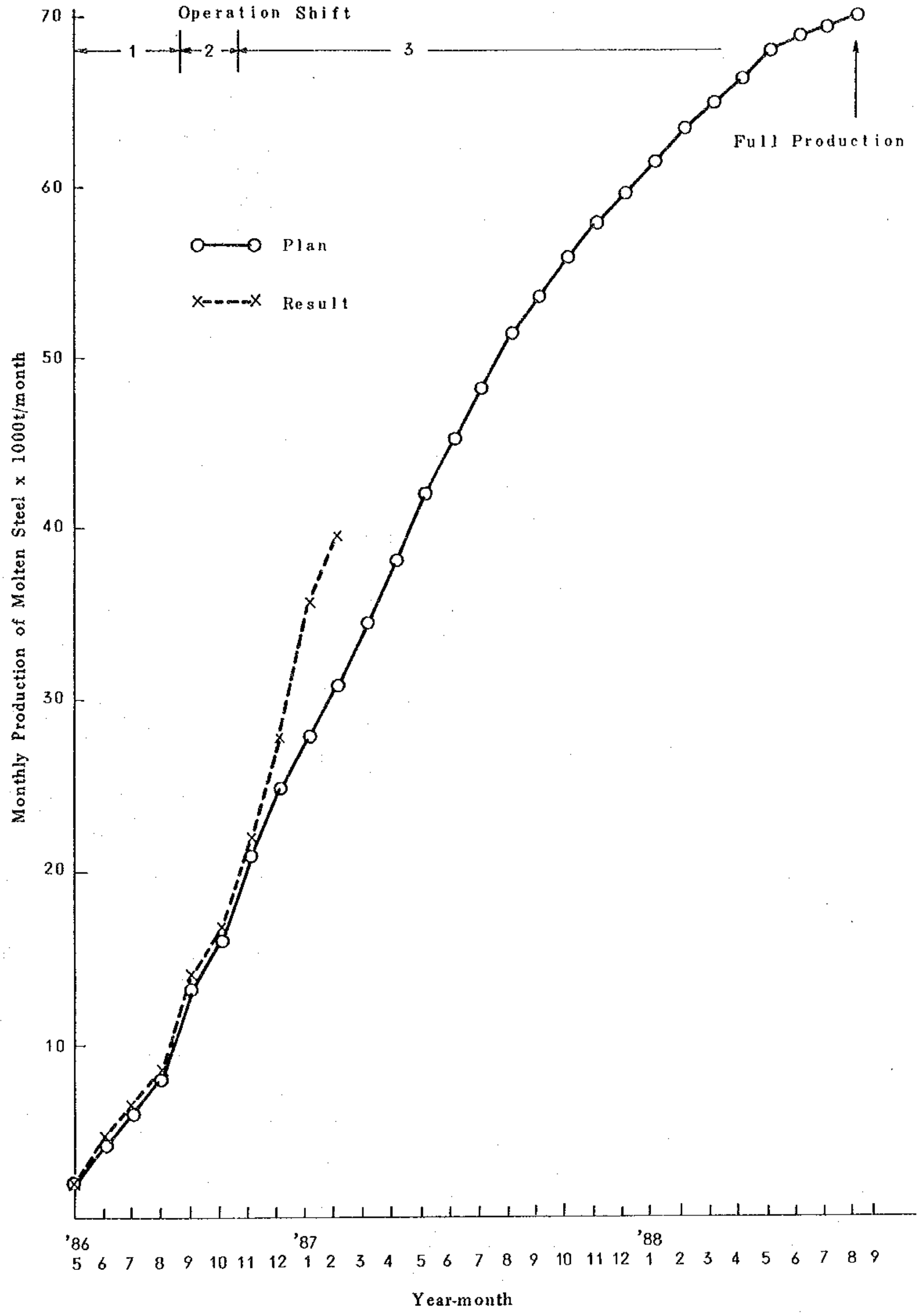


Fig. 5.2.4-1 Learning curve

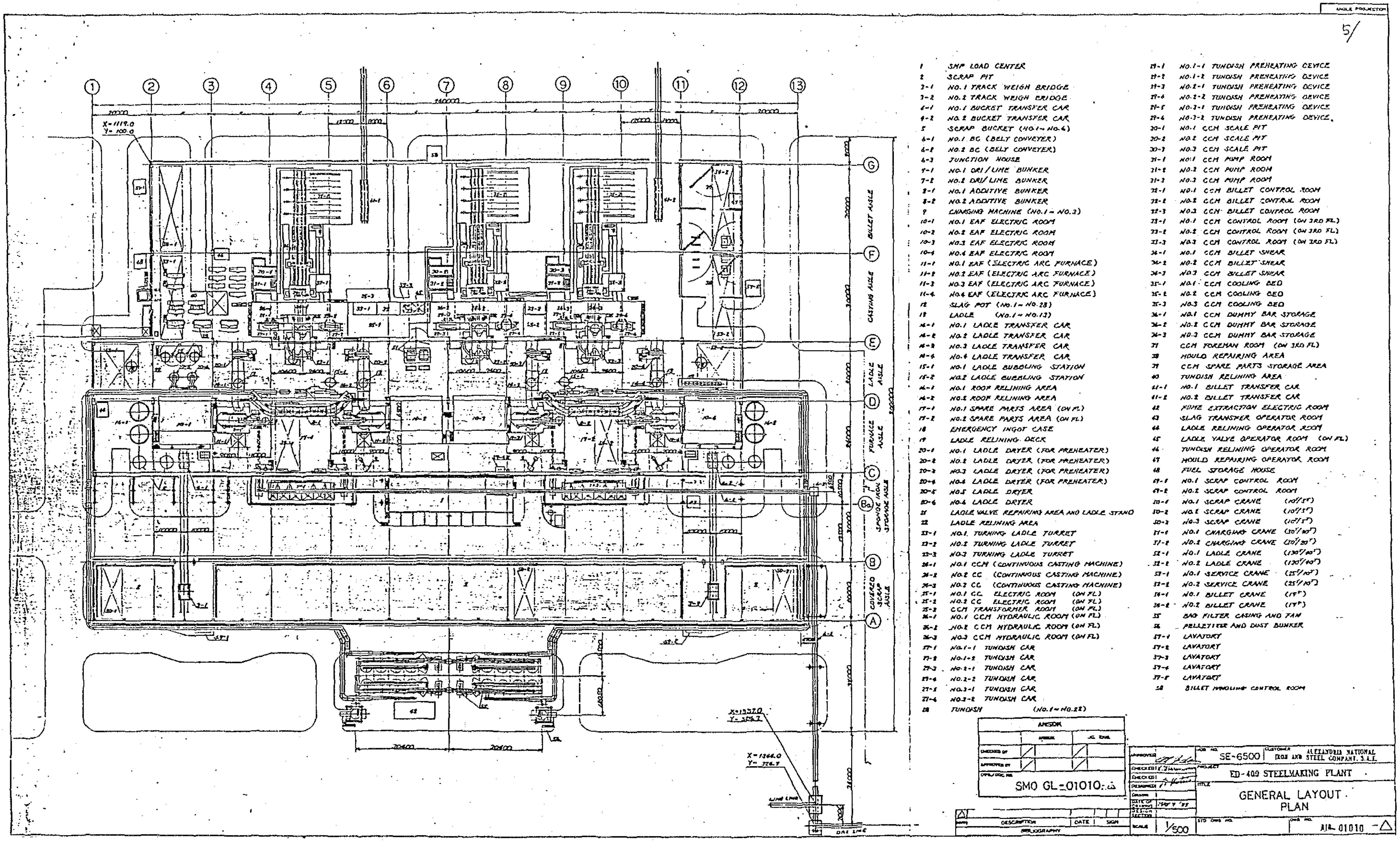


Fig. 5.2.4-2 Layout of the major facilities in SMP

Table 5.2.4-1 Equipment list of SMP

Equipment	Q'ty	Short Description
1. Electric Arc Furnace	4 sets	Type: UHP, non-split shell type Capacity: Nominal 70t, max. 75t Inner dia: 5,800 mm Transformer: Rated 46 mVA, 120% over load Primary voltage: 33kv, 3-phase, 50 Hz Tap voltage: Max. 550V min. 174V Secondary current: 59,680 A Electrode: 20"ϕ for UHP with water cooling pannel for wall and roof
2. Continuous Casting Machine	3 sets	Type: Vertical-bending type, 6 mR Strand: 4 strands Billet size: 130 mm square x 16 m length with turret tundish cars, diagonal cutting shear
3. Scrap Handling Facilities	1 set	Charging bucket: Clam shell type, 35 m^3, 6 sets Track weigh bridge: 100t, 2 sets Bucket transfer car: Electric self-travelling car with wound cabtyre cable type 50t, 2 sets
4. DRI/Burnt Lime Handling Facilities	1 set	Receiving Conveyor line: 250 t/h 1 set with junction, trippers DRI storage hopper: 150 m^3/set, 2 sets/f'ce with weigh feeder Burnt lime storage hopper: 100 m^3/set, 1 set/f'ce with weigh feeder Feeding conveyor line: 70 t/h, 1 set/f'ce
5. Additive Handling Facilities	1 set	Storage hopper: 6 m^3/set 6 set/2 f'ce with scale car Adding device to furnace and ladle: 1 set/f'ce

