8.5 Natural Gas Supply

8.5.1 Steel Complex natural gas requirements

A DR-based integrated Steel Complex and a power station for the Steel Complex in this study will require natural gas as indicated in Table 8-5-1.

Table 8-5-1 Required Quantity and Quality of Natural Gas for Steel Complex

	Steel complex	Power station for Steel Complex
Supply capacity	Max. 66,000 Nm^3/h Av. 54,000 Nm^3/h 396,000,000 $Nm^3/year$ 14,700,000 MMBTU/year	Max. 50,000 Nm^3/h Av. 45,000 Nm^3/h 265,000,000 $Nm^3/year$ 9,800,000 MMBTU/year
Service	Feed to DR plant (Direct Reduction plant) for reducing gas Fuel gas for furnaces	Fuel gas for gas turbine and/or steam boiler
Supply pressure and quality	4.0±0.1 kg/cm^2G C5+ (Heavy hydrocarbon) :<0.1(mol%) Sulfur (as H_2S): < 5 ~ 10 ppm	27 ~ 30 kg/cm^2G

8.5.2 Conceptual study for natural gas in Sohar

(1) New pipeline project

A new pipeline has been proposed to connect Fahud to Sohar to meet long-term domestic and industrial demands for the region.
The distance from Fahud to Sohar is approximately 300 km.
Front end design for the planned pipeline is based on a 32" diameter and design work has already been completed.
The construction of new pipeline is scheduled to be completed by the summer in 2001.

(2) Quality of natural gas

Natural gas supply quality in Saih Nihayda is received from PDO and is indicated in

Table 8-5-2.

According to Table 8-5-2, contents of heavy hydrocarbon is higher than that of the requirement of Steel Complex.

A heavy hydrocarbon removal system is required to reduce the content of heavy hydrocarbon in natural gas to be required by the Steel Complex.

The JT valve method, Turbo expander method, and pressure swing method, are referred to throughout the world as heavy hydrocarbon removal systems.

(3) Conceptual design of natural gas supply system

Natural gas will be used not only the Steel Complex but many other projects in the Sohar region.

The conceptual design of the natural gas supply system will be designed by the Government so as to meet the requirements of all concerned projects.

A conceptual design for natural gas is not therefore required by the Steel Complex.

