4.1.2. Supply source of pellets and lump ore for DR plant

In actual operations of DR plants which do not have captive mines and depend on imported iron ores, the materials from the following sources proved satisfactory.

1) Pellets	:	LKAB (Sweden)
		CVRD (Brazil)
		SAMARCO (Brazil)
2) Lump ore	:	MBR, MUTUCA (Brazil)

The annual capacity and production of the major brands mentioned in the above reached 13 million tons in 1991 & 1992, which are as shown in Table 4.1-2.
Demand of iron ores for DRI has been steadily increasing according to the start-up of new DR plants, while the world steel production and demand for iron ores is rather sluggish.

In response to the increase of demand for pellets, in particular for direct reduced iron (DRI), some of the existing pellet plants are trying to convert their pellet production from BF use to DR use or increase production of pellets for DR use by means of upgrading the quality of pellets as indicated in Table 4.1-2.
For example, CMP of Chile, KUDREMUKH of India and GIIC of Bahrain are making efforts to produce and market pellets for DR use.

Table 4.1-2 Supply of Iron Ore for DR

(Million tons/year)

	Kind	Sales			Remarks
		1982	1985	1991/92	
LKAB	Pellet	1.00	1.90	2.50	
CVRD	Pellet	1.10	2.40	4.00	No.1 Pellet plant (2 mil. t/y) and partly No.2 plant (3 mil. t/y)
SAMARCO	Pellet	0.50	1.60	2.00	One Pellet plant (5 mil. t/y) for both DR- & BF-grade pellets
KUDREMUKUH	Pellet	0.00	0.00	0.80	
GIIC (Bahrain)	Pellet	0.00	0.00	0.60	
MINPECO (Peru)	Pellet	0.30	0.30	0.05	
QCM	Pellet		-	1.00	
CMP	Pellet	-	-	0.05	
FERTECO	Lump	-	-	0.40	
CARAJAS	Lump	0.70	1.20	0.40	
MBR (MUTUCA)	Lump	0.70	1.20	1.40	
Total		4.30	8.60	13.20	

In addition, some mines are planning to expand their supply ability of iron ores or pellets for DR as indicated below:

- LKAB (Sweden) : A new pellet plant with capacity of 4 million tons per year will be operative in 1997.
- MBR/MUTUCA : An expansion plan is under consideration.
- FMO (Venezuela) : A new pellet plant with capacity of 3.3 million tons per year is under construction and will be operative in 1995.

4.1.3. Worldwide trend of DR plant

As shown in Table 4.1-3, the production by DR plants in the world increased rapidly from 2.69 million tons in 1975 to 7.36 million tons in 1980, and since then it showed a steady increase up to 19.37 million tons in 1991.

Among those DR plants, there are many which use iron ores from their captive mines. However, Table 4.1-4 shows the production of DR plants based on iron ores imported from overseas mines. The production of such DR plants based on imported ores is 8.14 million tons in 1991, consuming 12.21 million tons of iron ores.

Table 4.1-3 Worldwide DRI Production

(Million tons)

PROCESS	1975	1980	1985	1987	1988	1989	1990	1991
Midrex HyL Other Gas Based	1.11 1.09 0.26	3.97 2.59 0.43	5.99 3.850 .51	8.33 3.80 0.37	9.05 3.65 0.40	9.81 4.46 0.44	10.84 5.24 0.44	12.07 5.42 0.40
Gas Based Total	2.46	6.99	10.35	12.50	13.10	14.71	16.52	17.89
Coal Based	0.23	0.37	0.81	1.16	1.03	1.29	1.37	1.48
Grand Total	2.69	7.36	11.16	13.66	14.13	16.00	17.89	19.37

(Source:IISI, Midrex)

Table 4.1-4 Import Iron Ore Based DR Plant
(MIDREX and HyL)

(Unit : Million tons)

	Start-up	Rated Capacity	Production (1991)	Remarks
MIDREX				
HADEED (Saudi Arabia)	1982/1983	0.80	1.11	
ACINDAR (Argentina)	1978	0.60	0.45	
QASCO (Qatar)	1978	0.40	0.57	
SGI (Saba, Malaysia)	1984	0.72	0.62	
ISCOTT (Trinidad)	1980/1982	0.84	0.71	
DALMINE-SIDERCA (Argentina)	1976	0.33	0.51	
NHSW (West Germany)	1971	0.40	0.26	
DELTA STEEL (Nigeria)	1982	1.02	0.11	
ANSDK (Egypt)	1986	0.72	0.62	
EBISCO (Libya)	1989	1.10	0.79	
GEORGETOWN(USA)	1971	0.40	0.41	
AHWAZ STEEL COMPLEX (Iran)	1986	1.20	0.55	
Subtotal		8.53	6.71	
HyL PT Kurakatau (Indonesia)	1978/1982	2.30	1.43	
Total		10.83	Actual 8.14	Iron Ore Requirement (x 1.5) 12.21

(Source : Midrex, etc.)

The following are construction plans of DR plants in future.

HADEED in Saudi Arabia has started their operation of a new DR plant with capacity of 0.65 million t/y from January 1992.

Mobarakeh Steel Complex of NISCO, Iran, has already operated a portion of their DR plants (total capacity of 3.2 million t/y) from the end of 1992. NISCO has developed their captive mine and has almost completed the construction of pellet plant in Mobarakeh Steel Complex.

In addition, there are plans of DR plants as follows:

1) Kurakatau Steel (Indonesia)

The existing plant has a nominal capacity of 2.3 million t/y but its effective capacity utilization is no more than 60%. Therefore, it is under implementation to increase the capacity by one million t/y by modernization and expansion.

2) Perwaja Steel (Malaysia)

DR plant with total capacity of 1.2 million t/y is under construction and is planned to be operative at the end of 1993.

4.1.4 Forecast of demand and supply of iron ore for DRI

Although the DRI production has been steadily increasing, the supply of iron ores and pellets for blast furnaces has recently exceeded their demand, but these materials are mostly supplied to blast furnaces compared with DR use. Consequently the price of pellets was reduced largely in 1992 and 1993.

On the other hand, as shown in Tables 4.1-5 and 4.1-6, the world crude steel production since 1973 has remained at a level of around 700 million tons a year, and consequently the world production and demand of iron ores are also sluggish as shown in Table 4.1-5 and Table 4.1-6. The world steel production is not forecasted to increase largely in future, though there may be a change in the regional share and a change in the share among processes such as BF/DR and BOF/EAF. Therefore, in the medium-term and long-term views, the demand and supply condition of iron ores in the world is expected to be relatively stable. Under such circumstances, the demand and supply condition of iron ores for DR could be also stable.

However, as pellets for DR require higher Fe content and other quality better than iron ores for other use, it is necessary to ensure the stable supply of high quality iron ores by long-term (3- to 5-year) contracts with two or three supply sources.

Though the four brands of iron ores aforementioned have proved satisfactory so far, it may be necessary to consider diversification of supply sources after confirming the applicability of other brands through laboratory tests and basket tests for ensuring economic purchase of required iron ores.

Table 4.1-5 World Iron Ore Production (1/2)

thousand metric tons

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Belgium	0	0	0	0	0	0	0	0	0	0
Denmark	0	0	0	0	0	0	0	0	0	0
France	19,670	16,180	15,030	14,480	12,560	11,566	9,872	9,319	8,726	7,438
F.R. Germany	1,314	979	979	1,034	717	247	70	102	84	0
Greece (E: 1986-91)	515	1,300	1,452	1,712	1,500	1,500	1,500	1,500	1,500	1,500 E
Ireland	0	0	0	0	0	0	0	0	0	0
Italy	10	0	0	0	0	0	0	0	0	0
Luxembourg	40	40	0	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	0	0	0	0
Portugal	27	36	36	73	50	30	25	20	20	20
Spain	8,261	7,940	7,961	6,463	6,054	4,492	4,262	4,610	3,012	3,120
United Kingdom	470	384	379	274	289	263	224	32	53	57
E.C. Total	30,307	26,859	25,837	24,036	21,170	18,098	15,953	15,583	13,395	12,135
Austria	3,330	3,540	3,600	3,300	3,120	3,050	2,300	2,410	2,300	2,120
Finland	1,086	1,046	1,040	914	643	648	557	0	0	0
Norway	3,270	3,540	3,840	3,470	3,660	3,140	2,644	2,358	2,081	2,210
Sweden	16,138	13,534	18,122	20,265	20,473	19,707	20,447	21,763	19,877	19,328
Turkey	3,083	3,501	3,958	4,573	4,705	5,213	5,443	4,091	6,155	6,000
Yugoslavia	5,105	5,018	5,315	5,478	6,618	5,983	5,543	4,438	4,132	2,170
Other Western Europe	32,012	30,179	35,875	38,000	39,219	37,741	36,934	35,060	34,545	31,828
Total Western Europe	62,319	57,038	61,712	62,036	60,389	55,839	52,887	50,643	47,940	43,963
Canada	35,592	33,326	39,930	39,798	36,679	36,520	40,409	39,445	35,670	35,961
United States	36,000	38,574	52,097	49,277	39,613	46,992	56,444	57,872	55,468	55,520
Japan	362	298	331	360	293	415	277	251	208	227
Australia (1)	87,694	71,485	89,046	97,447	94,015	101,748	96,084	105,810	115,227	123,453
New Zealand	2,980	2,200	2,290	2,520	2,910	2,580	2,352	2,400	2,298	2,260
South Africa	24,600	16,605	24,647	24,414	24,483	22,008	25,248	29,958	30,291	28,958
Total Industrial Cts.	249,547	219,526	270,053	275,852	258,382	266,102	273,701	286,379	287,102	290,342
Argentina	583	590	572	578	788	844	1,162	1,266	1,266	342
Bolivia (1)							15	14	125	150 E
Brazil	93,147	88,695	111,311	128,200	129,500	134,700	145,040	153,740	15,230	15,060
Chile	5,760	5,170	5,590	5,840	6,326	6,131	7,295	8,112	7,811	8,960
Colombia	470	456	441	455	523	615	615	600	628	650 E
Mexico	8,795	7,888	10,544	8,103	7,581	7,374	7,985	8,120	9,209	7,800
Peru (1)	5,931	4,225	4,031	4,992	5,195	5,567	4,158	3,935	3,307	3,593
Venezuela	11,701	9,449	13,055	14,764	16,207	17,196	18,473	18,052	20,119	19,959
Total Latin America	126,387	116,473	145,544	162,932	166,120	172,427	184,743	193,839	57,695	56,514

Source : IISI

Table 4.1-5 World Iron Ore Production (2/2)

thousand metric tons

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Algeria	3,892	3,684	3,664	3,376	3,359	3,382	3,118	2,748	2,930	3,000
Angola	0	0	0	0	0	0	0	0	0	0
Egypt	2,155	2,007	1,955	2,066	2,013	1,112	2,274	2,493	2,386	2,371
Liberia	18,000	15,410	16,100	16,120	15,600	13,806	12,808	12,300	3,981	1,200
Mauritania	8,210	6,600	9,000	9,203	9,262	9,120	9,762	12,114	11,416	10,190
Morocco	224	252	250	140	200	204	117	126	50	130
Sierra Leone	10	360	420	70	0	0	0	0	0	0
Tunisia	270	313	309	307	310	295	300	280	291	295
Zimbabwe	1,083	1,168	1,226	1,419	1,502	1,437	1,339	1,118	1,256	1,136
Total Africa	33,844	29,794	32,924	32,701	32,246	29,356	29,738	31,179	22,310	18,322
India	42,752	38,089	42,310	44,090	51,169	51,335	49,961	51,434	53,702	56,884
Indonesia	140	120	100	130	160	190	200	200	200	170
Iran				1,000	2,000	3,000	4,300	5,630	5,500	6,180
R.o.Korea	541	553	502	561	525	500	435	422	375	284
Malaysia	400	100	160	182	208	161	209	193	350	380
Philippines	0	0	0	0	0	0	0	0	0	0
Thailand	30	70	70	94	37	97	99	160	130	230
Total Asia	43,863	38,932	43,142	46,057	54,099	55,283	55,204	58,039	60,257	64,128
Total Developing Cts.	204,094	185,199	221,610	241,690	252,465	257,066	269,685	283,057	140,262	138,964
Total Western World	453,641	404,725	491,663	517,542	510,847	523,168	543,386	569,435	427,364	429,306
Bulgaria	1,552	1,803	2,063	1,985	2,179	1,857	1,826	1,613	1,079	594
Czechoslovakia	1,861	1,903	1,869	1,824	1,784	1,798	1,773	1,780	470	445
German Dem. Rep.	41	40	36	0	0	0	0	0	0	
Hungary	214	215	193	184	0	0	0	0	0	0
Poland	49	10	11	12	9	6	6	7	2	0
Romania	2,146	1,987	1,916	2,287	2,431	2,281	2,000	2,000	2,002	1,461
U.S.S.R.	244,410	245,189	247,104	247,700	249,976	250,900	249,737	241,348	236,200	199,300
Total Eastern Europe	250,273	251,147	253,192	253,992	256,379	256,842	255,342	246,748	239,753	201,800
China	107,320	113,660	126,710	137,835	149,450	161,430	167,700	171,854	179,344	190,558
D.P.R. Korea (E)	8,000	8,000	8,000	8,000	8,000	8,000	8,000	9,000	9,500	9,500 E
Total C.P.E.s/E.I.T.s	365,593	372,807	387,902	399,827	413,829	426,272	431,042	427,602	428,597	401,858
World Total	819,234	777,532	879,565	917,369	924,676	949,440	974,428	997,038	855,961	831,164

(1) - dry weight
E - estimate

Source : IISI

Table 4.1-6 Iron Ore Export in the World

thousand metric tons

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Belgium-Luxembourg	0	1	0	15	1	3	7	11	16	13
Denmark	15	12	7	7	5	3	4	2	4	0
France	5,837	5,031	4,752	4,628	4,169	3,740	3,725	3,462	3,347	3,153
F.R. Germany	6	8	3	3	5	6	20	7	4	81
Italy	1	1	0	1	0	0	0	0	0	0
Netherlands	149	14	22	55	49	105	223	127	82	65
Portugal	0	0	2	0	0	2	0	0	0	0
Spain	1,869	1,579	1,973	2,128	1,791	1,991	2,282	1,632	1,633	2,157
United Kingdom	1	1	0	6	1	1	2	2	2	2
E.C. Total	7,878	6,647	6,759	6,843	6,021	5,851	6,263	5,244	5,089	5,471
Austria	0	0	1	0	8	1	0	0	0	0
Finland	0	0	0	0	0	0	0	0	0	0
Norway	2,336	2,946	3,083	2,579	2,532	2,531	1,744	1,987	2,113	2,099
Sweden	12,597	14,279	17,615	18,241	17,137	16,762	17,553	17,464	16,430	15,482
Yugoslavia	21	0	0	0	0	0	0	8	533	...
Other Western Europe	14,954	17,225	20,699	20,820	19,677	19,294	19,297	19,459	19,076	17,581
Total Western Europe	22,832	23,872	27,458	27,663	25,698	25,145	25,560	24,703	24,165	23,052
Canada	27,281	25,528	30,737	32,266	31,008	29,679	30,523	30,222	27,041	29,651
United States	3,229	3,841	5,073	5,114	4,553	5,093	5,285	5,895	3,506	4,045
Australia	75,400	76,900	88,700	88,000	82,600	80,600	98,300	108,100	100,316	112,660
New Zealand	2,299	2,462	2,200	2,120	2,217	1,791	1,464	1,400	1,014	1,403
South Africa	11,356	7,811	11,870	10,226	8,850	8,802	11,503	14,566	17,029	15,827
Total Industrial Cts.	142,397	140,414	166,038	165,389	154,926	151,110	172,635	184,886	173,071	186,638
Brazil	80,444	69,008	87,179	89,394	91,603	95,332	112,815	118,472	113,511	114,103
Chile	5,502	4,719	5,232	4,816	4,846	5,329	6,397	7,741	6,545	7,405
Peru	5,596	4,182	4,091	5,242	4,212	4,430	4,668	4,014	3,306	2,582
Venezuela	6,616	6,245	8,456	9,032	10,027	11,698	12,288	14,435	14,804	13,385
Total Latin America	98,158	84,154	104,958	108,484	110,688	116,789	136,168	144,662	138,166	137,475
Algeria	1,444	1,302	1,051	7	48	13	22	20	18	20 E
Angola	0	100	0	0	0	0	0	0	0	0
Liberia	16,304	15,704	16,870	16,100	13,940	13,510	13,779	12,747	3,887	1,020
Mauritania	7,753	7,402	9,527	9,333	8,929	9,002	10,004	11,138	11,356	10,469
Morocco	0	0	0	0	0	0	80	82	59	0 E
Sierra Leone	0	355	400	80	0	50	20	20	0	0
Total Africa	25,501	24,863	27,848	25,520	22,917	22,575	23,905	24,007	15,320	11,509
India	25,359	22,001	25,696	28,840	32,225	28,981	32,251	33,478	31,585	31,500
Philippines	3,800	3,061	3,990	3,918	3,597	4,202	4,764	4,507	4,849	4,864
Total Asia	29,159	25,062	29,686	32,758	35,822	33,183	37,015	37,985	36,434	36,364
Total Developing Cts.	152,818	134,079	162,492	166,762	169,427	172,547	197,088	206,654	189,920	185,348
Total Western World	295,215	274,493	328,530	332,151	324,353	323,657	369,723	391,540	362,991	371,986
Poland									0	321
U.S.S.R.	42,836	42,805	45,922	43,880	46,168	45,433	43,063	40,788	38,570	27,388
World Total	338,051	317,298	374,452	376,031	370,521	369,090	412,786	432,328	401,561	399,374

E - estimate

Source : IISI

4.2. Steel Scrap and HBI

4.2.1. Scrap supply in Egypt

The domestic supply of steel scrap to the steel industry (mainly mini-mill steel) in Egypt is about 200,000 t/y according to ANSDK and import scrap is gradually increased from 1988 in which ANSDK was put into normal operation as shown in Table 4.2-1.