Equipment	Q'ty	Short Description
6. Molten Steel Handling Facilities	1 set	Ladle: Max. 80t including slag, 13 sets with Rotary Nozzles Ladle transfer car: 130t, 4 sets Bubbling station: Top bubbling of nitrogen gas type 2 sets
7. Slag Handling Facilities	1 set	Slag pot: 10 m^3, 25 sets
8. Preparation and Miscellaneous Facilities	1 set	Ladle dryer: Natural gas combustion, 6 sets Oxygen gas lancing device: 1,000 Nm^3/h, 1 set/f'ce Dry gun: 1 set/f'ce Wet gun: 1 set/f'ce Charging machine: 3 sets Others: Areas for roof relining, ladle relining, tundish relining, mould assembling
9. Fume Extraction System	4 sets	Type: Bag filter and suction type Capacity: 1,900 m^3/min at 90°C Emission limit of dust: 50 mgr/Nm^3 with pelletizer
10. Cranes	1 set	10/5t scrap handling crane with lifting magent: 3 sets 50/20t charging crane: 2 sets 130/40t ladle crane: 2 sets 25/10t service crane: 2 sets 17t billet handling crane with lifting magnet: 2 sets
11. Electrical and Instrumentation Facilities	1 set	Power distribution system consiting of Step-down transformers 2-33 kV/6.9 kV 8/10 mVA 4-6.6 kV/0.4 kV 1.5 mVA 4-6.6 kV/0.4 kV 1.5 mVA Switchgear 1 - 6.6 kV 4 - 380 V

Equipment	Q'ty	Short Description
		Flicker and power factor compenastor consisting of 1 - 33 kV/1,33 kV 52 mVA High impedance transformer 1 - 52 mVA Thyristor controlled reactive power controller 1 - Static capacitor bank 2nd harmonic filter 20 mVA 4th harmonic filter 7 mVA 5th harmonic filter 8 mVA 6th harmonic filter 4 mVA 4 - Static capacitor units 3rd harmonic filter 12 mVA Computer control system consisting of 1 - Central processor panel 8 - Character display 7 - Logging printer 6 - PI/O panel 4 - Computer control desk

3) Outline of operation

(1) Start-up operation

After erection of facilities and cold load test were completed, the first steel was tapped from No. 3 EAF on May 3, 1986, and EAFs were put into start-up operation, one after another, for one week with production of one heat a day, and so soon, in the fourth week, No. 4 EAF could began commercial operation.

(2) Operation performance after the start-up

In early days of start-up, EAFs were operated with 100% scrap charge, but after the start-up of DR plant, the furnaces began operation with DRI.

The operation results after the start-up are given in Table 5.2.4-2.

Table 5.2.4-2 Operation Results after Start-up

Item	PLAN	'86/MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	'87/JAN	FEB
1. Total Heat (ht)	1,001	28	63	89	114	189	231	299	386	490	541
2. Molten Steel (t)	70,040	1,875	4,691	6,540	8,438	14,005	16,584	21,870	27,821	35,661	39,759
3. Molten Steel (t/ht)	70	67.0	74.5	73.5	74.0	74.1	71.8	73.1	72.1	72.1	73.5
4. Billet (t)	66,540	1,576	4,319	6,216	7,913	13,278	16,067	21,197	27,101	34,937	39,030
5. billet (t/ht)	66.5	56.3	68.6	69.8	68.4	70.3	69.6	70.9	70.2	71.3	72.1
6. DRI Ratio (%)	74	-	-	-	-	-	-	-	56.4	79.3	80.4
7. Burnt Lime (kg/t-MS)	61	42.1	35.2	31.0	35.4	33.3	40.8	37.4	35.7	36.8	37.8
8. Steel Yield (%)	87.0	87.9	96.4	96.1	96.3	97.2	94.1	95.8	91.0	90.4	90.9
9. Billet yield (%)	95.0	84.1	92.1	95.0	93.3	94.8	96.9	96.9	97.4	98.0	98.2
10. On-to-Tap (hr-min)	1-54	3-26	2-50	2-22	2-05	2-03	2-00	1-55	1-55	1-53	1-52
11. Electorc Power for EAF (kwh/t-MS)	680	882	592	581	579	545	563	551	673	695	678
12. Electirc Power for CCM (kwh/t-BT)	15	79	32	27	22	17	15	15	15	12	11
13. Electric Power for Auxiliaries(kwh/t-MS)	40	78	81	68	25	36	34	34	39	27	25
14. Electrode (kwh/t-MS)	6	5.9	2.8	5.5	3.7	3.7	4.0	3.7	4.1	3.5	3.8
15. Oxygen Gas (Nm^3/t-MS)	1.5	5.3	2.3	2.0	2.5	1.8	1.8	1.7	0.5	0.3	0.4
16. Sequence Casting (%)	-	21.4	50.8	76.4	87.0	87.8	85.2	95.7	95.3	98.2	99.5
17. Ave.Heats/TD(ht/TD)	-	1.21	1.51	1.76	1.87	1.88	1.85	2.36	2.59	2.89	3.06
18. Strand stoppage Ratio (%)	-	21.4	15.1	3.4	3.9	4.8	2.2	1.6	1.7	1.5	1.2

5-2-5. Rolling mill plant

1) Outline

(1) Basic idea

Rolling mill plant has Bar mill and Rod mill to produce re-bars. Bar mill was started up in July 1986 and Rod mill in April 1987.

Bar mill produces straight bars of 10 mm ∅ - 38 mm ∅ and Rod mill rods in coil of 6 mm ∅ - 12 mm ∅.

Kind of bars includes plain bar (37 kg/mm^2) and deformed bar (52 kg/mm^2), but plain bar accounts for 90% of the market demand.

Production is 745,000 t/y (Bar mill = 425,000 t/y and Rod mill = 320,000 t/y).

(2) Layout

The layout of rolling mill plant is shown in Drawing JICA RMP-001. Bar mill is one strand rolling and this will not change in the expansion.

Rod mill is at present one strand rolling, but the facilities will be expanded for two strand rolling in the expansion.

2) Production plan

(1) Product mix

Table 5.2.5-1 shows product mix of rolling mill plant in full operation of Stage I.

(2) Product yield and by-product

Table 5.2.5-2 shows product yield and by-products. The figures of yield and by-products are based on actual values in January-March 1987.

(3) Unit consumption and consumable

Table 5.2.5-3 shows unit consumptions of natural gas, power, water and compressed air.

Table 5.2.5-4 shows unit prices ($/t) of consumables.

(4) Material flow in Rolling mill plant

Table 5.2.5-5 shows material flow in Rolling mill plant (1st Stage).

3) Personnel

Tables 6.4.5-9, 10 and 11 show comparison of the number of personnel between Stage I and the expansion. Base of working condition of the personnel in Stage I is as follows:

a) Shift system: 3-crew 3-shift
b) Meal : No recess for meal at the same time for all workers
c) Weekly maintenance: One day/week

4) Major facilities

Equipment list of Rod mill is shown in Table 6.4.5-12 and equipment detail in Table 6.4.5-13.

Table 6.4.5-13 shows both Stage I and the expansion so that the contents of the expansion can be compared.

Though no expansion is planned for Bar mill, equipment detail of Bar mill is shown in Table 6.4.5-14 for reference.