Table 8-5-2 Natural Gas Supply Quality in Saih Nihayda

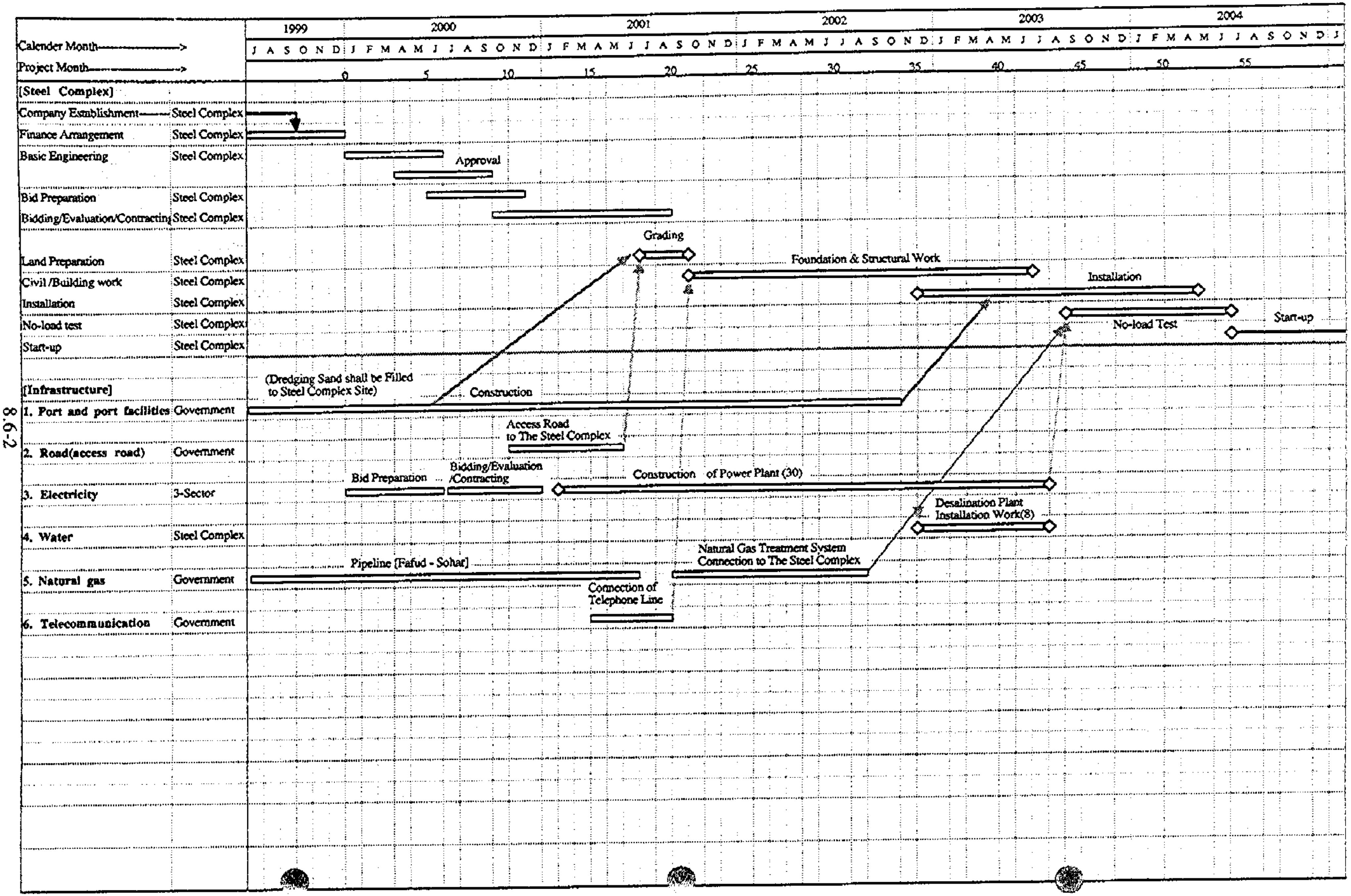
Composition in mol%	Present	2020 (Expected)
N2	4.42	2.85
CO2	0.49	2.7
C1	85.49	89.05
C2	5.38	3.22
C3	2.63	1.13
i-C4	0.52	0.35
n-C4	0.68	0.32
i-C5	0.15	0.13
n-C5	0.13	0.11
C6	0.06	0.14
Water(ppm)	-	-
H2S (ppm)	<5	<5
Organic sulfur (ppm)	-	-
Mol. Weight	18.9	18.38
LHV (MJ/Sm^3)	36.4	36.7

Source: PDO, the above data are preliminary and subject to change

8.6 Infrastructure Implementation Schedule

The Infrastructure Implementation Schedule including port and port facilities, road, electricity, water, natural gas is summarized in Figure 8-6-1.
The critical path will be the Power plant because electric power is required before starting the No-load test of the Steel Complex (at the project month =44 months).
The power plant (200 MW) will require 30 months for construction.
The power plant project shall be started at the same time as the Steel Complex project(at the project month =0 month).

Figure 8-6-1 Infrastructure Implementation Schedule



Chapter 9. SITE CONDITIONS FOR THE STEEL COMPLEX

9.1 Location and Natural Condition

9.1.1 Location

Sohar, which has a population of about 100,000 faces the Gulf of Oman and is located 250 km northwest of Muscat. Sohar is strategically located along important sea routes that connect the Indian Ocean to GCC countries. After the completion of the new port construction in Sohar, it is expected that Sohar will be further developed as one of the most important bases or hubs for marine transportation in northern Oman. The development and construction plan is already underway, in a site located about 20 km away from the center of Sohar. The proposed construction site of the Steel Complex is located within the port area of the development plan, with an area of 1,200,000 m^2 (800 m×1500 m). ----- (Refer to Figure 7-1-1)

9.1.2 Natural condition

(1) Meteorological condition

1) General

Meteorological conditions are not always important factors as compared with other site conditions in general. However, the impact of stormy wind on port operation should be taken into account. Moderate and stable conditions are desirable based from economic and environmental points of view.