Table 4.2-1 Import Scrap

Unit:t/y

Year	Import Scrap
1984/85	2,197
1985/86	1,539
1986/87	1,992
1987/88	11,772
1988/89	34,029
1989/90	196,652
1990/91	115,507
1991/92	109,818

Source:CAPMAS

Scrap is mainly imported from Europe such as United Kingdom, Netherlands and Switzerland.

Table 4.2-2 Origin of Import Scrap

Unit:t/y

	1988	1989	1990	1991	1992
USSR		10			
People's Republic of China		14			
USA		26,567	40,503		
Other Countries in Central America		950			
Japan	23				
Foreign Ships	9,268	4,670	471	1,876	718
Alexandria Free Area		318	8		
Port Said Free Area		1,000	1,102	864	43
Suez Free Area	2,200	500			
Hungary			664		
United Kingdom			84,376	36,349	43,572
Federal Republic of Gernamy			15		
France			26,722	19,239	
Netherlands			42,541	43,066	36,828
Investment Corporation	252		250	874	718
Saudi Arabia				3	
Libya				7,938	5,011
Rumania				1,461	3,403
Austria				0	
Sierra Leone				3,837	
Switzerland					19,525

Source:CAPMAS

4.2.2. Scrap procurement in ANSDK

Table 4.2-3 shows the purchased scrap in ANSDK for recent 5 years. Of the purchased scrap, the domestic scrap is about 150,000-200,000 t/y. After the expansion, scrap of 753,900 t/y including home scrap of 65,300 t/y will be required and scrap of about 500,000 t/y should be imported considering that the procurement of more than 200,000 t/y would not be expected in local market. ANSDK should try to purchase cheaper domestic scrap.

Table 4.2-3 Scrap Procurement in ANSDK

Unit:1000 t/y

Year	Domestic Scrap	Import Scrap	Home Scrap	Total
1988	221.6	0	28.3	249.9
1989	206.2	26.5	47.1	279.8
1990	178.4	221.8	41.6	441.8
1991	132.0	210.3	34.4	376.7
1992	152.4	147.6	39.3	339.3

Source:ANSDK
Note:Pig iron is included in purchased scrap.

4.2.3. Worldwide supply of DRI/HBI

1) Present supply source of DRI/HBI

The direct reduced iron (DRI) and hot briquetted iron (HBI) are currently traded internationally in the quantity of 2-3 million tons per year.

The major suppliers of HBI are OPCO in Venezuela and SGI in Malaysia which are merchant HBI plants oriented to export the whole production. In addition, there are several DR plants currently exporting some portion of

Their DR production, though they are originally destined to supply their DR production to the steelmaking shop in their own steelworks.

The merchant HBI/DRI plants existing and under construction are shown in the following list.

(Million tons/year)

· FIOR Venezuela	HBI	0.20	
· CIL(ISCOTT) Trinidad	DRI	0.25	(partly for export)
· SGI Malaysia	HBI	0.65	
· OPCO Venezuela	HBI	0.83	
· VENPRECAR Venezuela	HBI	0.60	(for domestic & export)
· ESSAR India	HBI	1.32	(3 units)
· GRASIM India	HBI	0.75	(under construction)
· NIPPON DENRO			
· ISPAT India	HBI	1.00	(under construction)
· USHA India	DRI	0.75	(under construction)
· OEMK Russia	DRI	0.25	(partly & spot basis)

Note: Indian HBI and DR plants are destined for the domestic market.

2) Worldwide merchant DRI/HBI supply in future

The merchant supply of DRI/HBI is expected to increase according to the growing requirements of low-residual ferrous materials in the world.

In the following areas, merchant HBI plants are being planned.

- Venezuela
- Russia

· Iran
· Bahrain
· India

HBI has started to draw keen interests of worldwide steel mills as pure iron materials with less residual contents because there is an increasing trend of contamination in steel scraps. However, due to the limited supply of HBI amounting currently to 2-3 million tons per year by the existing HBI suppliers such as MINORCA and SGI, the wide international market is on the way of its establishment.

3) HBI procurement in ANSDK

In order to increase the production, ANSDK began to consume HBI by import in 1990 as shown in Table 4.2-4.

Table 4.2-4 HBI Procurement in ANSDK

Unit:t/y

Year	Import HBI
1990	89,900
1991	173,200
1990	132,400

Source:ANSDK

4.3. Limestone

4.3.1. Present situation in Egypt

Egyptian production of limestone in 1990/91 was 18 million m3 (Table 4.3-1) and the production shows an increasing trend recently.

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

Table 4.3-1 Production of Limestone in Egypt

(Unit: 1,000 m3)

Year	Production
1985/86	13,000
1986/87	15,000
1987/88	17,000
1988/89	16,000
1989/90	16,000
1990/91	18,000

Source:CAPMAS

4.3.2. Present situation of ANSDK's purchasing

It is expected presently that ANSDK purchases 103,000 tons of limestone from Arab Quarry Products Co. from April 1992 to March 1993. Arab Quarry Products Co. is located near the desert road connecting Alexandria and Cairo and a little close to Cairo, providing easy access to truck transport.

A part of produced burnt lime, 11,900 tons, was sold to the outside in this period.

ANSDK specifies the properties of limestone required: compressive strength not less than 250 kg/cm2 and CaO content not less than 52.5%. ANSDK studied properties of limestone of other suppliers and confirmed that five brands are qualified.

4.3.3. Present situation of burnt lime and outlook after the expansion of ANSDK

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

ANSDK has calcining facilities with the nominal 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 64,900 t/y, which can be covered by full use of the existing calcining facilities.

Table 4.3-2 Purchasing of Limestone by ANSDK

Year	Purchase		Unit Price (LE/t)
	(t)	(LE)	
1987	60,091	1,012,550	17
1988	65,118	662,877	10
1989	66,885	875,800	13
1990	86,467	1,249,387	14
1991	79,792	1,342,301	17
1992	97,389	1,928,316	20

Table 4.3-3 Selling of Burnt Lime by ANSDK

Year	Purchase		Unit Price (LE/t)
	(t)	(LE)	
1987	1,874	64,155	34
1988	470	35,279	75
1989	728	54,576	75
1990	651	48,825	75
1991	3,930	275,661	70
1992	10,485	810,857	77

4.4. Fluorspar

4.4.1. Present situation and outlook after the expansion of ANSDK

Fluorspar is one of the additives used to improve fluidity of EAF slag.
Purchasing of the fluorspar by steel industry in Egypt is shown in Table 4.4-1.

Table 4.4-1 Purchasing of Fluorspar by Steel Industry

Year	Purchasing(t)
1987/88	1,725
1988/89	1,000
1989/90	1,178
1990/91	1,591
1991/92(estimate)	541

Source:the Ministry of Planning

Very small quantity of it is used at present because slag fluidity is good, and so in 1993 there is no plan to purchase it. It is expected that the consumption of fluorspar at ANSDK after the expansion will be small quantity. They will be purchased from domestic source.

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 imported 15,472 tons of ferro-manganese in 1992 at average unit price of LE 1,742/t as shown in Table 4.5-1.

Table 4.5-1 Import of Ferro-manganese by Steel Industry in Egypt

Year	Import		Unit Price (LE/t)
	(t)	(LE)	
1985	11,016	2,192,000	199
1986	5,371	2,754,000	513
1987	16,415	9,502,000	579
1988	11,770	9,279,000	788
1989	7,962	11,795,000	1,481
1990	17,844	29,382,000	1,647
1991	26,260	54,905,000	2,091
1992	15,472	26,945,000	1,742

Source:CAPMAS

4.5.2. Present situation of ANSDK's purchasing

ANSDK has purchased and consumed the material since 1987 as shown in Table 4.5-2. The sources of the material are France, South Africa and Belgium.

Table 4.5-2 Purchase & Consumption of Fe-Mn in ANSDK

Year	Purchase (t)	Cosumption (t)
1987	8,500	6,500
1988	6,000	10,000
1989	11,000	10,400
1990	11,000	10,600
1991	10,000	10,600
1992	10,000	11,900

Source:ANSDK

4.5.3. Outlook after the expansion of ANSDK

The ferro-manganese requirement of ANSDK after the expansion is expected to be about 15,000 t/y.
Supply source of the material may be import.
As shown in Table 4.5-3, the major supply sources of Fe-Mn for Egypt are France, Switzerland and United Kingdom.

Table 4.5-3 Imports of Fe-Mn of Steel Industry by Country for Years from 1985 to 1992

Country	Quantity(t)
France	42,135
Switzerland	31,991
United Kingdom	26,568
Federal Republic of Germany	4,456
Japan	3,620
Belgium	1,752
Other countries	1,588
Total	112,110

Source:CAPMAS

4.6. Ferro-silicon

4.6.1. Present situation in Egypt

At present, ferro-silicon is produced in Egypt, as shown in Table 4.6-1.

Table 4.6-1 Production of Fe-Si in Egypt

Year	Production(t)
1988/89	26,725
1989/90	40,553
1990/91	41,516
1991/92	39,705

Source:CAPMAS

Export and import of Fe-Si in Egypt is shown in Table 4.6-2.

Table 4.6-2 Export and Import of Fe-Si in Egypt

Year	Export		Import	
	Q'ty(t)	Value(LE)	Q'ty(t)	Value(LE)
1986	-	-	7	7,000
1987	8,853	6,968,000	38	203,000
1988	15,170	16,316,000	162	498,000
1989	14,815	23,349,000	3,149	3,248,000
1990	36,390	45,322,000	826	3,210,000
1991	20,051	39,466,000	1,783	5,809,000
1992	35,406	47,489,000	1,255	4,275,000

Source:CAPMAS

4.6.2 Present situation of ANSDK's purchase and consumption

ANSDK has purchased and consumed the material since 1987 as shown in Table 4.6-3. The source of the material is KIMA Co., Aswan.

Table 4.6-3 Purchase & Consumption of Fe-Si in ANSDK

Year	Purchase (t)	Consumption (t)
1987	3,300	3,000
1988	3,100	3,300
1989	3,700	3,600
1990	4,600	3,900
1991	4,000	4,200
1992	5,300	4,700

Source:ANSDK

4.6.3. Outlook after the expansion of ANSDK

ANSDK will purchase the material about 4,300 tons in 1993, and about 5,400 tons after the expansion.

It can be expected that the domestic supply of ferro-silicon is adequete in quantity and in quality even after the expansion of ANSDK.

4.7. Aluminium

4.7.1. Present situation in Egypt

At present, aluminium is produced in Egypt as shown in Table 4.7-1.

Table 4.7-1 Production of Aluminium in Egypt

Year	Production(t)
1987/88	178,984
1988/89	185,466
1989/90	179,269
1990/91	177,707
1991/92 (estimate)	180,000

Source:the Ministry of Planning

4.7.2. Present purchase and consumption in ANSDK

ANSDK has purchased and consumed the material since 1987 as shown in Table 4.7-2.

Table 4.7-2 Purchase & Consumption of Al in ANSDK

Year	Purchase (t)	Consumption (t)
1987	48	44
1988	142	85
1989	72	116
1990	130	94
1991	41	87
1992	100	86

Source:ANSDK

Aluminium is used only as an additive into ladle prior to continuous casting. Therefore aluminium consumption remains small.

4.7.3. Outlook after the expansion of ANSDK

As the aluminium consumption at ANSDK is expected to be as low as about 160 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

4.8.1. Production of coke and coke breeze in Egypt

Production of coke and coke breeze in Egypt is shown in Table 4.8-1.

Table 4.8-1 Production of Coke and Coke Breeze in Egypt

Year	Production(t)
1987/88	936,000
1988/89	1,034,500
1989/90	1,141,600
1990/91	1,219,330
1991/92	1,234,400

Source:the Ministry of Planning

4.8.2. Present situation of ANSDK's purchase and consumption

ANSDK has purchased and consumed the material since 1987 as shown in Table 4.8-2. The source of it is domestic. ANSDK will purchase the material about 9,300 tons in 1993.

Table 4.8-2 Purchase & Consumption of Coke in ANSDK

Year	Purchase(t)	Consumption(t)
1987	2,500	2,000
1988	3,000	3,500
1989	6,900	6,000
1990	4,800	3,200
1991	4,000	4,100
1992	7,100	7,100

Source:ANSDK

4.8.3. Outlook after the expansion of ANSDK

The coke requirement after the expansion is expected to be about 26,000 t/y. The quality of coke breeze should be carefully checked because of introduction of carbon injection technology to EAF operation after the expansion.

4.9. Graphite Electrodes

4.9.1. Present situation in Egypt

At present, graphite electrodes are not produced in Egypt and are all imported.
The Egyptian steel industry imported 2,127 tons of electrodes in 1992 at average unit price of 7,391 LE/t as shown in Table 4.9-1, and imports of the material by steel industries for years from 1985 to 1992 are shown in Table 4.9-2.

Table 4.9-1 Imports of Graphite Electrodes by Steel Industry in Egypt

Year	Import		Unit Price (LE/t)
	Q'ty(t)	Value(LE)	
1985	4,279	4,079,000	953
1986	348	627,000	1,802
1987	1,946	5,673,000	2,915
1988	1,991	5,617,000	2,821
1989	1,038	4,495,000	4,330
1990	1,745	11,024,000	6,317
1991	2,896	20,101,000	6,941
1992	2,127	15,720,000	7,391

Source:CAPMAS

Table 4.9-2 Import of Electrodes of Steel Industry by Countries for Years from 1985 to 1992

Country	Quantity (t)
Federal Republic of Germany	5,807
Japan	3,665
U.S.A.	1,090
Italy	1,013
Poland	979
Belgium	824
India	705
Others	2,287
Total	16,370

Source:CAPMAS

4.9.2. Present situation of ANSDK

ANSDK has purchased the material from Europian countries, Japan and India.
In 1993 ANSDK is expected to purchase 4,200 tons of graphite electrodes.

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 6000 t/y, and they will have to be all imported from Germany, U.S.A. and Japan.

4.10. Refractories

4.10.1. Production of refractories in Egypt

Production of refractories in Egypt is shown in Table 4.10-1.

Table 4.10-1 Production of refractories in Egypt

Year	Production(t)
1988/89	122,855
1989/90	137,331
1990/91	153,167
1991/92	141,163

Source:CAPMAS

4.10.2. Imports of refractories of steel industry in Egypt

Imports of refractories of steel industry in Egypt for years 1985 to 1992 are shown in Table 4.10-2.