Table 5.2.5-1 Product Mix

Size (mm)	Bar mill	Rod mill	Total
6	-	70	70
8	-	152	152
10	77	98	175
12	149	0	149
16	96	-	96
19	53	-	53
22	17	-	17
25	30	-	30
28	3	-	3
Total	425	320	745

(Unit: 1,000 t/y)

Table 5.2.5-2 Yield & By-products

		Bar mill							Rod mill		
		Actual result				Target Ist, expansion stage			Target Ist, expansion stage		
		87/1	2	3	Total	%	Direction SMP	Direction Out Site	%	Direction SMP	Direction Out Site
Billet	t	15,716	19,726	19,750	55,192						
(Products)											
∘Long (12m)	t	14;754	18,653	18,710	52,113						
∘Short (6 ~ 12m)	t	176	235	220	631						
∘Total	t	14,930	18,888	18,930	52,744						
∘Long (12m)	%	93.8	94.5	94.7	94.4	95.0					
∘Short (6 ~ 12m)	%	95.0	95.7	95.8	95.5	96.0		96.0	97.0		97.0
(Scale)	t	389	219	347	955						
	%	2.4	1.1	1.7	1.7	1.5		1.5	1.5		1.5
(Crop)											
∘Crop cut	t		148	206	354						
	%		0.8	1.0	0.9	1.0	1.0		1.0	1.0	
∘Cold shear	t		40	58	98						
	%		0.2	0.3	0.2	0.2	0.2				
∘Less 6m	%		0.3	0.3	0.3	0.3	0.3				
∘Total	%		1.3	1.6	1.5						
(Mis-roll)	t	246	248	260	754						
	%	1.6	1.3	1.3	1.3	1.0	1.0		0.5	0.5	
Grand Total	%					100.0	2.5	96.0 + 1.5	100.0	1.5	97.0 + 1.5

Table 5.2.5-3 Unit consumption (Ist stage)

- 301 d/y = 365 d/y - 50 d/y - 14 d/y
- Natural gas = 9,540 kcal/Nm^3

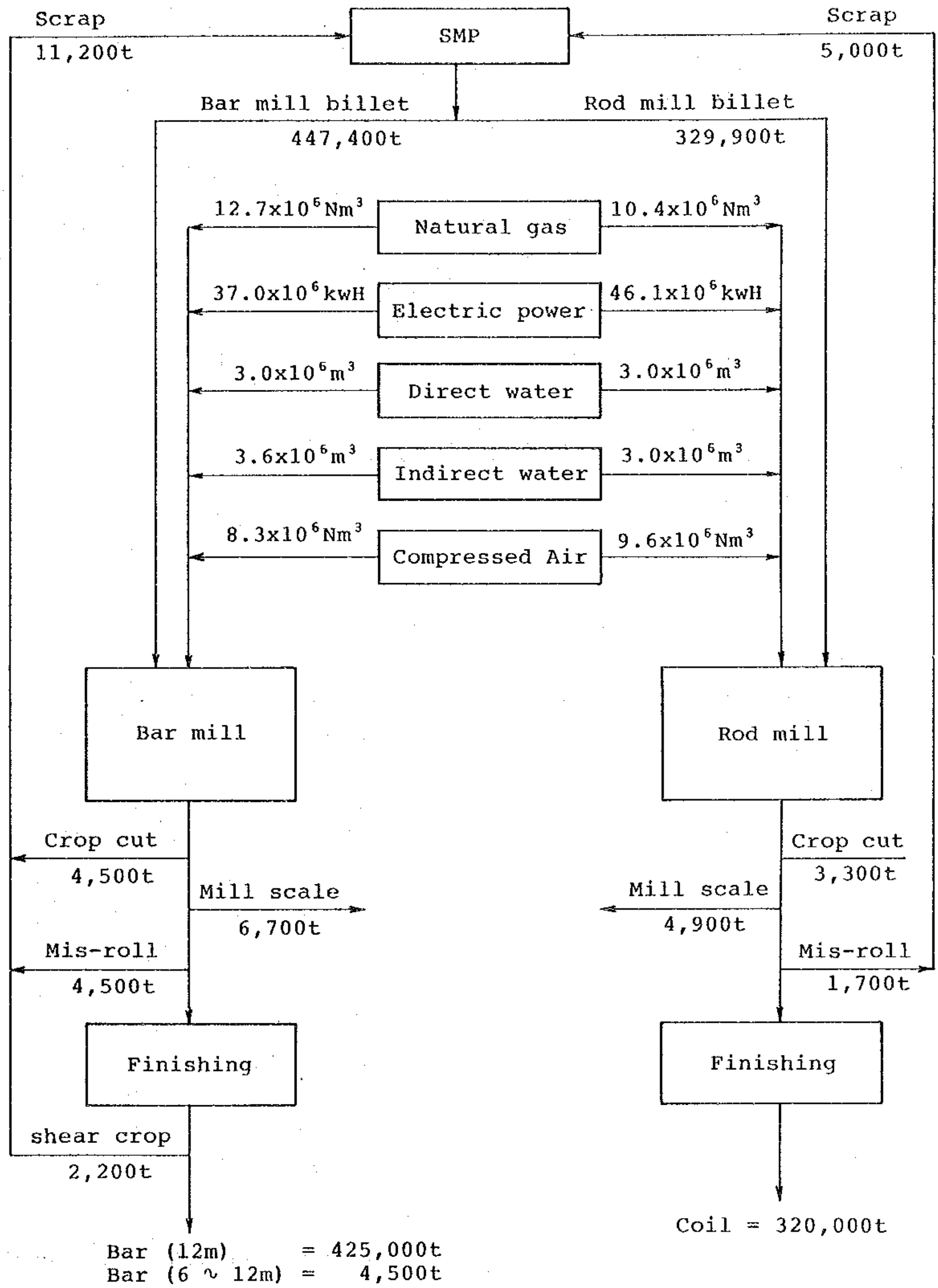
Mill	Item	Unit Consumption		Product Quantity	Consumption Quantity	
					Year	Day
		①		②	①x②=③	③÷ 301
Bar	Natural gas	$27x10^4$	kcal/BT·t			
		28.3	Nm^3/BT·t	447,400 BT·t		
		29.8	Nm^3/Bar·t	425,000 Bar·t	$12.7x10^6$ Nm^3	$42.2x10^3$
	Electric power	87	kwH/Bar·t	425,000 Bar·t	$37.0x10^6$ kwH	$123.0x10^3$
	Direct water	6.9	m^3/Bar·t	425,000 Bar·t	$3.0x10^6$ m^3	$10.0x10^3$
	Indirect water	8.4	m^3/Bar·t	425,000 Bat·t	$3.6x10^6$ Nm^3	$11.9x10^3$
Rod	Natural gas	$30x10^4$	kcal/BT·t			
		31.5	Nm^3/BT·t	329,000 BT·t		
		32.5	Nm^3/Coil·t	320,000 Coil·t	$10.4x10^6$ Nm^3	$34.6x10^3$
	Electric power	144	kwH/Coil·t	320,000 Coil·t	$46.1x10^6$ kwH	$153.2x10^3$
	Direct water	9.4	m^3/Coil·t	320,000 Coil·t	$3.0x10^6$ m^3	$10.0x10^3$
		9.4	m^3/Coil·t	320,000 Coil·t	$3.0x10^6$ m^3	$10.0x10^3$
	Compressed air	30.0	Nm^3/Coil·t	320,000 Coil·t	$9.6x10^6$ Nm^3	$31.9x10^3$

Table 5.2.5-4 Consumable

Unit: $/t of product

	Bar mill	Rod mill
Roll	1.7	2.4
Lubricant	1.0	1.3
Roll guide	1.0	1.2
Binding wire	0.3	1.6
Wasted clothe	1.7	0.7
Label	0.3	0.3
Total	6.0	7.5

Table 5.2.5-5 Material flow in Rolling mill plant (Ist stage)



5-2-6. Lime calcining plant

1) Outline

There is ANSDK lime calcining plant with production capacity of 52,800 t/y. This plant was supplied by Mitsui & Co., Ltd. Contract was signed in July 1984 and erection work began in August 1985. The plant was completed in April 1986 and started up in November the same year.

At present, the lime calcining plant is forced to be operated at a low level to meet the demand for burnt lime by the steelmaking plant.

Maerz process is adopted in the lime calcining plant and the process is known by its high thermal efficiency, high quality of product, easy operation and high turn-down ratio.

2) Capacity

ANSDK LC plant has nominal capacity of 160 t/d and with 330 working days a year, its annual capacity is 52,800 tons.

Since its start-up in November 1986, the production of the LC plant was 50-60% of the above nominal capacity. This is because the production was coordinated to the demand of burnt lime by the steelmaking plant and the LC plant can fully attain the nominal capacity.

In addition, this plant was so designed as to have capacity equivalent to 120% of the nominal capacity and so can produce more than 52,800 t/y if so desired.

3) Raw material

The LC plant uses limestone produced abundantly in the country. At present, the raw stone is being purchased from one supplier, Saami Saad Co. in the suburb of Giza, but it is planned to increase the number of suppliers in future.

Fines produced was expected to be about 10%, but it is now about 15%, a little higher.

4) Operation condition and unit consumption

Table 5.2.6-1 shows operation data of LC plant.

Average production is 87 t/d, about 54% of the nominal capacity of 160 t/d. The reason was already mentioned.