Table 4.10-2 Imports of Refractories of Steel Industry in Egypt

Year	Import		Unit Price (LE/t)
	Q'ty(t)	Value(LE)	
1985	1,758	1,387,000	789
1986	910	1,487,000	1,634
1987	2,844	6,373,000	2,241
1988	2,425	7,618,000	3,141
1989	5,670	9,979,000	1,760
1990	4,539	1,1470,000	2,527
1991	3,121	2,0293,000	6,502
1992	1,462	12,124,000	8,293

Source : CAPMAS

4.10.3. Present situation of ANSDK

At present, ANSDK imports all of refractories for EAF, ladle, tundish and ladle valve from Europe.

4.10.4. Outlook after the expansion of ANSDK

After the expansion, ANSDK will also have to import most of required refractories. However, purchase from domestic source should be increased from economical point of view through experimental test if necessary.

4.11. Dolomite

4.11.1. Present situation in Eqypt

The production of dolomite in 1991/1992(estimated) in Eqypt was 264,043 tons as shown in Table 4.11-1.

Table 4.11-1 Production and Consumptin of Dolomite in Eqypt

Year	Production(t)	Consumption(t)
1987/88	193,325	12,291
1988/89	132,259	12,281
1989/90	227,268	10,832
1990/91	254,652	11,852
1991/92(estmate)	264,043	11,522

Sourece:the Ministry of Planning

4.11.2. Present situation of ANSDK

ANSDK purchases burnt dolomite from domestic source only. ANSDK's purchase in 1993 is expected to be about 840 tons.

4.11.3. Outlook after the expansion of ANSDK

ANSDK's purchase after the expansion is expected to be about 1000 t/y, which can be obtained stably in Eqypt.

CHAPTER 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 Iron and 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 nominal production capacity is 745,000 t/y of final products and the production reached more than one million tons in 1992.

The idea of El Dikheila Works originated when natural gas fields were found in Ab Qir in the suburbs 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 that 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 (IFC)	3%
Japanese Consortium (JC)	10%

*Members of the Egyptian shareholders

Egyptian General Petroleum Corporation (EGPC)
Executive Organization for Industrial and 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

Organization chart of the company is shown in Fig. 5.1.2-1. The organization comprises 10 departments and 30 sections including the head office of secretary section and public relations department.

The number of employees was about 1,900 at the time of completion of Stage 1 and is about 2,400 at present.

Japanese staff were dispatched under the Management Agreement entered into between ANSDK and JC to assume important positions such as GM (General Manager), FDM (Fellow Deputy General Manager), FDM (Fellow Department Manager), FSM (Fellow Section Manager) and FASM (Fellow Assistant Section Manager) and to transfer production and management technologies. Maximum 155 personnel were dispatched at start-up. In January 1989, as the purpose of the Management Agreement deemed to be achieved, the Management Agreement was switched to the Consultant Agreement and 9 persons are dispatched at present.

Since the start-up of steelmaking plant in May 1986, Works has been smoothly operated without any problem for environmental control and safety to produce in 1992 1.03 million tons which is about 40% increase of nominal capacity. It was confirmed that the managing 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.

Functions of officers are as follows:

CMD (Chairman and Managing Director)

- To present the company
- To have general authority to ensure smooth relation between national policy, implementation of the project and management of the company

- To execute and oversee measures determined at the board of directors

JMD (Joint Managing Director)

- To supervise daily management condition of the company
- To execute buisiness assigned by CMD
- To report the above to CMD
- To act for CMD

GM (General Manager)

- To have authority assigned by CMD or JMD overall employees for the purpose of attaining company's objectives
- To take responsibility for CMD and JMD as to daily management of the company
- To report to CMD and JMD
- To act for JMD
- To attend directors' meeting (without the vote)
- To coordinate work of DMs

Note : Japanese staff is assigned as CGM (Consultant General Manager) for GM for which Egyptian staff is not assigned.

DGM (Deputy General Manger)

- To assist GM as staff (Specific assignment of DGM determined by GM)
- To act for GM when absent. However, any decision is made by GM (GM should designate his acting DGM during his absence).

- To study and report specific assigned work according to the instruction of GM

DM (Department Manager)

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

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 percentage of school attendance is comparatively high. Employment of competent workers is relatively easy. It is said that under such circumstances, ANSDK also obtained generally satisfactory manpower.

At the beginning, the experienced staff and skilled workers were mainly employed and recently, young people who have capability required for performing jobs in future are mainly recruited.

The paper test and interview are applied after the examination of a written application for employment of personnel.

2) Education and training

Education and training was conducted by JC, before and after the start-up of the Works, on the special training under Training Services Agreement concluded between ANSDK and JC and on On-the-Job Training in which employees learn technique by doing jobs in Japan and Qatar. The special training includes 3-month basic education at ANSDK and OJT in Japan and Qatar for about 3 months. In addition to these, ANSDK carried out management education conducted by AOTS of Japan and trainer education to cotinue education and training by ANSDK itself. At present, training for most of employees is carried out by instructors from outside institutions or by those selected from among the higher class employees and trained as per special programs besides refreshing training courses for plant workers.

The following education and training were carried out at the beginning.

a) Basic education

Basic education was given by room lectures in Egypt to engineers and assistant foremen, divided into 11 groups by plant and job. Lectures were given on the outline of the Works, plant, equipment and facilities, operation process, quality and cost control and safety measures for 2 months. About 300 persons received this basic education.

b) Overseas training

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

c) Management education

This is a course for DM class to receive the management education conducted by AOTS of Japan. This education has been continuing and is now also applied to engineer and specialist class.

d) Trainer education

This is an education course to train trainers so that the education and training by ANSDK itself can last. Candidates for the trainer were picked up among those who received the overseas education. The education terminated in June 1987. At present, an education for employees is conducted by the trainer.

3) Welfare

Various programs have been and are implemented to help employees maintain and improve their health and living environment and solve the majority of their social and economic problems.

The housing problem is keen. The company constructed 228 flats adjacent or near to the Works to provide for its key personnel free of charge and 1286 flats have been prepared for employees as their own houses by an interest-free loan from the company. The loan is repayable over a period of 15 years with a grace period of five years. 1500 flats will be constructed further in future.

In order to provide a high level medical care services, the company carries out periodic checkups for all employees, pays all medical expenses for its employees, and established its own health clinic in the Works. In addition, the company contracted with Alexandria Health Insurance Authority and four other hospitals and medial centers.

On the other hand, in 1990, the company started several sporting and picnic programs and rest houses on the seashore are utilized to live a healthy life.

The company established a restaurant inside the Works to provide employees with fresh cooked meals with the company's account of all costs for plant workers and of 70% for the office staff.

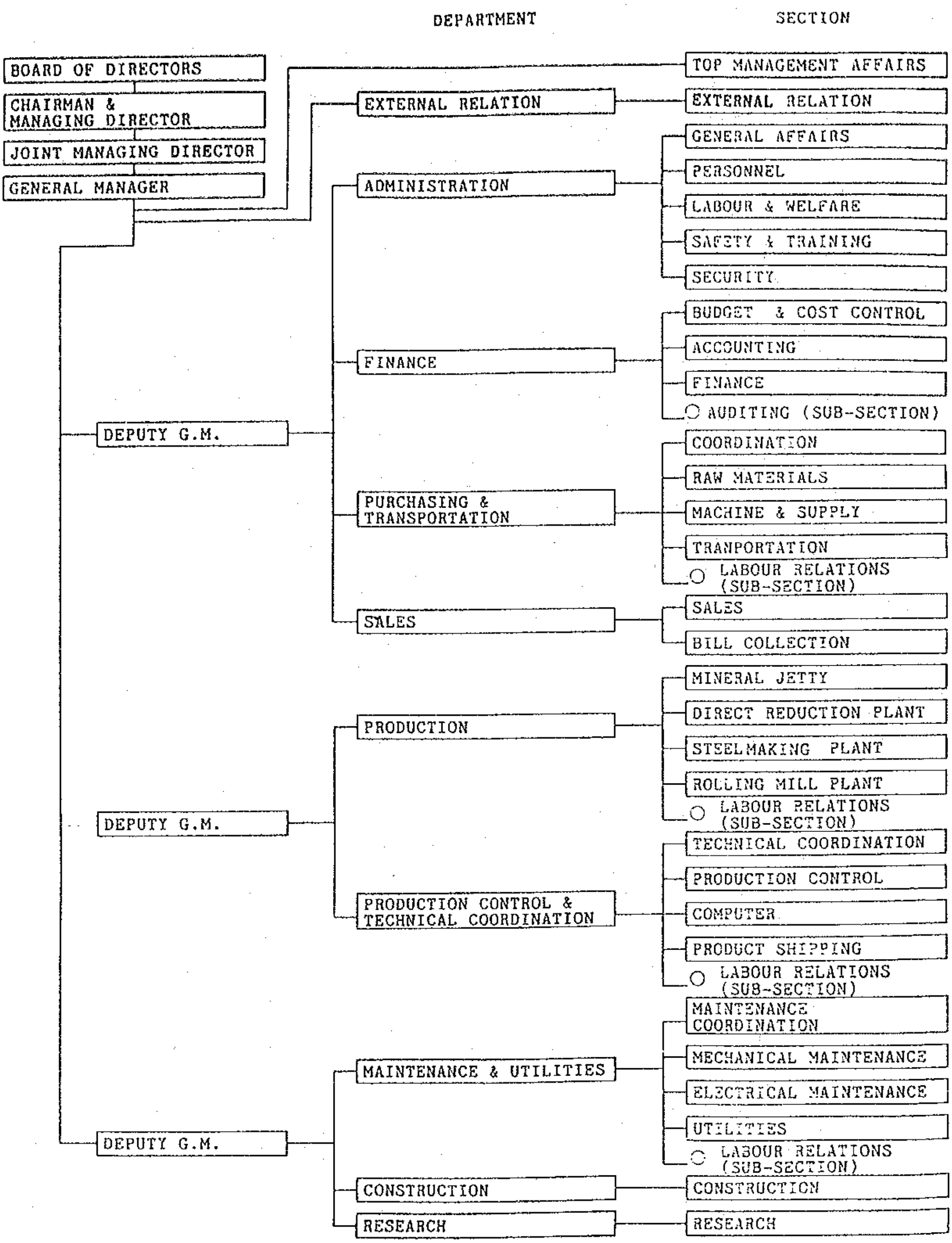


Fig. 5.1.2-1 ANSDK'S ORGANIZATION CHART

5.2. El Dikheila Iron and Steel Works

5.2.1. Location condition

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 3 million. It is also famous as a port city like Port Said.

El Dikheila area selected as the site for the Works is located about 15 km west of Arexandria 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. Dikheila Port is constructed at Dikheila Bay. It is reputed as a site which adequately fulfills requirements of a steel mill. 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 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 El Dikheila substation.

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

5.2.2. Outline of El Dikheila Iron and Steel Works

1) Major facilities

El Dikheila Works produces bars and rods on DRI-EAF-CCM route and major facilities are as outlined in the following.

a) Direct reduced iron plant (DRP)

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

b) Steelmaking plant (SMP)

EAF 70 t/ht x 4 units
Molten steel 840,000 t/y

CCM 4-strand x 3 units
Billets 798,000 t/y

Start-up in May 1986

c) Bar mill plant (BAR)

Bars 425,000 t/y
Start-up in July 1986

d) Rod mill plant (ROD)

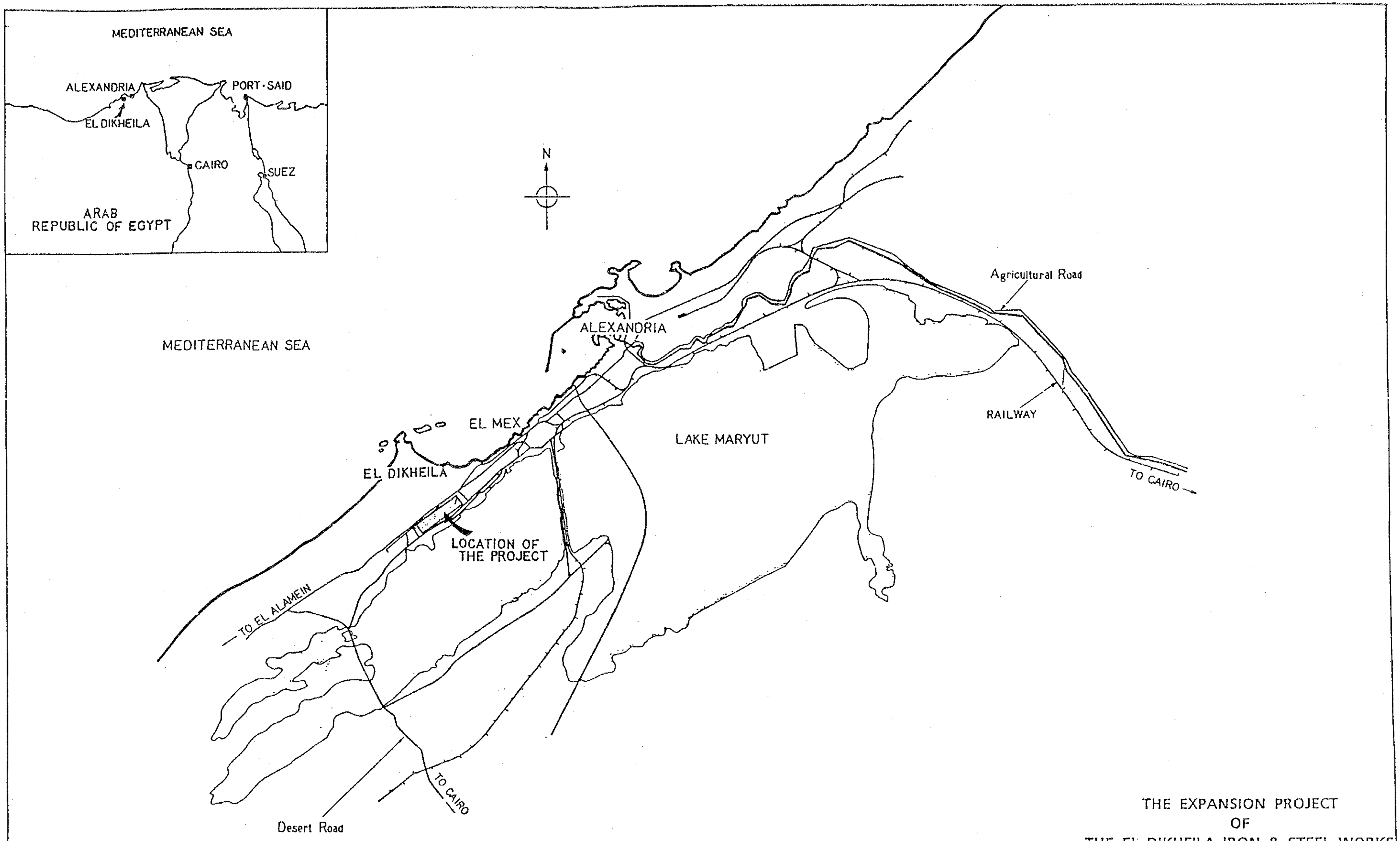
Rods 320,000 t/y
Start-up in March 1987

In addition to the above major facilities, the Works has lime calcining facilities, utilities facilities, power receiving and distribution facilities, in-works transportation facilities, inspection and analysis facilities and offices.

The site of the Works is about one million m2 and all the facilities are laid out rationally in straight line from receiving 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 1992 is shown in Fig. 5.2.2-1.

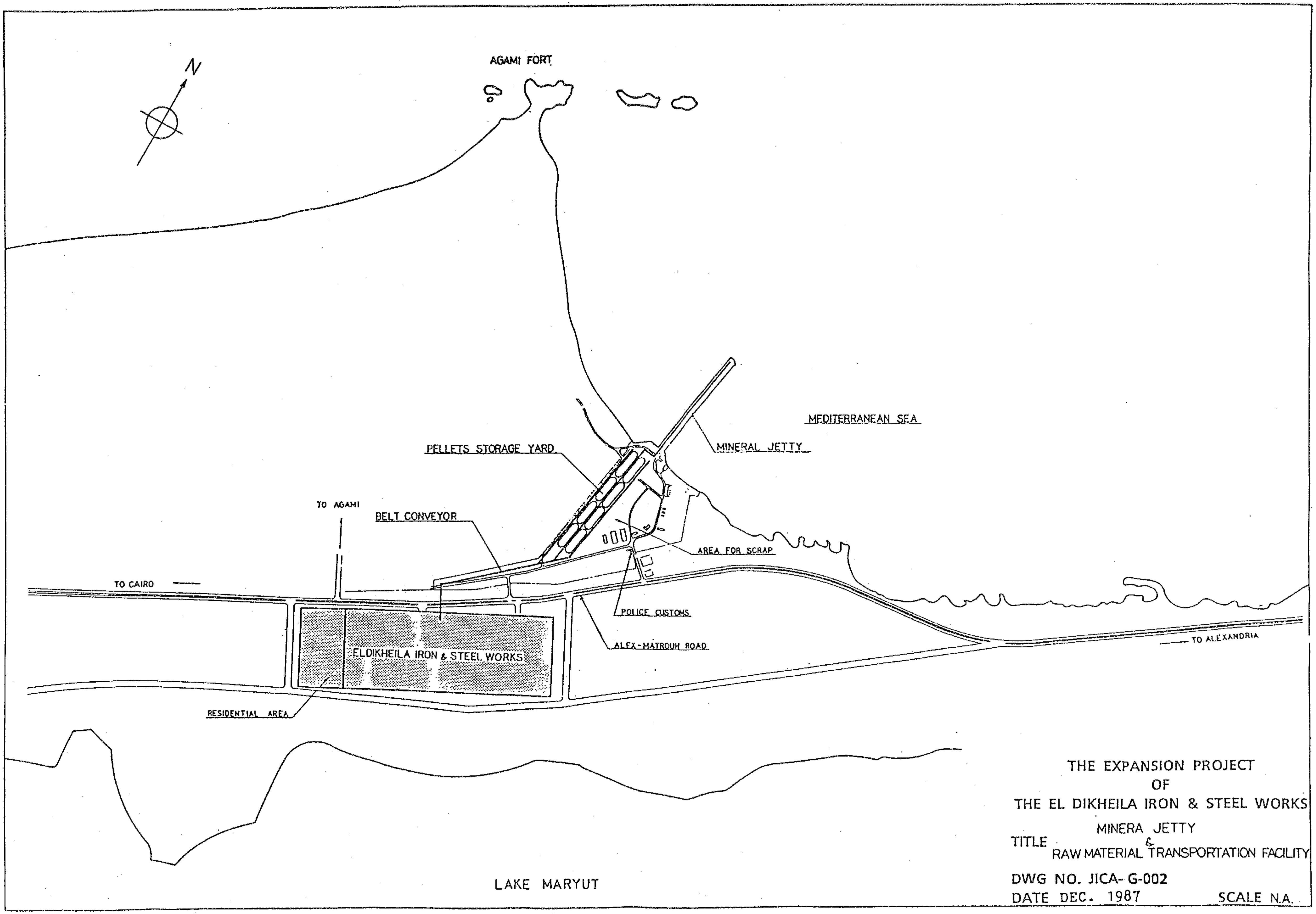


THE EXPANSION PROJECT
OF
THE EL DIKHEILA IRON & STEEL WORKS

TITLE LOCATION OF ELDIKHILA IRON & STEEL WORKS

DWG NO. JICA- G-001

DATE DEC. 1987 SCALE N.A.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AGAMI FORT
MEDITERRANEAN SEA
MINERAL JETTY
PELLETS STORAGE YARD
TO AGAMI
BELT CONVEYOR
AREA FOR SCRAP
TO CAIRO
POLICE CUSTOMS
ALEX-MATROUH ROAD
TO ALEXANDRIA
ELDIKHEILA IRON & STEEL WORKS
RESIDENTIAL AREA
LAKE MARYUT
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.

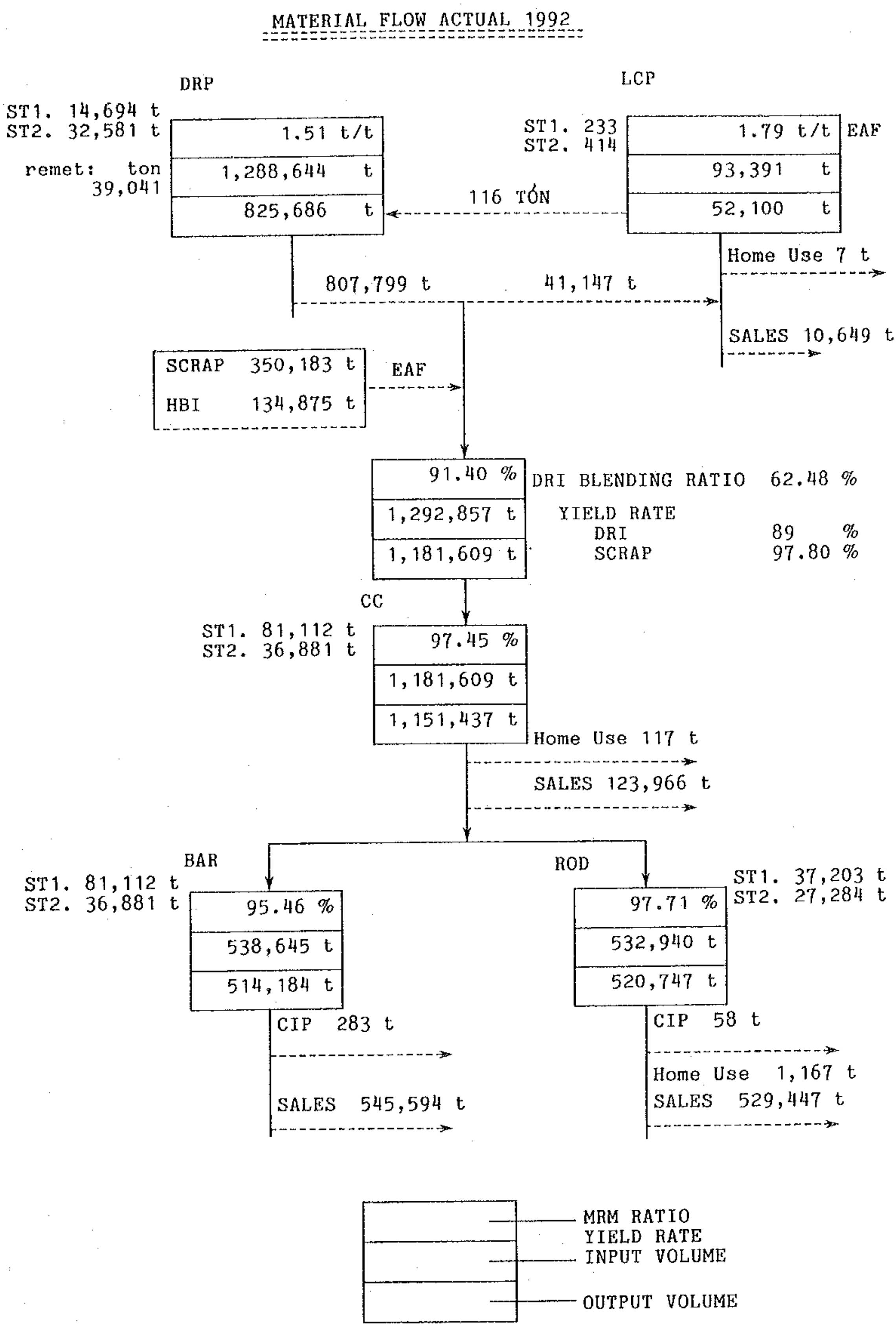


Fig 5.2.2-1 Material Flow in 1992

5.2.3. DR plant (DRP)

1) Outline

ANSDK installed one DR plant on MIDREX process, which was supplied by Kobe Steel, Ltd. The contract was signed in March 1984, its erection work was commenced in September 1985, the construction was completed in October 1986 and the plant started up in November 1986.

2) DR process

The existing DR plant uses natural gas basis MIDREX process because of its reliability.

3) Capacity

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

4) Operational condition and unit consumption

The DR plant is operated with three brands of pellets (LKAB, CVRD and SAMARCO) to produce desired quality of DRI.

Table 5.2.3-1 shows current 6 months operation data, ie from September 1992 to February 1993.

Average production per hour is 100.4 t/h, which is about 108 % of the nominal capacity.

Average metallization throughout this period is 92.9 %, which is more than the standard value of 92 %.

Average carbon content throughout this period is 1.47%, which is slightly less than the standard value of 1.5 %.

Table 5.2.3-2 shows current 6 months result of unit consumption of materials and utilities, ie from September 1992 to February 1993.

Average unit consumption of raw material is 1.54, which is based on the following calculation formula:

Unit consumption = (Pellets without fines +
Lump without fines +
Oxide middle fines +
Oxide fines) /
(DRI pellets + Briquettes +
Cluster + Fines)

The amount of the remet is not included in this calculation because it is reused for furnace feed.

All the other unit consumptions of electric power, natural gas, nitrogen gas, compressed air and water are lower than design base.

Table 5.2.3-1 Current Operation Data of DR Plant

	Monthly Data						Average
	Sept.'92	Oct.'92	Nov.'92	Dec.'92	Jan.'93	Feb.'93	
Production (Ton/month)	60,349	68,716	67,120	74,248	69,505	52,584	65,420
Operation days (Day / month)	25.4	29.3	27.9	30.1	28.7	21.6	27.2
Production hours (Hour / month)	608.7	702.2	668.8	723.1	689.9	518.2	651.8
Productivity (Ton / hour)	99.1	97.9	100.4	102.7	100.8	101.5	100.4
Product quality:							
Metallization(%)	93.5	93.0	92.8	92.8	92.7	92.9	92.9
Carbon(%)	1.48	1.40	1.38	1.46	1.54	1.57	1.47

Table 5.2.3-2 Current Unit Consumption of DR Plant

	Monthly Data						Average
	Sept.'92	Oct.'92	Nov.'92	Dec.'92	Jan.'93	Feb.'93	
Oxide material (Ton / ton-DRI)	1.61	1.47	1.50	1.51	1.53	1.61	1.54
Natural gas (Nm3 / ton-DRI)	295.6	288.2	279.1	276.1	282.8	290.1	285.3
Electric power (kWh / ton-DRI)	110.6	98.2	102.6	103.3	102.5	109.5	104.5
Water (m3 / ton-DRI)	1.7	1.7	1.5	1.3	1.3	1.4	1.48
Air (Nm3 / ton-DRI)	6.8	6.0	5.5	5.3	7.0	11.7	7.1
Nitrogen (Nm3 / ton-DRI)	2.4	2.9	3.0	2.5	2.8	3.3	2.8

5) Existing plant layout

Although several modifications have been executed within a few years since plant start-up in 1986, after that there is almost no change in view of plant layout (shown in Fig. 5.2.3-1) except the following:

- New refrigerant unit : Installed at the north of purge gas tank
- New liquid caustic soda tanks : Installed at the west of chemical dosing station building

6) Process/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.

a) 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 primarily uses 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

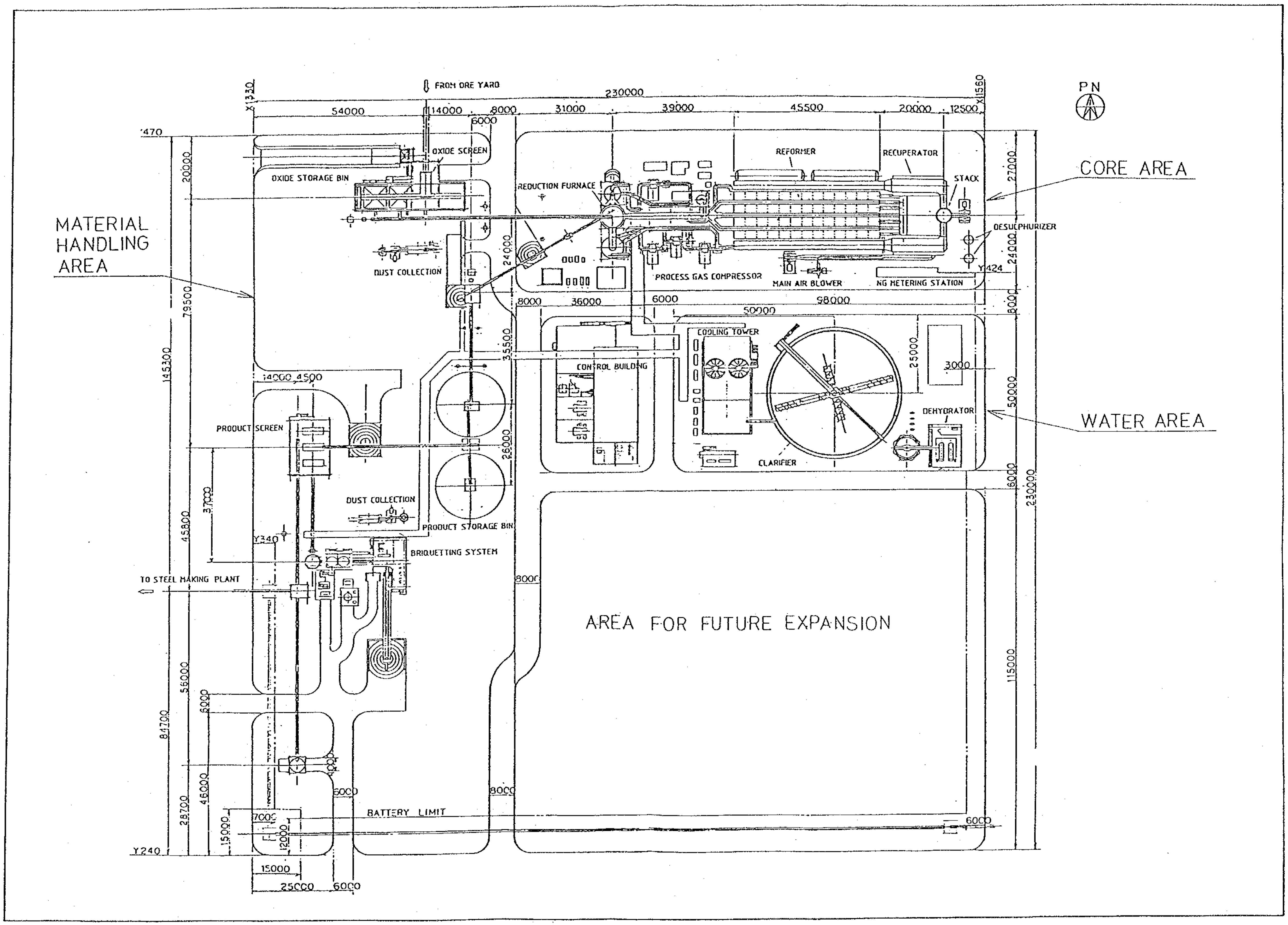


Fig 5.2.3-1 DR PLANT

oxygen for the conversion of methane to 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 scrubber. The cleaned, cooled gas is pumped to the reformer by the process gas compressors, then 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.

Cooling gas in a separate closed loop 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 measuring device. The oxide feed flows into the furnace through charging tubes installed underneath the hopper.

b) Fundamental chemistry

(1) Reduction

Most of natural iron oxide is formed as Fe2O3 and contains about 30% oxygen by weight. In the MIDREX process, oxygen in the iron oxide reacts with carbon monoxide (CO) and hydrogen (H2) in the reducing gas to form metallic iron (Fe), carbon dioxide (CO2), and water vapor (H2O). The overall reduction reactions are:

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$
$$Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_2O$$

An important property of the reducing gas is the reductant/oxidant ratio. This ratio indicates 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:

$$\text{Reductant/oxidant ratio} = \frac{\text{Moles}(CO_2 + H_2)}{\text{Moles}(CO_2 + H_2O)}$$

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

$$\text{Degree of metallization, \%} = \frac{\text{Weight of metallic iron}}{\text{Weight of total iron}} \times 100\%$$

The MIDREX plant production rating is based on the degree of metallization of 92%, and it can be operated from 90% 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.

(2) Reforming

In the MIDREX reformer, natural gas is reacted with

CO_2 and H_2O and reformed to reducing gas rich in CO_2 and H_2. The important reforming reactions are:

$$CH_4 + CO_2 \rightarrow 2CO + 2H_2$$
$$CH_4 + H_2O \rightarrow CO + 3H_2$$

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.