Average Rest CO_2 is 5.83%, which exceeds the standard of 3% max. of LC plant. The reason is believed that, if calcining proceeds too far at low production level, lime becomes sticky. When the production level rises, occurrence of Rest CO_2 will decrease. Incidentally, the present Rest CO_2 level does not pose any problem to the operation of the steelmaking plant.

Unit consumptions of utilities are generally close to the standards except water and compressed air. Once the production level reaches the nominal capacity, it is expected they will come close to the standards.

Table 5.2.6-1 Operation Data of LC Plant

	Unit	Actual	Standard
Production	t/d	87	160
Rest CO_2	%, max.	5.83	3
Limestone	t/t*	1.98	1.93
Natural gas	Nm^3/t	88	98.7
Electric power	kWh	60.8	59
Water	m^3/t	0.006	0.001
Air	Nm^3/t	83.4	45

Note: Average figures from Dec.'86 to Feb.'87

* Figure with fine being 10%

5) Plant layout

The layout of the existing LC plant is shown in Fig. 5.2.6-1.

In the plant, lime calcining kiln sits in the center and raw material facilities are arranged on the east of the kiln and product conveyor on the west towards the steelmaking plant, and product bins also are laid out closer to the steel-making plant.

On the south side of the existing plant is a site for expanded LC plant, but it is being utilized as scrap yard.

6) Process/Plant description

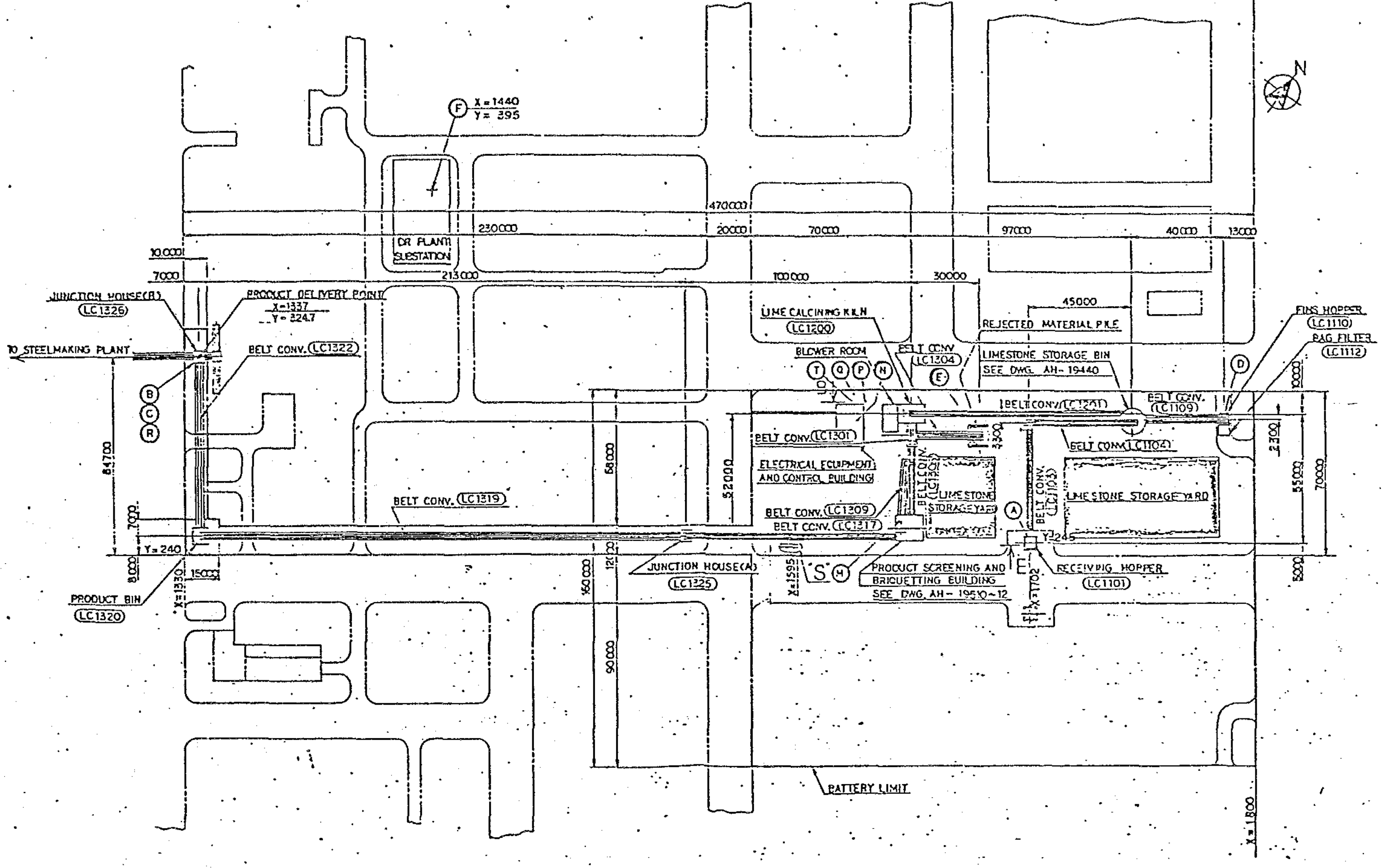
Limestone, raw material of LC plant, is piled open-air at limestone storage yard and transferred by dump truck to receiving hopper. From the hopper, limestone is transported by conveyor to lime storage bin and stored there. The capacity of the lime storage bin is about 3-day's consumption.

Limestone discharged from the bin is screened by 20mm mesh to remove -20mm stone and charged by conveyor into the weigh hopper on the top of the lime kiln.

Limestone is preheated, calcined and cooled in the lime kiln. Heated in the kiln, limestone is calcined to burnt lime by the following reaction.

$$CaCO_3 \longrightarrow CaO + CO_2$$

Lime kiln consists of two towers, which are used for calcining and regenerating, alternately. The cycle of each kiln is about 120 cycles/day. The kiln can be divided to preheating zone, calcining zone and cooling zone from the top. Limestone undergoes the above reaction as it descends in the kiln.



RECEIVING/DELIVERY POINTS

- (A) LIMESTONE FROM STORAGE YARD
- (B) BURNT LIME TO STEELMAKING PLANT
- (C) BURNT LIME TO OUTSIDE (ON TRUCK)
- (D) LIMESTONE FINES
- (E) UNBURNT LIME
- (F) ELECTRIC POWER FROM DR PLANT (NORMAL & EMERGENCY)
- (G) NATURAL GAS
- (H) COMPRESSED AIR
- (J) MAKE-UP WATER
- (K) POTABLE WATER (SUPPLY)
- (M) BURNT LIME FINE FOR DR PLANT (ON TRUCK)
- (N) CONNECTION OF INTRAWORKS TELEPHONE SYSTEM AND PUBLIC ADRESS SYSTEM
- (P) POTABLE WATER (DELIVERY)
- (Q) BLOW DOWN WATER AND DRAINAGE (DELIVERY)
- (R) CONNECTION OF CONTROL SIGNALS FOR PRODUCT DELIVERY EQUIPMENT
- (T) POTABLE WATER (DRAINAGE)

Fig. 5.2.6-1 LC PLANT

As supporting equipment of the kiln, blower for combustion air, natural gas combustion system, hydraulic equipment, dust catcher, etc. are installed.

Burnt lime is discharged from the kiln to conveyor and after weighing, transferred to product screen. The screen separates burnt lime to +40 mm and -5 mm and lumps of +40 mm are crushed by jaw crusher and returned to the product screen. Fines of -5 mm are briquetted by briquetting machine and stocked in the product bin. Burnt lime of 5-40 mm is sent by conveyor direct to the product bin. The product bin can hold about 2-day's consumtion of burnt lime.

Burnt lime discharged by vibrating feeder from the product bin is, after weighing, transferred by conveyor to the steelmaking plant.

Dust collecting facilities are installed at certain places of raw material facilities, lime kiln and product facilities where dust tends to occur. After collected by the dust collector, product dust is briquetted and sent to the product bin.

7) Equipment list

Major equipment of the lime calcining plant is shown in the equipment list on the following pages. They are classified into the following categories.

Raw Material Receiving System
Lime Calcining System
Product Handling System

Table 5.2.6-2 Equipment list of LC Plant

EQUIPMENT LIST PLANT: LIME CALCINING SHOP

NO.	EQUIPMENT	Q'TY	MAIN SPECIFICATION
	RAW MATERIAL RECEIVING SECTION		
LC-101	Receiving Hopper	1	Type : Welded steel construction Capacity : 15 m^3 Size : 3.5 m sq. opening
LC-102	Vibrating Feeder	1	Type : Rotary vibrating Capacity : 100 t/h Size : 600 mmW x 1,000 mmL
LC-103	Belt Conveyor	1	Type : 30° x 3 rollers Capacity : 100 t/h Belt width: 600 mm Horizontal length : 52 m Lift : 15.8 m
LC-104	Single Deck Screen	1	Type : Single deck, low head Capacity : 72 t/h Screening size : 40 mm Screen size : 900 mmW x 1,800 mmL
LC-105	Belt Conveyor	1	Type : 30° x 3 rollers Capacity : 100 t/h Belt width: 600 mm Horizontal length : 46.2 m Lift : 14.1 m
LC-106	Fines Hopper	1	Type : Welded steel plate construction Capacity : 30 m^3 Size : 4 m dia opening x 5.1 mH
LC-107	Conveyor Scale	1	Type : Load cell Capacity : 100 t/h
LC-108	Belt Conveyor	1	Type : 30° x 3 rollers Capacity : 60 t/h Belt width: 600 mm Horizontal length : 98.4 m Lift : 30.1 m

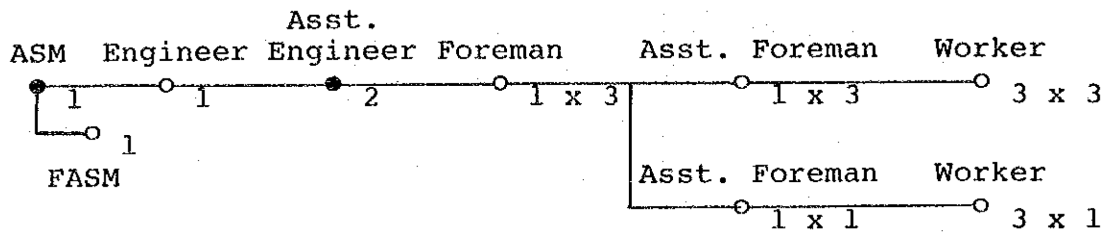
NO.	EQUIPMENT	Q'TY	MAIN SPECIFICATION
LC-109	Submergible Pump	1	Type : Volute Capacity : 10 m^3/h Head : 10 m Size : 50 mm
	LIME CALCINING SECTION		
LC-201	Limestone Storage Bin	1	Type : Welded steel plate construction Capacity : 770 m^3 Size : 9.5 m dia. x 17.1 mH
LC-202	Belt Conveyor	1	Capacity : 10 t/h Belt Width: 600 mm Herizontal Length : 41.2 m Lift : 9.1 m
LC-203	Calcining Kiln	1	Type : Shaft kiln Capacity : Normal 160 t/d Max. 190 t/d Composed of: 1 - Hopper scale 1 - Hydraulic unit 1 - Lime kiln 1 - Primary dust collector 1 - Secondary dust collector
	PRODUCT HANDLING SYSTEM		
LC-301	Belt Conveyor	1	Type : 30° x 3 rollers Capacity : 20 t/h Belt width: 600 mm Horizontal length : 13.2 m Lift : 4 m
LC-302	Damper	1	Capacity : 20 t/h
LC-303	Belt Conveyor	1	Type : 30° x 3 rollers Capacity : 20 t/h Belt width: 600 mm Horizontal length : 32.5 m Lift : 5 m

NO.	EQUIPMENT	Q'TY	MAIN SPECIFICATION
LC-304	Belt Conveyor	1	Type : 30° x 3 rollers Capacity : 20 t/h Belt width: 600 mm Horizontal length : 39 m Lift : 11.9 m
LC-305	Vibrating Screen	2	Type : Double deck Capacity : 20 t/h Size : 900 mm x 1,800 mm
LC-306	Jaw Crusher	1	Type : Single toggle Capacity : 10 t/h
LC-307	Belt Conveyor	1	Type : 30° x 3 rollers Capacity : 20 t/h Belt width: 600 mm Horizontal length : 31.5 m Lift : 7.6 m
LC-308	Belt Conveyor	1	Type : 30° x 3 rollers Capacity : 20 t/h Belt width: 600 mm Horizontal length : 104.9 m Lift : 8.8 m
LC-309	Screw Conveyor	1	Type : Single pitch Capacity : 3 t/h
LC-310	Chain Conveyor	1	Type : Single flow Capacity : 3 t/h
LC-312	Cushion Hopper	1	Capacity : 15 ton
LC-313	Screw Conveyor	1	Type : Single pitch Capacity : 3 t/h
LC-314	Briquetting Machine	1	Type : Double roll Capacity : 2.5 t/h

NO.	EQUIPMENT	Q'TY	MAIN SPECIFICATION
LC-315	Belt Conveyor	1	Type : 30° x 3 rollers Capacity : 20 t/h Belt width: 600 mm Horizontal length : 213.7 m Lift : 10.8 m
LC-316	Product Bin	1	Type : Welded steel construction Capacity : 300 m^3
LC-317	Vibrating Feeder	1	Type : Rotary vibrating Capacity : 200 t/h Size : 800 m x 1,200 mm
LC-318	Belt Conveyor	1	Type : 30° x 3 rollers Capacity : 200 t/h Belt width: 1,050 mm Horizontal length : 76.7 m Lift : 8.1 m
LC-319	Conveyor Scale	1	Type : Load cell Capacity : 200 t/h
LC-321	OHT Hoist Crane	1	Type : Single girder Capacity : 5 tons Span : 10 m Lift : 15 m Control : Pendant switch
LC-322	Dust Collector	1	Type : Bag type Capacity : 470 Nm^3/min.
LC-323	Bag Filter	4	Type : Insertable with turbo fan Efficiency: 99 %

8) Personnel

Present operation personnel are as follows:



ASM : Assistant Section Manager

FASM : Fellow Asst. Section Manager

● : Japanese

o : Egyptian

They are three Japanese dispatched by Management Agreement and 21 Egyptians, totalling 24 persons.

Working condition of operation team is 3-crew 3-shift system.

5-2-7. Utilities

The existing utilities facilities include the following 7 systems and since their start-up in March 1985, they are in continuous operation smoothly without any major trouble of equipment.

- Raw water treatment system
- Recirculation water treatment system
- Sewage treatment system
- Drainage treatment system
- Oxygen, nitrogen & compressed air system
- Natural gas system
- Outdoor fire fighting system

In the following is given outline of each system.

1) Raw water treatment system

Raw water used in the Works is all supplied by Alexandria Water Authority (AWA). The raw water is firstly kept in Raw water basin and treated by filtration and softening devices, and then supplied as industrial water used as make-up water in the recirculation water treatment system and as living potable water to users.

This treatment system has a capacity of 930 m^3/h and consists of the following units.

(1) Filtration unit
(2) Water softening unit
(3) Pumping unit
(4) Chemical injection unit

Flow sheet of this system is as shown in DWG-JICA-UT-001.

2) Recirculation water treatment system

As recycling and treating facilities of cooling water used in steelmaking plant, rolling mill plants, substation and oxygen shop, the following three stations are installed. Flow sheet of this system is as shown in DWG-JICA-UT-001.

(1) Water treatment station - I

This station is installed on the south side of the R.M. section and treats indirect cooling water of R.M. and direct cooling water of R.M. and S.M.P. in separate lines. The station has a capacity to treat 2,000 m^3/h of indirect cooling water and 3,190 m^3/h of direct cooling water and consists of the following units.

a) Sedimentation unit
b) Filtration unit
c) Cooling unit
d) Sludge dehydration unit
e) Pumping unit
f) Chemical injection unit

(2) Water treatment station - II

This station is the facilities for treating indirect cooling water of S.M.P. and has a elevated head tank and a emergency water supply pump used in emergency. The station has a capacity of 7,150 m^3/h and consists of the following units.

a) Cooling unit
b) Pumping unit
c) Emergency water supply unit
d) Chemical injection unit

(3) Water treatment station - III

This station is installed on the south side of Oxygen shop and treats indirect cooling water of O_2 shop and substation. It has a capacity to treat 284 m^3/h of water and consists of the following units.

a) Cooling unit
b) Pumping unit
c) Chemical injection unit

3) Sewage treatment system

This system collects sewage discharged from plants and buildings and treats sewage by activated sludge process. It has a capacity of 500 m^3/h and consists of the following units.

(1) Pumping unit
(2) Pre-treatment unit
(3) Biological treatment unit
(4) Sedimentation unit
(5) Chlorination unit

Flow sheet of this system is as shown in DWG-JICA-UT-002.

4) Drainage treatment system

This system is used mainly for treatment of rainwater in the Works. After treated in sedimentation unit, the water is discharged into the Mediterranean Sea. The system also treats blow-down water from water treatment facilities.

The system has a capacity to treat 1,950 m^3/h of water and consists of the following units.

(1) Sedimentation unit
(2) Pumping unit

5) Oxygen, nitrogen & compressed air system

This system supplies oxygen gas, nitrogen gas and compressed air to plants and includes equipment to refill O_2 cylinders.