- In steam reformer, H_2O content in feed gas is usually between two and three times that necessary for complete hydrocarbon conversion. H_2O content in feed gas 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 existing 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.

(3) Carburization

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:

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

Most iron- and steelmaking process requires 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.

c) 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 preheater, 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 CO2 and some H2O.

The reforming of natural gas with CO2 and H2O 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 preheated air, 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 650°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 and seal gas coolers, settling pond, 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 is cooled in a cooling tower.

For dust collection in the oxide handling system and the product handling system, wet scrubbers are provided with cyclones.

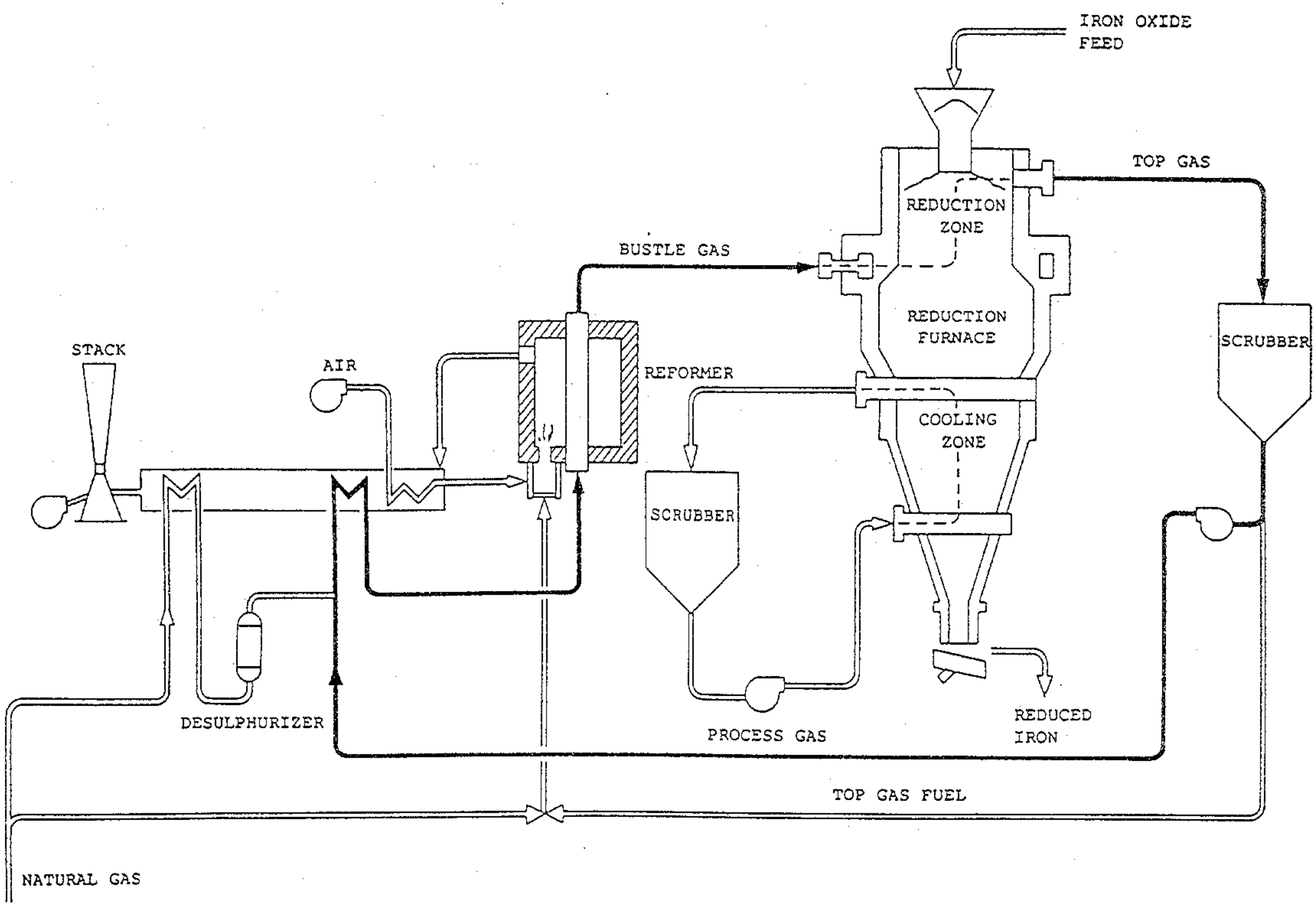


Fig. 5.2.3-2 Flowsheet of MIDREX DR Process

d) Description of the plant

(1) 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 should be eliminated before 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 depending upon reduction furnace operating condition.

The -3 mm oxide fines should not be charged to reduction furnace, thus to be sold to the outside such as cement plant.

(2) 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 point 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, cooled and scrubbed to remove entrained dust, compressed, and then returned to the reformer for recycling. The reduction reactions are as described in paragraph 6) b)-(1).

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.

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-contact 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) if an emergency or long shutdown requires 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).

(3) Product handling system

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

The +50 mm over-size material is discharged to the cluster pile by means of a grizzly. A sampler is installed to take samples of the metallized material 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 7,500 t 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 eliminates -3 mm product fines, which are transportated into the product fines bin via a belt conveyor and a bucket elevator, and the fines are used in the briquetting facility. The oversize product is transported via conveyors to the metallized product delivery point to the steelmaking plant and to the truck loadout station.

In initially starting up the process, and 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 charging the middle fines onto the furnace feed conveyor.

(4) 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.

In the direct reduction furnace, some amount of DRI fines are generated. On the other hand, in the dedusting system (a combination of a dry cyclone and wet scrubber), the metallized dry dust is also collected by the cyclone.

In order to utilize these metallized fines and the metallized dry dust, a briquetting system is installed with binders supply facilities. One of binders is hydrated lime made from fine calcined lime produced in lime calcined 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 or dry reoxidation.

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.

(5) Gas reformer

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. The 36 tubes form 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 is 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. Each tube has its own inlet distributor below the reformer bottom. The tubes of two parallel rows are connected to common reformed gas outlet headers above the reformer box.

Connection of the feed gas distributors to the lower reformer tube ends is made 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 counterweights made of concrete. This supporting system is located underneath the reformer. For process reasons, better efficiency and improved tube life, the reformer box is gastight 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 reformer tubes in the fire-box and bottom are sealed against the tubes using expansion of lined woven asbestos. 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 firebricks backed by block insulation. Sufficient horizontal and vertical expansion joints are provided in the brick lining for long life 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 box and floor are designed with a special lining: roof is lined with layers of fibre and the floor is insulated by block insulation and insulating firebricks covered with a layer of refractories.

The three reformed gas headers as well as the entire reformed gas line to the reduction shaft furnace are lined with insulating refractories.

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 made by flow adjustment of mixing top gas fuel with natural gas.

The auxiliary burners are fired only by natural gas. During normal operation they are used with main burners, fed with a constant quality of natural gas.

Further, during cold start-up, the reformer is heated up to nearly operating temperature only by the auxiliary burners. And, during plant operation, when it is necessary to stop process 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 refractory 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 box.

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

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

(6) 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 at 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, and (4) 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 paralleled 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 650°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 is first preheated to about 380°C in the preheater (3), and then 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 leave the recuperator after heat exchanging with cold air (4). Thus heat in the flue gas is recovered to the economic 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.

(7) Blowers, scrubbers and other process equipment

(a) 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 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.

(b) Top gas and cooling gas scrubbers, and reformed gas cooler

The top gas and cooling gas scrubbers 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 pass through two different packed towers within the scrubber, followed by process gas compressors or fuel gas mixer.

Dust-laden effluent water with a high content of solids from the bottom of the scrubbers is routed to the clarifiers through settling pond. 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 by-passing the gas through the packing.

(8) Water system

The cooling water system has been designed to function in a closed loop and is divided into two systems - 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 several treatments in the process water system (chemical additive treatment, clarification, and cooling) and is again recirculated continuously through the system.

(a) 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 also 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.

(b) Process water system

Water in this system is 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, and with dust-laden gases in the top gas and cooling gas scrubbers and the dust collecting scrubbers.

The water with a higher content of solids from the bottom of the top gas and cooling gas scrubbers is passed through settling ponds to the clarifier. The rest of the process water from the top and cooling gas scrubbers flows directly to the clarifier. The returning water from the reformed gas cooler, the seal gas cooler, and the emergency inert gas generator is collected and pumped directly to the warm water basin of the cooling tower. The overflow from the clarifier is 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 for easy disposal.

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

7) Equipment list

Major equipment of DR plant is shown in the list of equipment in Table 5.2.3-3 under the following categories:

·Oxide handling system

- Reduction furnace & reformer
- Blower area, scrubber & other process equipment
- Product handling system
- Water system

Table 5.2.3-3 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°C, 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 Consisting of : Furnace charge hopper, upper seal gate, burden feeders, 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, gastight, welded steel structure Capacity : Natural gas basis, Normal 160,000 Nm3/h Size : 200 mm in diameter reformer tubes Consisting of:Reformer tubes, catalyst, burners, reftactories, strcture 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 typè
DR-210	Process Gas Compressors	3	Type : Positive displacement, rotary lobe type Consisting 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 Consisting 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 inlet positioner Consisting of:Stack and fan
DR-250	Main Air Blower	1	Type : Centrifugal type, with silencer and lubrication oil pump unit

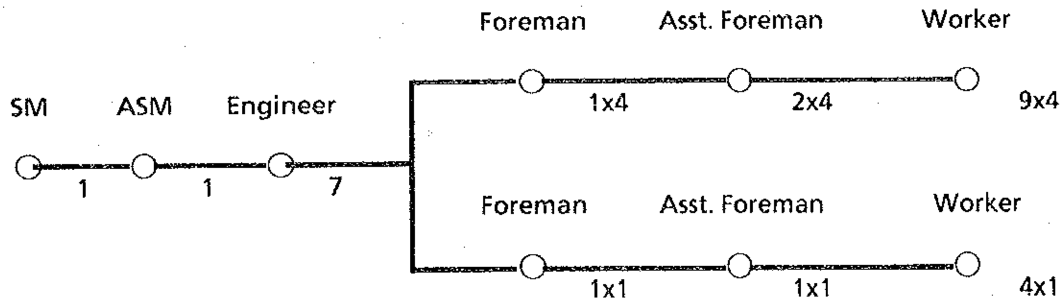
NO.	EQUIPMENT	Q'TY	MAIN SPECIFICATION
DR-251	Auxiliary Air Blower	1	Type : Centrifugal type, with inlet filter
DR-260	Reformed Gas Cooler	1	Type : Direct water cooled, packed tower type
DR-261	Process Gas Mixer	1	Type : Bending duct type
DR-262	Seal Gas Facility	1set	Type : Utilizing flue gas generated in reformer Consisting 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 Scale	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 Consisting 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 m3/h @50°C Consisting of: Cyclone, venturi scrubber, fan, dust storage bin and duct
DR-341	Product Dust Collector	1	Type : Cyclone & scrubber Capacity : Approx. 54,000 m3/h @50°C Consisting of: Cyclone, venturi scrubber, fan and duct
	WATER SYSTEM		
DR-401	Clarifier	1	Type : Concrete basin with rake Size : 40 m dia.
DR-402	Cooling Tower	1	Type : Mechanical induced draft cross flow Capacity : 2,600 m3/h
DR-403	Pump	1set	Type : Vertical turbine type Consisting of: Contaminated water pump, machinery cooling water pump, and miscellaneous pump
DR-404	Sump and Tank	1set	Consisting of: Thickener tank, mixing tank, miscellaneous sump and tank
DR-405	Miscellaneous Equipment for Water System	1set	Consisting of: Chemical injection system, piping, materials, structure, etc.

8) Personnel

Present operational personnel are as shown below.



SM : Section Manager
ASM: Assistant Section Manager

In accordance with the change of Management Agreement to Consultant Agreement, there is one Japanese consultant (equivalent to Section Manager) in charge of DR plant operation now.

5.2.4. Steelmaking plant (SMP)

1) Outline

The steelmaking plant is planned to produce 840,500 t/y of molten steel with 4×70-t EAFs using DRI and scrap and cast to 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. The production exceeded the planned start-up production and the production of molten steel in December 1987 was 70,000 t/M (Nominal capacity of monthly production) earlier than the plan by 8 months. And as shown in Fig.5.2.4-1, the production of molten steel in 1992 reached 1,181,700 t/y and that of billets reached 1,151,400 t/y .

Billets produced in the steelmaking plant are of medium and low carbon ordinary steel for concrete reinforcing bar of 37 kg, 52 kg and 60 kg classes.

Facilities related to EAFs were supplied by NKK and those related to CCM by Kobe Steel.

2) Outline of facilities

a) 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 hoppers in the steelmaking plant, from which DRI is charged into EAF with the 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 scrap transfer car to the EAF yard. The scrap is then charged by charging crane into EAF.

Molten steel melted and refined in EAF is, after ferro-alloys are added by ferro-alloys 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 tranfer car and sent to rolling plants.

b) Major facilities

Table 5.2.4-1 shows outline of the major facilities.

3) Outline of operation

a) The latest operation performance

The latest operation results are given in Table 5.2.4-2.

The plant has been consuming HBI (Hot Briquetted Iron) as main raw material since 1990 and the consumption of HBI in 1992 was 133,000 t/y.

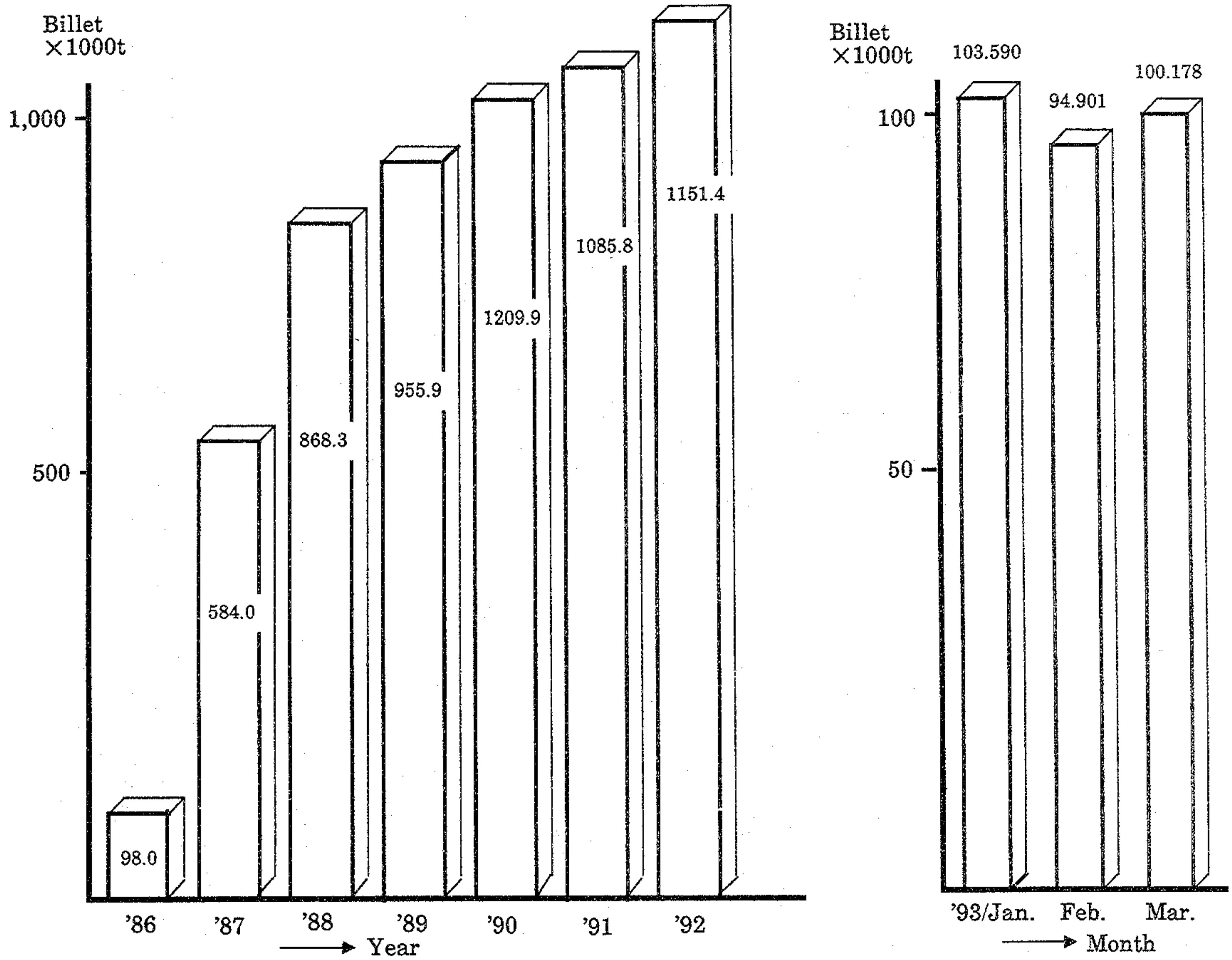


Fig 5.2.4-1 Production of SMP

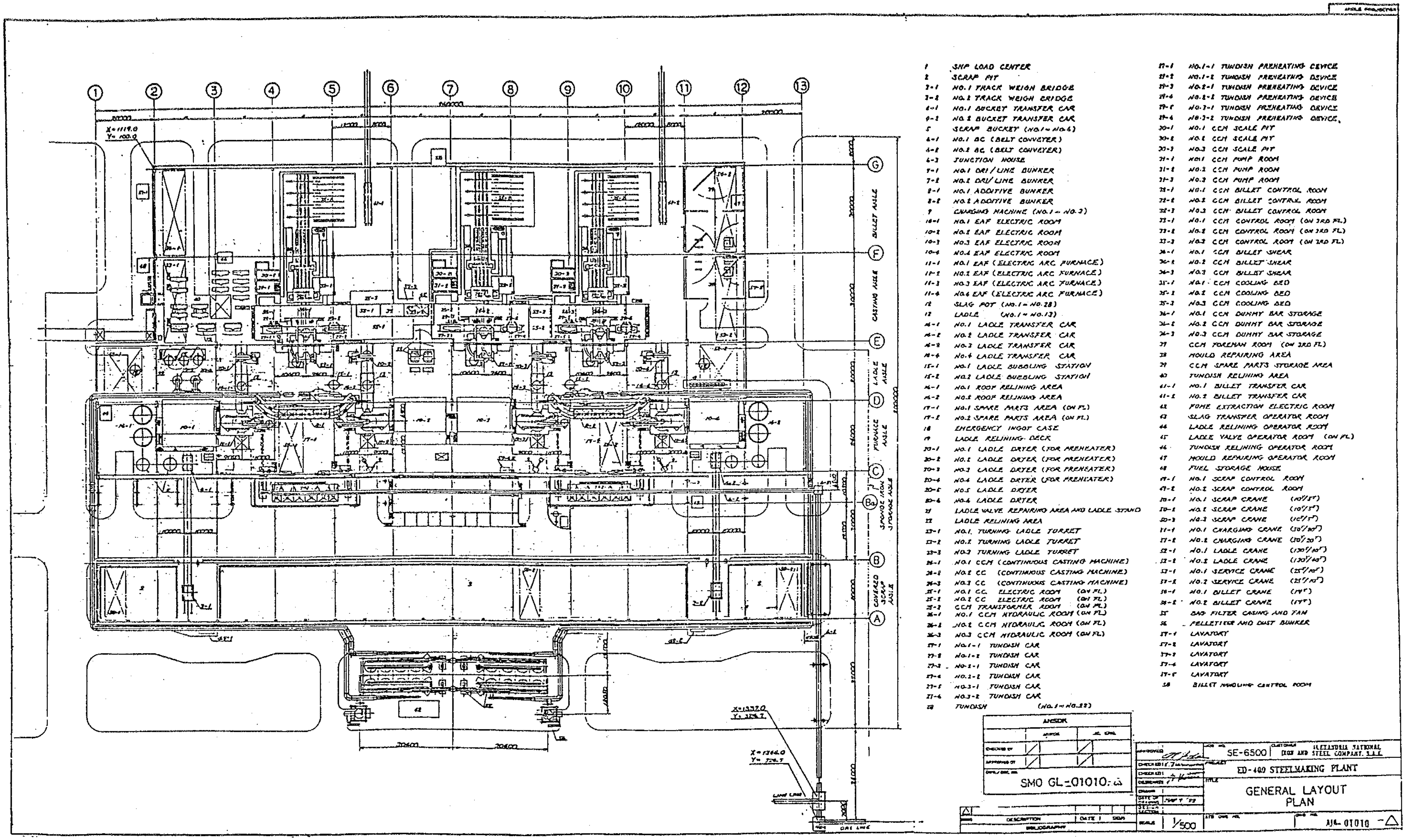


Fig. 5.2.4-2 Layout of the major facilities in SMP

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 Truck 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 sets/f'ce
5. Additive Handling Facilities	1 set	Storage hopper: 6 m^3/set 6 sets/2 f'ce with scale car Adding device to furnace and ladle: 1 sets/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 m3, 25 sets
8. Preparation and Miscellaneous Facilities	1 set	Ladle dryer: Natural gas combustion, 6 sets Oxygen gas lancing device: 1,000 Nm3/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 set	Type: Bag filter and suction type Capacity: 1,900 m3/min at 90°C Emission limit of dust: 50 mgr/Nm3 with pelletizer
10. Cranes	1 set	10/5t scrap handling crane with lifting magnet: 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 compensator 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

Table 5.2.4-2 The Latest Operation Results

ITEM	92/ Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	93/ Jan	Feb	Mar
1.Total Heat (ht)	1,025	1,302	1,255	1,272	1,177	1,161	1,246	1,201	1,331	1,305	1,188	1,265
2.Molten Steel (t)	83,777	104,319	101,194	103,557	95,625	95,673	102,296	97,999	108,776	106,593	98,092	103,240
3.Molten Steel (t/ht)	81.7	80.1	80.6	81.4	81.2	82.4	82.1	81.6	81.7	81.7	82.6	81.6
4.Billet (t)	81,110	102,141	98,966	101,018	92,828	92,224	98,721	95,325	106,174	103,590	94,901	100,178
5.Billet (t/ht)	79.1	78.4	78.9	79.4	78.9	79.4	79.2	79.4	79.8	79.4	79.9	79.2
6.DRI Ratio (%)	68.0	61.9	57.7	59.4	57.1	56.2	58.0	65.1	68.9	62.4	57.1	57.1
7.HBI Ratio (%)	8.5	12.6	13.7	8.4	10.9	14.0	11.3	11.2	7.7	12.4	15.6	14.0
8.Burnt Lime (kg/t-MS)	35.2	35.7	35.8	35.2	35.6	35.7	35.3	34.4	31.9	32.6	32.8	34.1
9.Steel Yield (%)	92.9	91.2	91.0	91.6	91.5	92.3	91.6	91.1	91.4	90.9	91.4	90.4
10.Billet Yield (%)	96.8	97.9	97.8	97.5	97.1	96.4	96.5	97.3	97.6	97.2	96.7	97.0
11.On - to - Tap (min)	105.8	104.3	105.2	105.0	105.0	107.5	106.4	107.6	104.7	101.4	104.0	105.6
12.Electric Power for EAF (kWh/t-MS)	631.8	636.6	626.2	627.3	643.2	635.9	634.1	663.9	662.1	647.3	645.0	660.8
13.Electric Power for CCM (kWh/t-BT)	7.6	7.1	7.3	7.2	7.7	7.5	7.3	7.3	6.8	6.7	6.6	7.1
14.Electric Power for Auxiliaries (kWh/t-MS)	17.1	15.7	16.5	16.4	17.4	16.9	16.4	16.7	15.5	15.1	14.9	16.1
15.Electrode (kg/t-MS)	3.6	3.7	3.8	3.6	3.9	3.7	3.7	3.8	3.7	3.6	3.6	3.9
16.Oxygen Gas (Nm3/t-MS)	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.6	0.5	0.5	0.5	0.4
17.Sequence Casting (%)	99.8	99.7	99.7	99.6	99.5	99.5	98.4	97.3	98.2	97.8	95.9	95.7
18.Av. Heats/TD (ht/TD)	5.3	6.0	6.0	6.0	5.8	5.7	5.0	5.2	5.5	5.5	5.6	5.1
19.Strand Stoppage Ratio (%)	0.5	0.8	1.4	1.3	1.6	1.4	1.2	1.3	0.8	1.0	1.3	1.2

5.2.5. Rolling mill plant (RMP)

1) Outline

Bar mill (BAR) was started up in July 1986, and Rod mill (ROD) in April 1987.

As steel grades, the bars for concrete reinforcement (Rebar) are mainly produced and the low carbon steels are also partially produced.

Most of these products are consumed in domestic market, and some of them are exported.

2) Operation of BAR and ROD

a) Production by year

Table 5.2.5-1 shows the production by year.

The production amount of both mills has been increasing year by year.

b) Production by steel grade

Table 5.2.5-2 shows the production by steel grade.

In ROD, 75% of production is rebar, and 25% is low carbon steels.
In BAR, 100% of production is rebar.

c) Production by size

Table 5.2.5-3 shows the production by size.

In ROD, the size is mainly D10, D12 and in BAR D10, D12 and D16.

d) Rolling productivity (t/h) by size

Table 5.2.5-4 shows the rolling productivity (t/h) by size.

In both mills, the rolling productivity (t/h) by size is almost at the same level in 1990, 1991 and 1992.

e) Yield by size

Table 5.2.5-5 shows the yield by size.

In ROD, the yield by size is almost at the constant level, but in BAR getting worse.

f) Yield and by-product

Table 5.2.5-6 shows the yield and by-product.

g) Utilities unit consumption

Table 5.2.5-7 shows the utilities unit consumption.

h) Effective rolling hours ratio

Table 5.2.5-8 shows the effective rolling hours ratio.

The effective rolling hours ratio has increased remarkably in ROD, and steady improvement is seen in BAR.

i) Scheduled maintenance hour

Table 5.2.5-9 shows the scheduled maintenance hour.

The scheduled maintenance hours in both mills are reduced year by year.

3) Equipment list

Table 5.2.5-10 shows the existing equipment list.

4) Organization and employee

Table 6.4.3-7 shows the organization and employees.

5) Layout

Fig. 6.4.3-1 shows the layout of RMP, and Fig. 6.4.3-2 shows the layout of ROD.

Table 5.2.5-1 Production Tonnage by Year

Unit : 1,000 t/y

Year	BAR	ROD	Total
1986	47	0	47
1987	299	126	425
1988	442	382	825
1989	485	447	932
1990	510	460	970
1991	520	480	1,000
1992	514	520	1,034
Nominal capacity	425	320	745

Table 5.2.5-2 Production Tonnage by Steel Grade

Unit : Product-tons/year or month

Mill		Steel grade	1990	1991	1992	Sep/92 - Feb/93							93 Mar
						Sep	Oct	Nov	Dec	Jan	Feb	Average	
BAR	A	Re-bar(AS37)	281,914	213,270	145,425	10,855	12,729	14,776	12,865	7,305	19,779	13,021	18,990
		Re-bar(AS52)	208,107	281,506	188,380	16,718	23,975	10,362	11,322	12,668	9,588	14,106	15,059
		Re-bar(GR60)	21,025	14,604	135,650	8,826	11,862	17,170	19,407	17,594	9,378	14,039	14,369
		Re-bar(other)		10,780	44,735	4,533	721	2,891	3,832	167	1,230	2,229	3,453
		Re-bar(Total)	511,046	520,160	514,190	40,932	49,287	45,199	47,246	37,734	39,975	43,395	51,871
	B	Low carbon											
	C	others											
		Sub-total(A+B+C)	511,046	520,160	514,190	40,932	49,287	45,199	47,246	37,734	39,975	43,395	51,871
ROD	D	Re-bar(AS37)				42,800	37,262	25,717	30,576	38,231	32,670	34,542	27,711
		Re-bar(AS52)											
		Re-bar(GR60)				379	283	73	491	379	236	243	160
		Re-bar(other)											
		Re-bar(Total)											
	E	AISI 1008, 1010				5,132	10,594	11,891	18,520	11,823	11,750	11,618	16,954
	F	others				80	95	81	124	215	157	125	160
		Sub-total(D+E+F)	459,599	479,850	520,755	48,011	48,234	37,762	49,711	50,269	44,840	46,471	44,985
Bar + ROD Total			970,645	1,000,010	1,034,945	88,943	97,521	82,961	96,957	88,003	84,815	89,866	96,866

Table 5.2.5-3 Production Tonnage by Size

Unit : Product-tons/year or month

Mill	Diameter(mm)	1990	1991	1992	Sep/92 - Feb/93							93 Mar
					Sep	Oct	Nov	Dec	Jan	Feb	Average	
ROD	5.5	14,960	15,026	19,808	1,522	-1				494	341	4,289
	6	41,449	57,792	63,199	5,939	5,662	6,650	9,648	8,745	7,281	7,321	4,764
	7									78	13	3,374
	8	71,427	88,728	91,469		9,953	1,920	12,955	12,070	4,143	6,840	8,568
	10	184,634	178,447	174,469	20,461	17,891	15,586	19,980	12,634	15,708	17,043	12,156
	12	147,129	139,860	169,293	20,072	14,728	13,606	7,128	16,820	14,945	14,550	11,834
	13			2,517	-13				other	2,191	363	
	Sub-total	459,599	479,850	520,755	48,011	48,234	37,762	49,711	50,269	44,840	46,471	44,985
BAR	10	104,976	125,771	117,400	9,194	8,382	12,216	6,823	7,010	5,007	8,105	4,723
	12		4,225	167,784	14,741	12,567	11,448	14,215	9,630	8,951	11,925	11,855
	13	128,382	133,928								0	
	14								290	5,509	967	-20
	16	155,341	148,871	142,402	10,906	15,952	9,727	16,813	14,269	6,412	12,347	16,534
	18			2,787		619		2,168	6,551	7,677	2,836	8,031
	19	52,858	50,538	37,748	6,021	5,870	4,100	39		20	2,675	
	20			594			594				99	3,219
	22	36,307	21,945	26,900	100	587	7,133	3,103	-35	3	1,815	4,585
	25	32,149	31,203	15,240	-30	5,312	-19	2,342	19	6,396	2,337	4
	28	1,033	3,679	3,011				1,400			233	
	32			343				343			57	2,940
	Sub-total	511,046	520,160	514,190	40,932	49,287	45,199	47,246	37,734	39,975	43,396	51,871
Grand total (ROD+BAR)		970,645	1,000,010	1,034,945	88,943	97,521	82,961	96,957	88,003	84,815	89,867	96,856

Table 5.2.5-4 Rolling Productivity (t/h) by Size

Unit : Billet-tons/hour

Mill	Diameter (mm)	1990	1991	1992	Sep/92 - Feb/93							93 Mar
					Sep	Oct	Nov	Dec	Jan	Feb	Average	
ROD	5.5	51.6	48.1	50.8	53.0					50.3	51.6	47.97
	6	61.8	61.6	63.0	63.2	65.5	61.3	64.0	64.0	63.4	63.6	64.6
	7	-								65.2	65.2	82.5
	8	84.7	85.7	85.9		86.4	85.2	85.8	85.1	85.0	85.5	85.3
	10	85.3	86.5	85.9	86.5	85.8	85.9	85.8	85.4	86.0	85.7	85.6
	12	86.0	86.5	85.9	86.3	85.8	85.9	87.03	86.1	85.6	86.1	86.3
	13	-		-86.7						88.2	88.2	
	Sub-total	80.5	80.3	80.2	80.9	92.9	80.1	80.6	80.9	80.5	81.0	76.9
BAR	10	65.7	65.7	65.5	65.6	65.7	65.7	64.6	65.6	65.7	65.5	65.6
	12	-	83.8	86.6	86.6	86.6	86.3	86.6	86.5	86.6	86.5	86.6
	13	100.3	99.9									
	14	-							98.9	98.8	98.9	
	16	113.0	111.0	110.4	111.5	111.5	109.8	112.6	109.2	111.1	111.0	111.3
	18	-		100.0		98.4		100.1	100.0	89.8	99.6	100
	19	109.9	112.9	111.5	111.8	109.2	112.3				111.1	
	20	-		110.1			110.1				110.1	110
	22	112.9	113.8	112.1		112.7	112.5	112.4			112.5	112.3
	25	116.2	113.8	112.0		112.5		112.5		112.1	112.4	
	28	107.2	113.1	111.8				111.8			111.8	
	32	-		108.2				108.1			108.1	111.8
	Sub-total	95.6	92.9	88.7	88.4	93.2	88.1	93.5	90.4	93.5	91.2	97.17