The system has a capacity to supply 400 Nm^3/h of oxygen, 550 Nm^3/h of nitrogen and 12,800 Nm^3/h of compressed air and consists of the following units.

(1) Air compressor unit
(2) Freon refrigeration unit
(3) Desiccation and decarbonation unit
(4) Low temperature separation unit
(5) Production distribution unit

Flow sheet of this system is as shown in DWG-JICA-UT-003.

6) Natural gas system

High quality natural gas supplied by EGPC under pressure of about 10 kg/cm^2G is metered at this system and sent to DR plant, Steelmaking plant and others. The system has a flare stack and in emergency it is possible to flare natural gas into the atmosphere.

The system has a capacity to supply 50,000 Nm^3/h of the gas and consists of the following units.

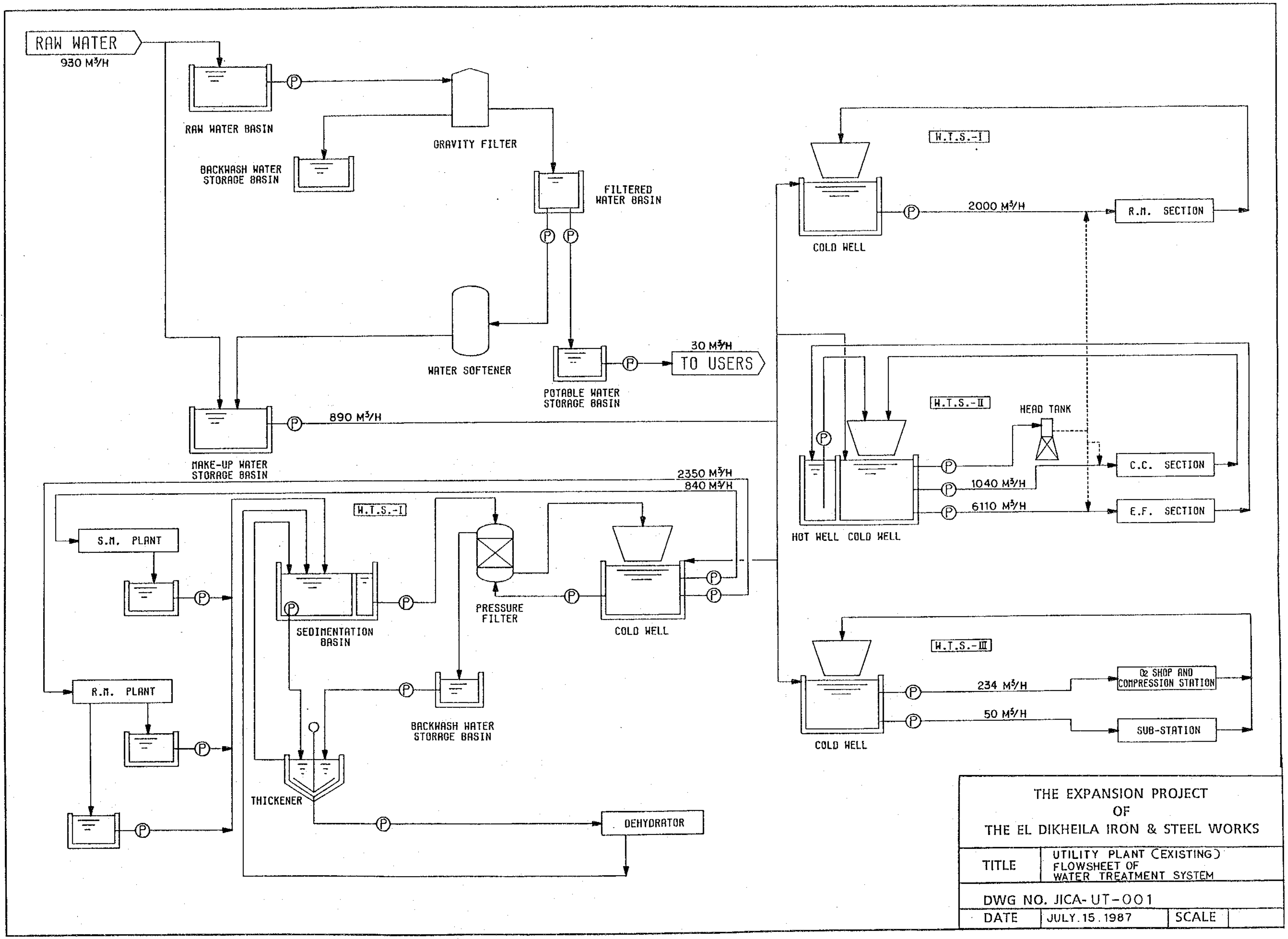
(1) Measuring unit
(2) Flare stack unit

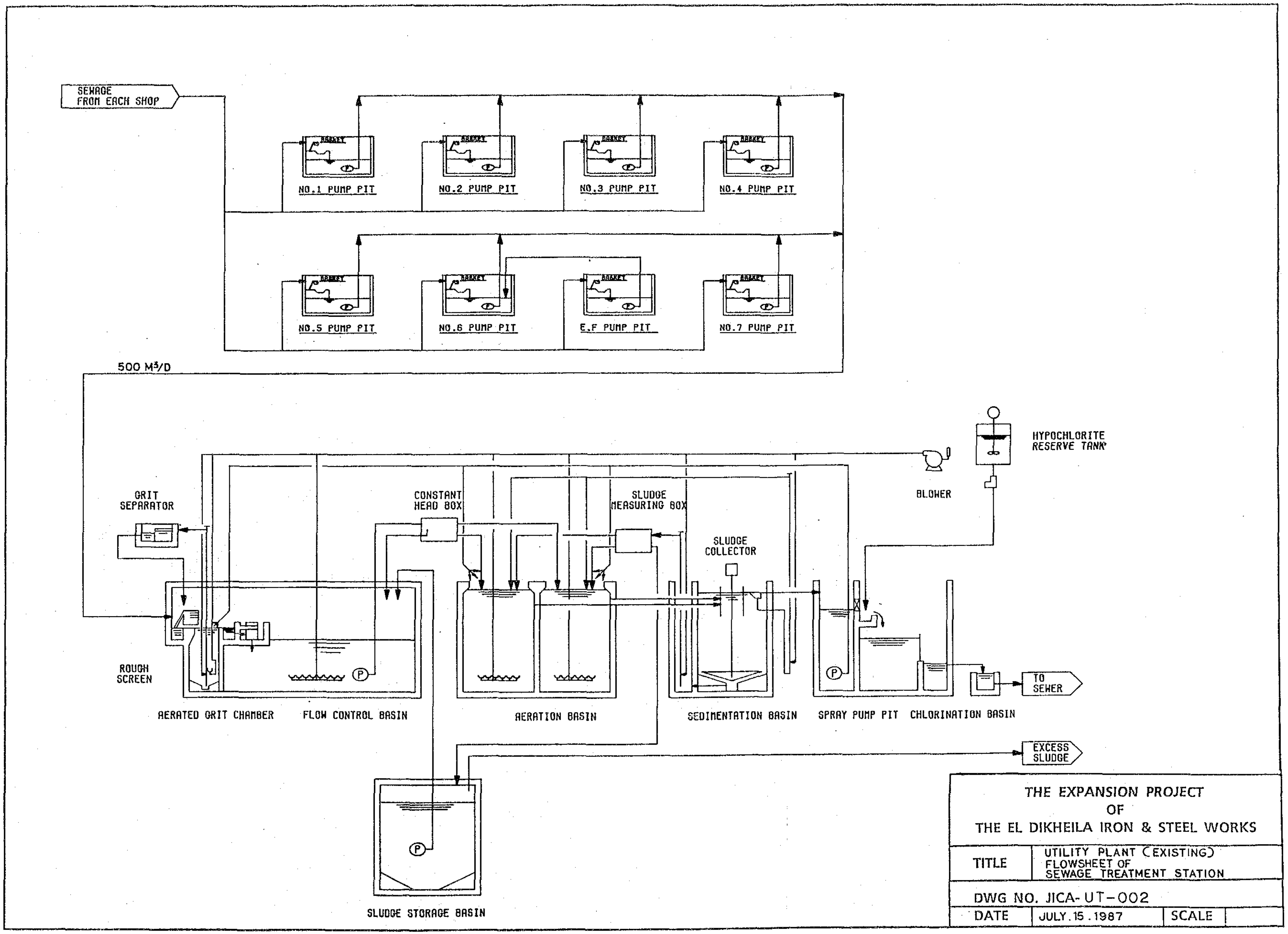
Flow sheet of the system is as shown in DWG-JICA-UT-004.