Table 5.2.5-5 Yield by Size

Unit : %

Mill	Dia (mm)	1990	1991	1992	Sep/92 - Feb/93							93 Mar
					Sep	Oct	Nov	Dec	Jan	Feb	Average	
ROD	5.5	93.9	94.8	95.1	94.7					96.8	95.8	95.8
	6	96.0	96.1	96.6	95.5	97.1	95.1	97.4	97.8	97.4	96.7	97.3
	7	-	-	-						98.7	98.7	97.4
	8	97.7	97.7	98.0		98.1	95.9	97.6	97.6	98.0	97.4	98.3
	10	98.1	97.9	98.0	98.2	97.5	97.8	98.3	98.2	98.4	98.1	97.8
	12	98.1	97.7	98.0	98.0	97.8	97.8	98.3	97.9	97.9	98.0	98.2
	13	-	-	98.3						97.7	97.7	
BAR	10	95.3	95.2	94.9	93.8	95.8	95.7	95.5	95.1	94.4	95.1	95.5
	12	-	95.9	95.5	97.1	95.1	95.2	95.8	95.6	94.9	95.6	95.8
	13	95.5	95.6	-							-	
	14	-	-	-					95.1	92.7	93.9	
	16	95.7	95.6	95.2	92.8	96.2	95.5	95.5	95.8	96.3	95.4	95.9
	18	97.2	96.7	97.2		96.0		97.6	96.8	97.0	96.9	96.7
	19	-	-	-	96.6	97.1	96.6				96.8	
	20	-	-	96.6			96.6				96.6	96.87
	22	97.3	97.5	96.9		91.0	98.4	96.5			95.3	97.16
	25	96.7	96.9	96.2		97.8		96.9		97.1	97.3	
	28	96.1	95.1	95.5				95.6			95.6	
	32	-	-	96.1				96.1			96.1	95.9

Table 5.2.5-6 Yield and By-products

Unit : %

Mill		Item	1990	1991	1992	Sep/92 - Feb/93							93 Mar
						Sep	Oct	Nov	Dec	Jan	Feb	Average	
ROD	(A)	Products (Coil)	97.65	97.47	97.71	97.63	97.66	97.24	97.92	97.87	98.0	97.7	97.7
	(B)	By-products											
		(c) Scrap } (d) Cobble }	1.42	1.93	1.93	1.78	1.96	2.3	2.06	2.10	2.05	2.0	2.27
		(e) Scale	0.88	1.48	1.27	1.11	1.19	1.34	0.93	1.23	1.16	1.2	0.23
		Sub-total(c)+(d)+(e)	2.3	3.41	3.2	2.89	3.14	3.64	2.99	3.33	3.21	3.2	2.5
	(C)	* Grand total(A)+(B)	99.95	100.88	100.91	100.5	100.8	100.88	100.91	101.2	101.21	100.9	100.2
BAR	(A)	Products											
		(a)Products (12m Bar)	95.9	95.7	95.5	95.3	96.0	96.0	95.9	95.7	95.5	95.7	96.1
		(b)Products (6-12m Bar)	1.0	1.0	1.4	1.8	1.0	1.2	2.6	1.1	0.9	1.4	0.9
		Sub-total (a)+(b)	96.9	96.7	96.9	97.1	97.0	97.2	98.5	96.8	96.4	97.1	97.0
	(B)	By-products											
		(c)Scrap	1.6	1.2	1.3	1.3	1.1	0.9	1.0	1.9	1.5	1.3	1.4
		(d)Cobble		1.4	1.7	1.9	1.8	1.3	1.2	1.6	1.4	1.5	1.2
		(e) Scale	1.1	1.3	1.3	1.6	1.1	1.2	1.2	1.7	1.5	1.4	1.2
		Sub-total(c)+(d)+(e)	2.7	3.9	4.3	4.8	4.0	3.4	3.4	5.2	4.4	4.2	3.9
	(C)	* Grand total(A)+(B)	99.6	100.6	101.2	101.9	101.0	100.6	101.9	102.0	100.8	101.3	100.9

* Grand total : The difference from 100% may be caused by the difference between actual billet weight and calculated billet weight, and by billet oxidation in the reheating furnace.

Table 5.2.5-7 Utilities Unit Consumption

Mill		Item	Unit	1990	1991	1992	Sep/92 - Feb/93							93 Mar
							Sep	Oct	Nov	Dec	Jan	Feb	Average	
ROD	(A)	Natural gass	Nm^3/Bt.t	30.9	30.8	29.8	28.7	28.2	29.4	28.3	29.1	28.6	28.7	29.7
	(B)	Electric power	kWh/Bt.t	110.2	106.7	105.8	101.3	104.2	106.8	104.3	103.9	101.7	103.7	107.2
	(C)	Direct water }	m^3/Bt.t	28.3	28.7	28.8	29.2	25.5	28.9	23.1	26.1	26.8	26.6	27.5
	(D)	Indirect water	m^3/Bt.t											
	(E)	Compressed air	Nm^3/Bt.t	20.2	19.6	18.2	16.0	17.2	18.2	16.2	16.3	14.7	16.4	16.1
BAR	(A)	Natural gass	Nm^3/Bt.t	33.8	33.4	33.7	33.7	32.3	32.9	32.9	32.8	33.5	33.0	32.7
	(B)	Electric power	kWh/Bt.t	54.0	50.0	59.8	61.7	56.4	59.4	55.4	59.5	57.4	58.3	53.5
	(C)	Direct water }	m^3/Bt.t	17.8	17.7	18.1	18.5	16.1	17.4	17.0	19.9	20.27	18.2	15.2
	(D)	Indirect water	m^3/Bt.t											
	(E)	Compressed air	Nm^3/Bt.t	71.4	84.9	99.4	99.7	88.8	99.0	101.4	113.3	99.77	100.3	93.0

Table 5.2.5-8 Effective Rooling Hours Ratio (ROD)

Unit : %

	Item	1990	1991	1992	Sep/92 - Feb/93							93 Mar
					Sep	Oct	Nov	Dec	Jan	Feb	Average	
	Effective rolling hours ratio 100-{(A)+(B)+(C)}	72.0	78.0	82.6	88.45	83.67	84.00	87.70	89.20	88.44	86.9	84.8
(A)	(a)Roll, groove change	7.8	3.3	2.9	2.26	2.16	2.10	2.74	3.15	2.74	2.6	3.12
	(b)Adjustment of roll, guide	6.9	5.0	4.1	4.15	3.14	4.32	3.84	3.99	4.64	4.0	3.81
	(c)Mis-roll	3.8	1.7	1.0	0.91	1.03	2.03	0.98	1.20	1.22	1.2	1.93
	Operational shutdown total (a)+(b)+(c)	14.5	10.0	8.0	7.32	6.33	8.45	7.57	8.34	8.61	7.8	8.86
(B)	(d)Mechanical equipment	6.5	7.9	6.3	1.94	7.1	5.50	3.10	0.96	1.42	3.3	1.82
	(e)Electrical equipment	2.0	2.4	2.0	1.70	1.88	1.20	1.10	0.91	0.53	1.2	1.65
	Equipment shutdown total (d)+(e)	8.5	10.3	8.3	3.64	8.98	6.70	4.20	1.87	1.95	4.6	3.47
(C)	Others	1.0	1.7	1.1	0.59	1.02	0.85	0.53	0.59	1.00	0.7	2.87
(D)	Shutdown total (A)+(B)+(C)	28.0	22.0	17.4	11.55	16.33	16.00	12.30	10.80	11.56	13.1	15.2

Table 5.2.5-8 Effective Rooling Hours Ratio (BAR)

Unit : %

	Item	1990	1991	1992	Sep/92 - Feb/93							93 Mar
					Sep	Oct	Nov	Dec	Jan	Feb	Average	
	Effective rolling hours ratio 100-{(A)+(B)+(C)}	72.0	73.6	73.7	71.3	78.00	78.70	75.00	73.35	74.80	75.2	77.61
(A)	(a)Roll, groove change	7.8	8.7	9.7	8.9	9.09	9.54	11.24	10.47	9.60	9.8	7.04
	(b)Adjustment of roll, guide	5.6	5.4	5.5	5.2	5.73	6.08	6.02	6.82	5.80	6.0	5.46
	(c)Mis-roll	3.6	3.9	3.3	4.4	2.78	2.28	2.61	2.91	2.70	2.9	1.86
	Operational shutdown total (a)+(b)+(c)	17.0	18.0	18.5	18.5	17.60	17.90	19.90	20.20	18.10	18.8	14.36
(B)	(d)Mechanical equipment	6.0	4.8	5.2	7.1	3.20	1.90	3.0	3.75	4.00	3.8	2.2
	(e)Electrical equipment	2.1	1.9	1.1	1.0	0.70	0.60	0.50	0.80	0.90	0.8	0.3
	Equipment shutdown total (d)+(e)	8.1	6.7	6.2	8.1	3.90	2.50	3.50	4.55	4.90	4.6	2.5
(C)	Others	2.9	1.7	1.6	1.9	0.50	0.90	1.60	1.50	2.20	1.4	3.03
(D)	Shutdown total (A)+(B)+(C)	28.0	26.4	26.3	28.7	22.00	21.30	25.00	26.25	25.20	24.8	22.39

Table 5.2.5-9 Scheduled Maintenance Hour

Unit : h/y

Mill	Item	Actual			Schedule
		1990	1991	1992	1993
ROD	Major repair	384	232	208	9 days + 1 shift = 224 h/y
	Minor repair	72	128	88	5 days + 1 shift = 128 h/y
	Periodic repair	624	550	403	16 h/time in every 2 weeks 365 d/y ÷ 14 d/time = 26 times/y (26-2) times/y × 16 h/time = 384 h/y
	Total	1,080	910	699	736 h/y
BAR	Major repair	198	200	-	8 days + 1 shift =200 h/y
	Minor repair	119	120	1,106.0	5 days + 1 shift =128 h/y
	Periodic repair	703	492	432.9	16 h/time in every 2 weeks 365 d/y ÷ 14 d/time = 26 times/y (26-2) times/y × 16 h/time = 384 h/y
	Total	1,020	812	538.9	712 h/y

Table 5.2.5-10 Equipment List (ROD-1)

Item	Equipment	Existing
Reheating furnace	Type of furnace	Walking Beam
	capacity (max)	88 t/h
	Furnace dimension	
	Effective	15.0m(L)x16.0m(W)
	Overall	19.0m(L)x18.1m(W)
	No. of burners	
	Top preheat zone	0
	Top heat zone	2x10x1000x10^3kcal/h
	Top soak zone	2x10x400x10^3kcal/h
	Bottom soak zone	10x1,100x10^3kcal/h
	Bottom heat zone	0
	Combustion air blower	
	No. of blowers	2
	Max air flow	38,000 Nm^3/h
	No. of walking beams	6 beams
	Warlking beam	7 beams
	Stationary	Matallic tublar
	Recuperator type	51,000 Nm^3/h (at 150 t/h)
	Combustion air volume	54,000 Nm^3/h (at 150 t/h)
	Waste gas volume	20°C/480°C
	Air temperature	700°C/360°C
	Waste gas temperature	
	Stack (Individual from bar furnace)	
	Draft type	Natural draft
	Height	GL + 60m
	BT receiving bed	80 t
	Loading capacity	

Table 5.2.5-10 Equipment List (ROD-2)

Item	Equipment	Existing
Reheating furnace	BT charging pusher	
	BT discharging Type of Bt discharge	Side discharging
Rolling mill & Roughing mill	No. of strands	1
	No. of stands	7
	Type of housing	2-High closed type
	Roll changing	Chock with roll
	Groove changing	Stand shift
	Switch plate	Fixed device
No. 1 inter-mediate mill	No. of strands	1
	No. of stands	4
	Type of housing	2-High closed type
	Roll changing	Stand with used roll and stand-by with new roll
	Groove changing	Shaft shift
No. 2 inter-mediate mill	No. of strands	1
	No. of stands	4
	Type of housing	Cantilever type
	Roll changing	Roll only
	Groove changing	Roll only
Finishing block mill	No. of strands	1
	No. of stands	10
	Type of housing	Cantilever type
	Roll changing	Roll only
	Groove changing	Roll only
	Product diameter	5.5 mm to 13 mm

Table 5.2.5-10 Equipment List (ROD-3)

Item	Equipment	Existing
Crop shear	Crop shear	After No.7 stand
	Crop shear	Before No.16 stand
Snap shear	Snap shear	Before No.12 stand
		Before No.16 stand
Looper	Side looper	Before No.12 stand
	Up looper	Between No.12- No.15
	Side looper	Before No.16 stand
Water cooling zone	Total length	38 m
	No. of zones	3
Laying head	Pinch roll dia x length	182mm(D)x74(L)x2
	Laying cone	One set
	Ring dia of rod	1,050mm approx
	Max revolution	1,820 r.p.m.
Cooling conveyer	Total length	98 m
	No. of cooling fans	5
Reforming tub	Type	Double mandrel type with tub shear
Coil trans-portation	Type	Power & free type C-hook conveyor
	No. of C-hooks	40
Coil compactor	Type	Horizontal
	No. of compactors	2
	Tying wire dia	6.0 mmϕ
	No. of tying wires	4
Coil scale	Type	Load cell
	Weighing range	Up to 2.5 t
	No. of coil scales	1

Table 5.2.5-10 Equipment List (ROD-4)

Item	Equipment	Existing
Coil off-loading	Type No of equipment	Load cell 1
Label stamping machine	Type No. of machines Metal tag	Automatic 1 Alminium or steel 110x55x0.3mm
Roll shop	Roll turning lathe Type No. of lathes Roll ribbing machine No. of machines Sintered hard roll grinders Roll & bearing assembly equipment Transfer car Roll racks & cabinets	 Numerical control 2(Bar)+1(Rod)=3 1(Bar)+1(Rod)=2 2 (Rod) One car (Bar & Rod common)
Crane	BT yard (Bar & Rod) Mill yard Coil yard Furnace yard Roll shop Mill scale pit yard	2 x 17 t 1 x (25 t, 5 t) 2 x 10 t 1 x 10 t 1 x 10 t 1 x 5 t(Semi-gantry) 1 x 3 t

Table 5.2.5-10 Equipment List (ROD-5)

Item	Equipment	Existing
Lubrication system	No.1 centralized oil lubrication system	1 set
	No.2 centralized oil lubrication system	1 set
	No.3 centralized oil lubrication system	1 set
	No.1 air-oil lubrication system	1 set
	No.2 air-oil lubrication system	1 set
	No.1 centralized grease lubrication system	1 set
	No.2 centralized grease lubrication system	1 set
	No.3 centralized grease lubrication system	1 set
	No.4 centralized grease lubrication system	1 set
	No.5 centralized grease lubrication system	1 set
	No.6 centralized grease lubrication system	1 set

Table 5.2.5-10 Equipment List (ROD-6)

Item	Equipment	Existing
Hydraulic system	No.1 hydraulic system	1 set
	No.2 hydraulic system	1 set
	No.3 hydraulic system	1 set
	No.4 hydraulic system	1 set
	No.5 hydraulic system	1 set
Fire pro-tection	Halogen fire extinguisher	1 set
	Dry-chemical fire extinguisher	1 set
Inter-communi-cation system		One system
Utilities electric power	Power source	AC33kv 3-phase 3 wire 50Hz
	Emergency source	AC6.6kv 3-phase 3 wire 50Hz
Natural gas	Piping dia Gas comsumption max.	3,200 Nm3/h
Compres-sed air		1,500 Nm3/h
Water system	Indirect water	726 m3/h
	Direct water	1,145 m3/h
	Flushing water	100 m3/h

Table 5.2.5-10 Equipment List (BAR-1)

Item	Equipment	Existing
BT yard bar, rod common	Building area	40,000mm x 196,000mm
	No. of cranes	2
	No. of BT transfer cars	2
	BT size	130mm x 130 x 16,000
	BT weight	2,000 kg
Bar reheating furnace	Type of furnace	Walking beam
	Capacity (Max)	110 t/h
	Furnace dimension	
	Effective	13.0m(L) x 16.8m(W)
	Overall	15.0m(L) x 18.1m(W)
	No. of burners	
	Upper left zone	6 sets x 97.5 Nm3/h
	Upper right zone	6 sets x 97.5 Nm3/h
	Lower left zone	6 sets x 97.5 Nm3/h
	Lower right zone	6 sets x 97.5 Nm3/h
	Combustion air blower	
	No. of blowers	1 set
	Max air flow	45,000 Nm3/h
	No. of walking beams	
	Walking beam	6 beams
	Stationary beam	7 beams
	Recuperator	
	Type	Metallic tublar
	Combustion air volume	36,000 Nm3/h
	Waste gas volume	40,000 Nm3/h
	Air temperature	20°C/430°C
	Waste gas temperature	640°C/260°C

Table 5.2.5-10 Equipment List (BAR-2)

Item	Equipment	Existing
Bar reheating furnace	Stack (Individual from rod furnace)	
	Draft type	Natural draft
	Height	GL + 55m
	BT receiving bed	
	Loading capacity	51 t
	Furnace approaching table	
	Type of drive	Individual
	Billet charging	
	Type of BT charging	Pusher
	Billet discharging	
	Type of BT discharging	Side discharge
Bar rolling mill roughing mill	No. of strands	1
	No. of stands	8
	Type of housing	2-High closed
	Roll changing	Roll with chock only
	Groove changing	Stand shift
Inter-mediate mill	No. of strands	1
	No. of stands	4
	Type of housing	2-High closed
	Roll changing	Stand with used roll and stand-by stand with new roll
	Groove changing	Stand shift
Finishing mill	No. of strands	1
	No. of stands	4
	Type of housing	2-High closed
	Roll changing	stand with used roll and stand-by stand with new roll
	Groove changing	Stand shift

Table 5.2.5-10 Equipment List (BAR-3)

Item	Equipment	Existing
Finishing Mill	Slit rolling size Product diameter	10mm to 16mm 10mm to 32mm
Crop shear		After No.8 stand
Snap shear		After No.12 stand
Dividing shear		After No.16 stand
Looper	Side looper (single) Up looper Side looper (double arrangement for slit rolling)	Between No.12 and No.13 stands Between No.13 and No.14 stands Between No.14 and No.15, and between No.15 and No.16 stands
Colling bed	Effective bar length	120 m
Cold shear	Cutting force Shape of knife blade	400 t Plain knife
Shear gauge	Gauge legth	6.0 to 12.5 m
Tying	Type	Automatic wire tying
Scale	Type Product weight	Load cell Max 2.5 t
Bending machine	Type	Hydraulically driven
Roll shop	See rod mill section	
Crane	Quantity & capacity BT yard (Bar and rod common)	2 x 17 t

Table 5.2.5-10 Equipment List (BAR-4)

Item	Equipment	Existing
Crane	Mill yard	1 x (25 t, 5 t)
	Bar storage yard	1 x 10 t indoor 2 x 10 t outdoor
	Furnace yard	1 x 5 t
	Roll shop	1 x 10 t 1 x 5 t (semi-gentry)
	Mill scale pit yard	1 x 5 t
Lubrication system	No.1 centralized oil lubrication system	1 set
	No.2 centralized oil lubrication system	1 set
	Centralized grease lubrication system	4 sets
	Other lubrication system	1 set
Hydraulic system	No.1 hydraulic system	1 set
	No.2 hydraulic system	1 set
	No.3 hydraulic system	1 set
	No.4 hydraulic system	3 sets
Fire protection system		One system
Inter communication system		One system
Utilities electric power	Power source	AC 33KV 3 phase 3 wire 50 Hz
	Emergency	AC 6KV 3 phase 3 wire 50 Hz
Natural gas	Capacity	4,000 Nm3/h

Table 5.2.5-10 Equipment List (BAR-5)

Item	Equipment	Existing
Compressed air		Max 1,923 Nm3/h
Water system	Indirect water Direct water	Max 916 m3/h Max 600 m3/h
Scale pit	Water flow rate	600 m3/h

5.2.6. Lime calcining plant (LCP)

1) Outline

ANDSK operates the lime calcining plant with nominal 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 3 the same year.

At present, the lime calcining plant is operated at the level of the nominal production capacity to meet the demand of burnt lime for the steelmaking plant.

Maerz process is adopted in the lime calcining plant and the process is known for its high thermal efficiency, high quality of product, easy operation and high turndown ratio.

2) Capacity

ANDSK LC plant has nominal capacity of 160 t/d and with 330 working days a year, and 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 nominal capacity, and recently has reached the nominal capacity level. This is because the production has been coordinated to the demand of burnt lime for the steelmaking plant.

In addition, this plant was designed to have capacity equivalent to 120% of the nominal capacity and so can produce more than 52,800 t/y if desired. Judging from the operation record in 1992, it is possible to increase working days in order to produce more burnt lime if required.

3) Raw material

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

Fines produced were expected to be about 10%, but now about 1%, very low.

4) Operational condition and unit consumption

Table 5.2.6-1 shows the operation data of LC plant.

Average production of the past three months is 148 t/d, about 92.5% of the nominal capacity of 160 t/d.

Average rest CO2 is 3.5%, which a little exceeds the standard of 3% max. of LC plant. When the production level rises, occurrence of rest CO2 will decrease. Incidentally, the present rest CO2 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.

Table 5.2.6-1 Operation Data of LC Plant

	Unit	Actual	Standard
Production	t/d	148	160
Rest CO2	% max.	3.5	3
Limestone	t/t*	1.95	1.93
Natural gas	Nm3/t	89.9	98.7
Electric power	kWh	48.6	59
Water	m3/t	0.018	0.001
Air	Nm3/t	70.7	45

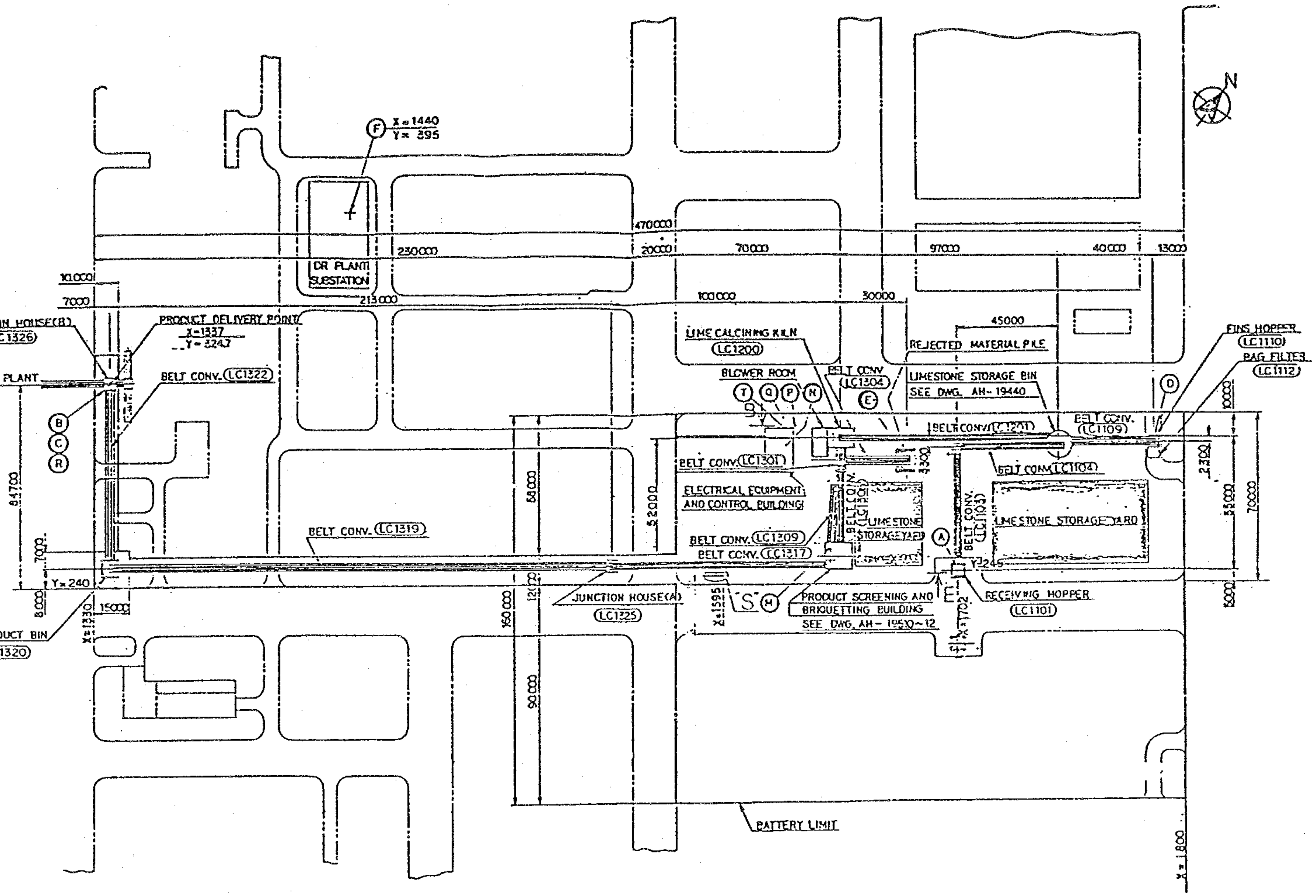
Note: Averages from January 1993 to March 1993
*With fines being 1%

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 steelmaking plant.

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



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

6) Process/plant description

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

Limestone discharged from the bin is screened by 20 mm mesh to remove - 20 mm 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.

$$CaCO_3 \rightarrow CaO + CO_2$$

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.

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

Burnt lime is discharged from the kiln to the conveyor and after weighing, transferred to the product screen. The screen separates the 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 the briquetting machine and stocked in the product bin. Burnt lime of 5-40 mm is sent by conveyor derectly to the product bin. The product bin can hold about 2 days' consumption of burnt lime.

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

Dust collecting facilities are installed at certain places of raw material facilities, lime kiln and product facilites 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 Section
- Lime Calcining Section
- 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 m3 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 m3 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 m3/h Head : 10 m Size : 50 mm
	LIME CALCINING SECTION		
LC-201	Limestone Storage Bin	1	Type : Welded steel plate construction Capacity : 770 m3 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 : 13.2 m Lift : 5 m

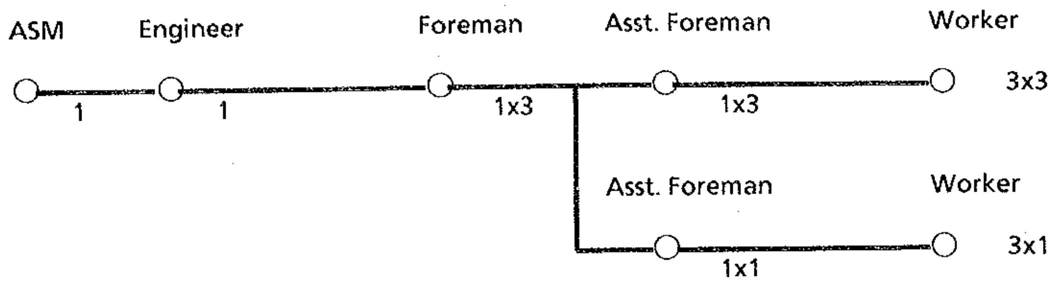
NO.	EQUIPMENT	Q'TY	MAIN SPECIFICATION
LC-304	Belt Conveyor	1	Type : 30° x 3 rollers Capacity : 20 t/h Belt width : 600 mm Horizontal length : 39 m Lift : 11.9 m
LC-305	Vibrating Screen	2	Type : Double deck Capacity : 200 t/h Size : 900 mm x 1,800 mm
LC-306	Jaw Crusher	1	Type : Single toggle Capacity : 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 t
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

EQUIPMENT LIST PLANT: LIME CALCINING SHOP (Cont'd)

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 m3
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 t Span : 10 m Lift : 15 m Control : Pendant switch
LC-322	Dust Collector	1	Type : Bag type Capacity : 470 Nm3/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

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

5.2.7. Utilities (UT)

The existing utility facilities consist of the following seven stations:

- Raw water treatment station
- Recirculation water treatment station
- Sewage treatment station
- Drainage pumping station
- Oxygen shop and air compression station
- Natural gas station
- Outdoor fire hydrants

Each station is outlined below.

1) Raw water treatment station

Raw water supplied from Alexandria Water Authority (AWA) is treated by filtration, softening devices and potable water units to produce the make-up water and potable water in this station.

2) Recirculation water treatment station

As recycling and treating facilities of cooling water used in the steelmaking plant (SMP), the rolling mill plant (RMP), the oxygen shop, the air compression station, and the substation, the following three water treatment stations are installed.

a) Water treatment station-I

This station treats and supplies indirect cooling water for RMP and direct cooling water for SMP and RMP in separate lines. The station has a capacity to treat 2,000 m3/h of indirect cooling water and 3,190 m3/h of direct cooling water.

b) Water treatment station-II

This station treats and supplies indirect cooling water for SMP and an emergency water supply system for SMP and RMP is also installed. The station has a capacity to treat 7,150 m3/h of indirect cooling water.

c) Water treatment station-III

This station treats and supplies indirect colling water for oxygen shop, air compression station and substation. The station has capacity to treat 284 m3/h of indirect cooling water.

3) Sewage treatment station

Collected sewage discharged from plants and buildings is treated in this station by activated sludge process. The station has a capacity to treat 500 m3/h of sewage.

4) Drainage treatment station

This station treats and discharges the rainwater and blow-down water into the Mediterranean Sea. The station has a capacity to treat 1,950 m3/h of water.

5) Oxygen shop and air compression station

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

6) Natural gas station

Natural gas supplied by EGPC at 10 kg/cm2G is metered on this station and sent to DRP, SMP and others. The station has a capacity to supply 50,000 Nm^3/h of natural gas.

7) Outdoor fire hydrants

Water supply facilities for these hydrants are placed in the raw water treatment station. When a fire breaks out, the fire fighting water is sent to outdoor fire hydrants for fire fighting. The water supply facilities have a capacity to supply 240 m^3/h of fire fighting water.

The design capacity of these utility facililies and present consumption of utilities are shown in Table 5.2.7-1

Table 5.2.7-1. Utility Requirements

Station/Shop	Design Capacity	Present Consumption	Surplus Capacity of Existing Facilities
1. Raw Water Treatment Station			
· Raw Water	930 m^3/h	550 m^3/h	380 m^3/h
· Make-up Water	890 m^3/h	500 m^3/h	390 m^3/h
· Potable Water	50 m^3/h	20 m^3/h	30 m^3/h
2. Water Treatment Station-I			
· Direct cooling water	3,190 m^3/h	2,300 m^3/h	890 m^3/h
· Indirect cooling water	2,000 m^3/h	1,500 m^3/h	500 m^3/h
3. Water Teatment Station-II			
· Indirect cooling water	7,150 m^3/h	7,150 m^3/h	0 m^3/h
4. Water Teatment Station-III			
· Indirect cooling water	284 m^3/h	284 m^3/h	0 m^3/h
5. Sewage Teatment Station			
· Sewage	500 m^3/d	320 m^3/d	180 m^3/d
6. Drainage Pumping Station			
· Drainage	1,950 m^3/h	290 m^3/h	1,660 m^3/h
7. Oxygen Shop			
· Oxygen gas	400 Nm^3/h	200 Nm^3/h	200 Nm^3/h
· Nitrogen gas	550 Nm^3/h	550 Nm^3/h	0 Nm^3/h
8. Air Compression Station			
· Compressed air	12,800 Nm^3/h	10,800 Nm^3/h	2,000 Nm^3/h
9. Natural Gas Station			
· Natural gas	50,000 Nm^3/h	33,000 Nm^3/h	17,000 Nm^3/h
10. Outdoor Fire Hydrants			
· Fire water	240 m^3/h	0 m^3/h	240 m^3/h