7) Outdoor fire hydrant system

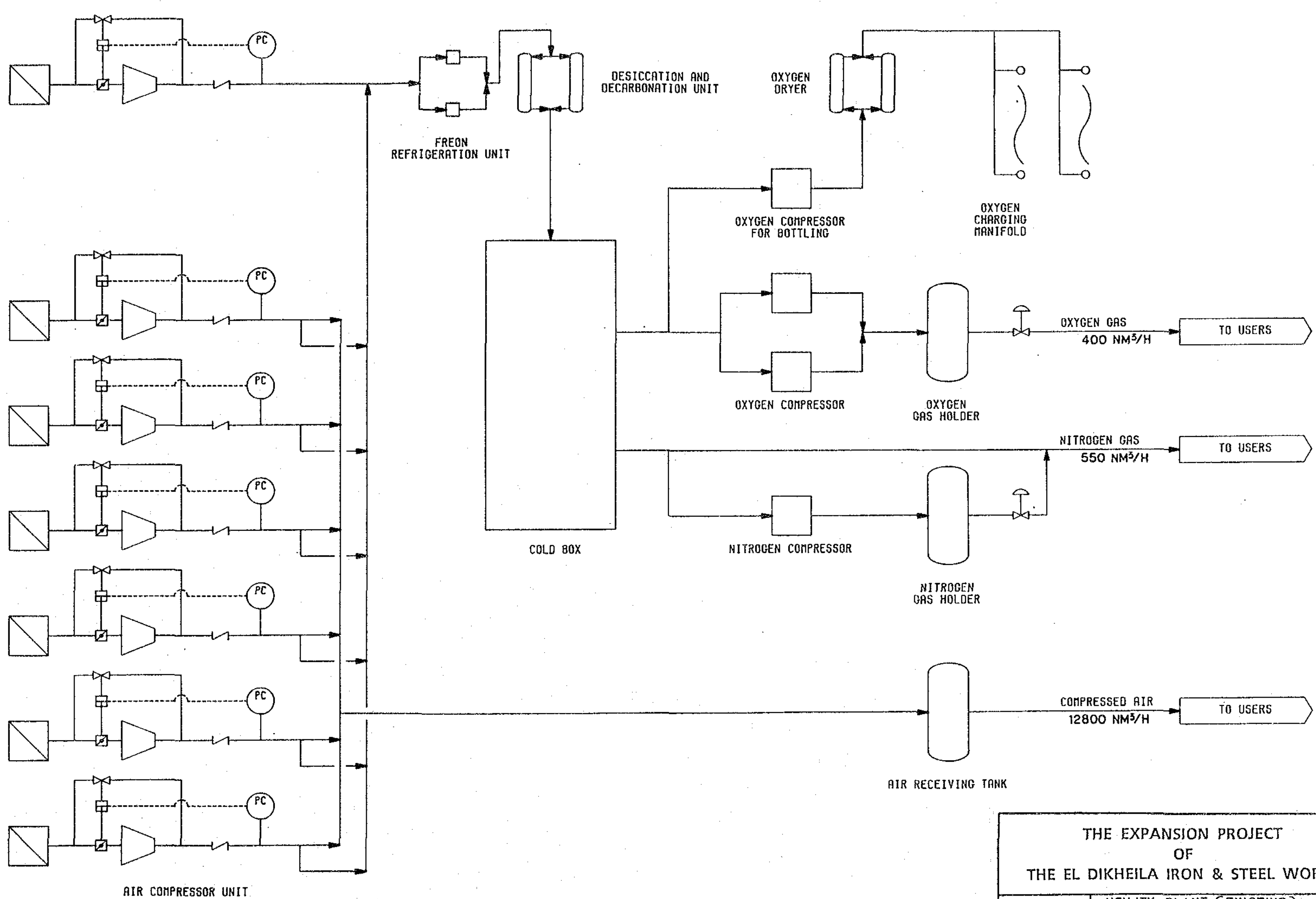
Water supply facilities of this system are placed in Raw water treatment station and use Raw water basin as source of water for fire fighting. When a fire breaks out, the fire fighting water is sent from this system to outdoor fire hydrants for fire fighting. This system has a capacity to supply 240m^3/h of fire fighting water and consists of the following units.

(1) Fire pump unit
(2) Booster pump unit
(3) Hydrant unit


RAW WATER
930 M³/H
RAW WATER BASIN
GRAVITY FILTER
BACKWASH WATER STORAGE BASIN
FILTERED WATER BASIN
WATER SOFTENER
POTABLE WATER STORAGE BASIN
30 M³/H
TO USERS
MAKE-UP WATER STORAGE BASIN
890 M³/H
2350 M³/H
840 M³/H
W.T.S.-I
S.M. PLANT
R.M. PLANT
SEDIMENTATION BASIN
PRESSURE FILTER
COLD WELL
BACKWASH WATER STORAGE BASIN
THICKENER
DEHYDRATOR
W.T.S.-I
COLD WELL
2000 M³/H
R.M. SECTION
W.T.S.-II
HEAD TANK
C.C. SECTION
1040 M³/H
6110 M³/H
E.F. SECTION
HOT WELL
COLD WELL
W.T.S.-III
234 M³/H
O2 SHOP AND COMPRESSION STATION
50 M³/H
SUB-STATION
COLD WELL
THE EXPANSION PROJECT
OF
THE EL DIKHEILA IRON & STEEL WORKS
TITLE
UTILITY PLANT (EXISTING)
FLOWSHEET OF
WATER TREATMENT SYSTEM
DWG NO. JICA-UT-001
DATE
JULY.15.1987
SCALE

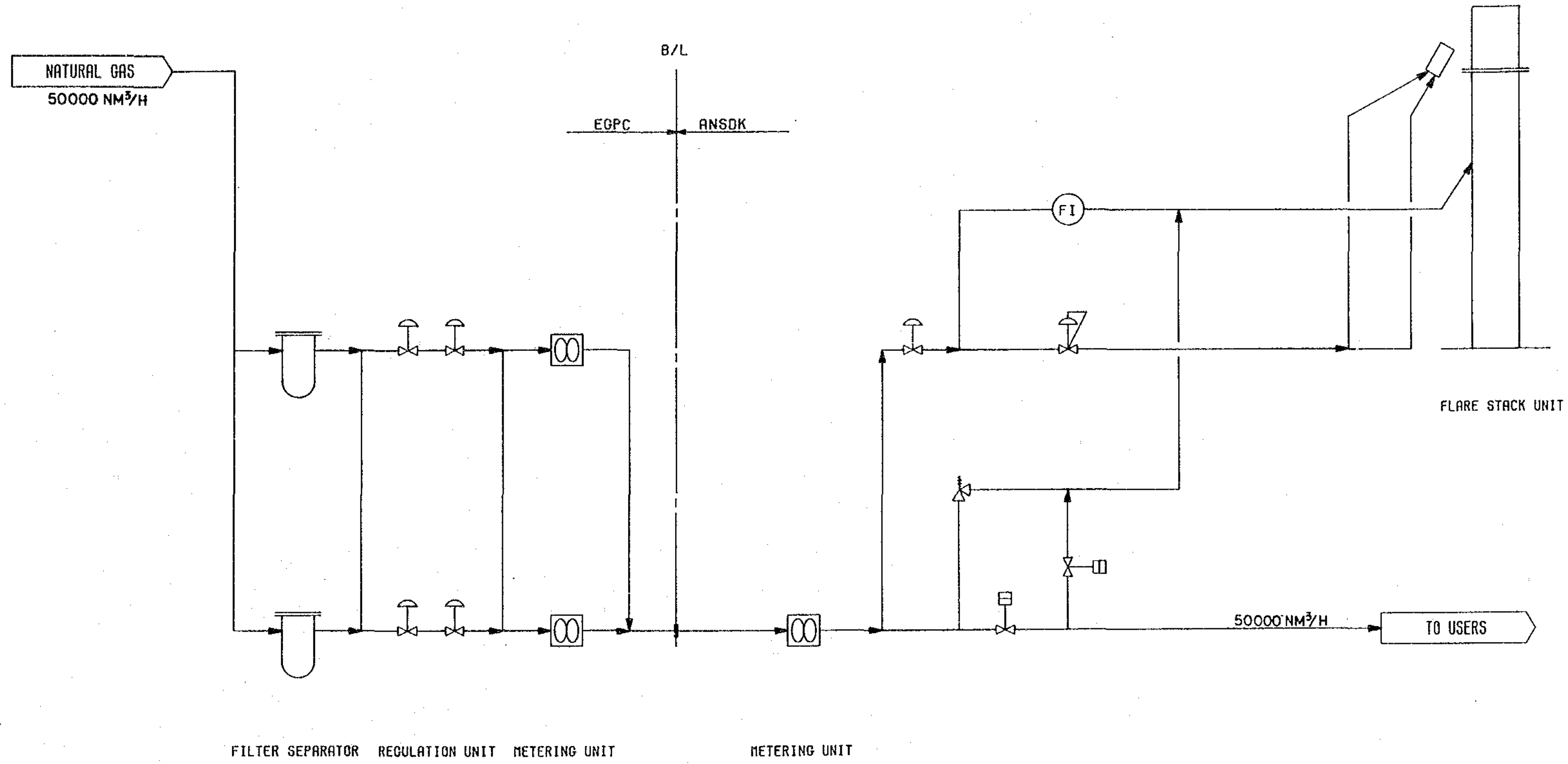


THE EXPANSION PROJECT OF THE EL DIKHEILA IRON & STEEL WORKS			
TITLE	UTILITY PLANT (EXISTING) FLOWSHEET OF SEWAGE TREATMENT STATION		
DWG NO. JICA-UT-002			
DATE	JULY.15.1987	SCALE	



THE EXPANSION PROJECT
OF
THE EL DIKHEILA IRON & STEEL WORKS

TITLE	UTILITY PLANT (EXISTING) FLOWSHEET OF OXYGEN SHOP AND AIR COMPRESSION STATION
DWG NO. JICA-UT-003	
DATE	JULY. 16 .1987 SCALE



THE EXPANSION PROJECT
OF
THE EL DIKHEILA IRON & STEEL WORKS

TITLE	UTILITY PLANT (EXISTING) FLOWSHEET OF NATURAL GAS RECEIVING STATION
DWG NO. JICA-UT-004	
DATE	JULY. 16. 1987 / SCALE

5-2-8. Power receiving and substation facilities

1) Outline

El Dikheila Iron and Steel Works is a mini-mill plant consisting of DR furnace, EAFs, CCMs, Bar mill and Rod mill, and compared with an integrated steel mill based on BF-BOF process, it is characterized by very high consumption of electric power per ton of steel product. Namely, unit consumption of power in the BF based integrated steel mill is generally 400~500 kWh/t, but this Works requires 700 kWh/t for EAFs alone and more than 900 kWh for the entire Works.

This means that stable supply of power is critical for efficient operation of El Dikheila Works. Features of power load can be illustrated by wide fluctuation large power load as EAF and load for which momentary power failure cannot be permitted as DR furnace. To ensure steady and stable supply of power, power system inside and outside of the Works is composed with the following characteristics.

Power is received by two circuit 220 kV system connected to EEA's El Dikheila substation in the vicinity of the Works. Each circuit has capacity to satisfy the load of the entire Works after expansion. El Dikheila Works is connected by 220 kV line with Ameria substation which belongs to 220 kV trunk lines in Egypt. Therefore, the Works depends on the reliability of such 220 kV trunk line network.

Power distribution in the Works begins with branching lines from 220 kV bus and after step-down to 33 kV and 6.6 kV by 4 units of 220 kV/33 kV transformers and 2 units of 33 kV/6.6 kV transformers, the power is distributed to each plant.

Each plant receives power through one or two circuits. Plants receiving power through one circuit have link lines with other plants using the same voltage to prepare against repair or trouble of their power lines.

Needless to say, failure of 220 kV receiving lines will force production stoppage at all plants. Even in such case, however, monitoring facilities, furnace facilities, sewage treatment facilities, etc. require power for the purpose of protection of facilities and men. To ensure power for those loads, 2 units of emergency generators are installed. Separate from the above ordinary power system, 6.6 kV emergency power lines with the 2 generators as power source are installed and security power is distributed to each plant. And after occurrence of trouble, each plant, upon start of the generators, is to switch power from the ordinary source to this emergency source.

2) Equipment list

Table 5.2.8-1 shows a summary of equipment of the substation.

Table 5.2.8-1 Outline of substation (S/S) in ANSDK

No.	System	Principal Equipment and Capacity	Remarks
1.	220 KV System	∘ GIS (Gas Insulated Switchgear) : 2 x Incoming, 1 x Bustie, 4 x Outgoing feeders using GCB (Gas Circuit Breaker) of 245 KV 1250 A & interrupting capacity 40 KA. Enclosed SF6 gas (6 or 4 bar) provides high insulation and interrupting ability. ∘ Main TR (Transformer) : 4 x 80/110 MVA (Natural/Forced cooling) 220/33 KV with on load tap changer. ∘ Fire Fighting Equipment for Main TR : Tank capacity 50 m^3 for water storage 30 m^3 and compressed air (12.5-14 bar) 20 m^3	∘ Maximum reliability, safety and simple maintenance with completely enclosed construction. ∘ Cooling fans run automatically according to loads. ∘ Automatic water spray system.
2.	33 KV System	∘ MCS (Metal-clad Switchgear) : 4 x Incoming VCB (Vacuum CB) 36 KV, 2,400A, 25 KA,/4 x Bustie VCB d.o./ 10 x Outgoing VCB 36 KV, 1,250A 25 KA and 5 x Outgoing GCB d.o. ∘ TR : 2 x 15/18 MVA (Natural/Forced cooling), 33/6.9 KV	
3.	6.6 KV System	∘ MCS : 2 x Incoming and 1 x Bustie VCB, 7.2 KV 2,000 A, 40 KA/15 x Outgoing VCB, 7.2 KV 1,250 A, 40 KA.	
4.	Common System	∘ Supervisory and Control Panel : 1 set to control all equipment ∘ Battery and Charger : 1 set 250 AH ∘ Air Conditioning System : 1 set for GIS, MCS and Control room.	∘ Coupled with Protective Reley Panel ∘ To control the temperature in the dust proof rooms.
5.	Diesel Generators	∘ Diesel Engine : 2 sets x 2,870 PS, V-type, 4 cycle, 1,000 rpm ∘ Generator : 2 sets x 2,500 KVA Brushless excitation, 6.6 KV 6 poles	
6.	Power Distribution Cables	∘ 33 KV x LPE : 1 Core 630 mm^2 x 4,400m, 1C. 300 mm^2 x 9,000 m ∘ 6.6 KV X LPE : 7,300 m	∘ XLPE = Cross Linked Polyethyrene Insulation Cable

5-2-9. Intraworks transportation facilities

1) Outline

Transportation in the compound of the Works includes transport and storing of raw materials, products, by-products and others required for production and sale of about 745,000 t/y of concrete reinforcing bar and also maintenance of transportation equipment and is classified and controlled as given below.

Transportation and purchasing department in charge of:

- Storing, handling and delivery of raw materials and sub-materials
- Control, storing and delivery of materials and spares
- Handling and disposal of wastes
- Control and operation of weighing stations
- Inspection and repair of vehicles

Production control department in charge of:

- Transportation of products from plants to yards and control of products at yards and delivery to users

2) Material transportation flow

Main routes of material transportation flow in the El Dikheila Works are as shown in the following table.

Table 5.2.9-1 Material to be Transported

Material	Route	Weighing
Purchased scrap	Scrap yard -- SMP scrap yard	o
Limestone	Storage yard -- LCP hopper	
Sub-raw material	Warehouse -- SMP	o
SMP refractories	-"-	
Electrodes	-"-	
Product (bars)	B.M.P. -- Product yard	
" (rods)	R.M.P. -- Product yard	
(To be cont'd)		

Table 5.2.9-1 Material to be Transported (Cont'd)

Material	Route	Weighing
Revert scrap:		
CC	SMP & CC -- SMP scrap yard	o
B.M.P.	B.M.P. -- -"-	o
R.M.P.	R.M.P. -- -"-	o
Slag yard	Slag yard -- -"-	o
M.S.	M.S. -- -- -"-	
Mill scale:		
CC	SMP & CC -- Yard	
Rolling mill	R.M.P. -- "	
By-products:		
Oxide fine	DRP -- "	
Limestone fine	LCP -- "	
Briquet	DRP -- SMP scrap yard	o
Wastes:		
Slag	SMP -- Slag yard -- Disposal area	
DRP	DRP -- Disposal area	
Water treat.	Water treat. -- "	
SMP	SMP -- Disposal area	

3) Major equipment

(1) Intraworks transportation vehicles

	Unit
Forklift	12
Wheel loader	8
Crawler shovel	5
Hydraulic power breaker	1
Bulldozer	2
Dump truck	38
Semi-trailer	6
Tractor	6
Truck crane	15
Flat deck truck	7
Others	

(2) Warehouse

For brick 8,700 m^2

For spare parts 3,100 m^2

For additives 2,300 m^2

(3) Slag yard 110 m^2 x 2

(4) Car repair shop 1 set, complete

(5) Product dispatch yard 56,600 m^2