2) Temperature

Northern Oman is classified as a sub-tropical zone. The monthly maximum temperature at Sohar varies from 27℃ to 47℃ while the monthly minimum temperature varies from 10℃ to 27℃. (Refer to Figure 9-1-1)

3) Rainfall

Total annual rainfall in Sohar is shown in Figure 9-1-2. Generally, the Sultanate has little and irregular rainfall, but occasionally experiences heavy rainfall. A monthly maximum total rainfall of 235.3 mm was recorded at Sohar (Majis) with a daily maximum rainfall of 110.3 mm.

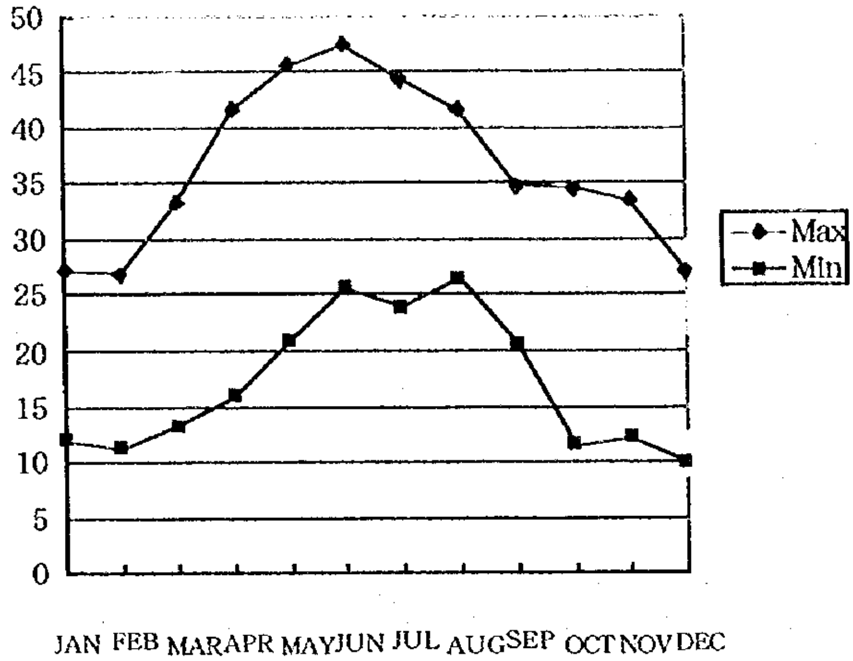


Figure 9-1-1 Temperature in Sohar
(Source: Annual climatological summary by the Steering Committee)

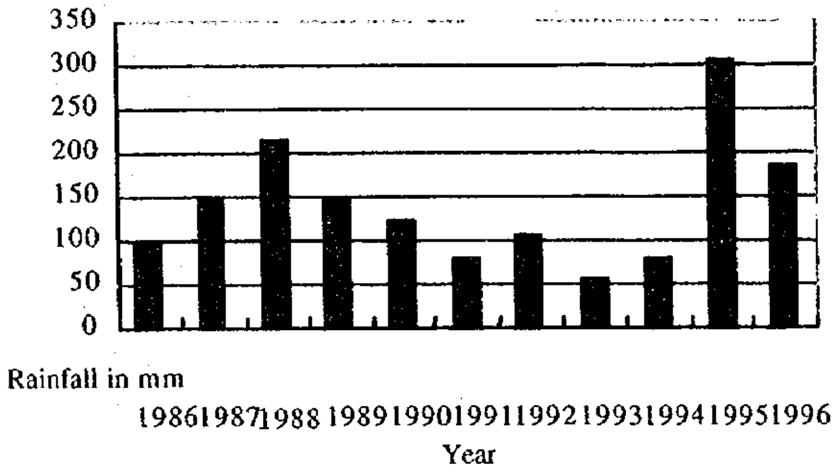


Figure 9-1-2 Total Annual Rainfall in Sohar
(Source: Annual Climatological Summary by the Steering Committee)

4) Wind

The wind rose at Sohar (Majis) for 3 years (June, 1986 - Dec., 1988) is shown in Figure 9-1-3. The predominant wind direction is eastward during winter season and westward during summer season.

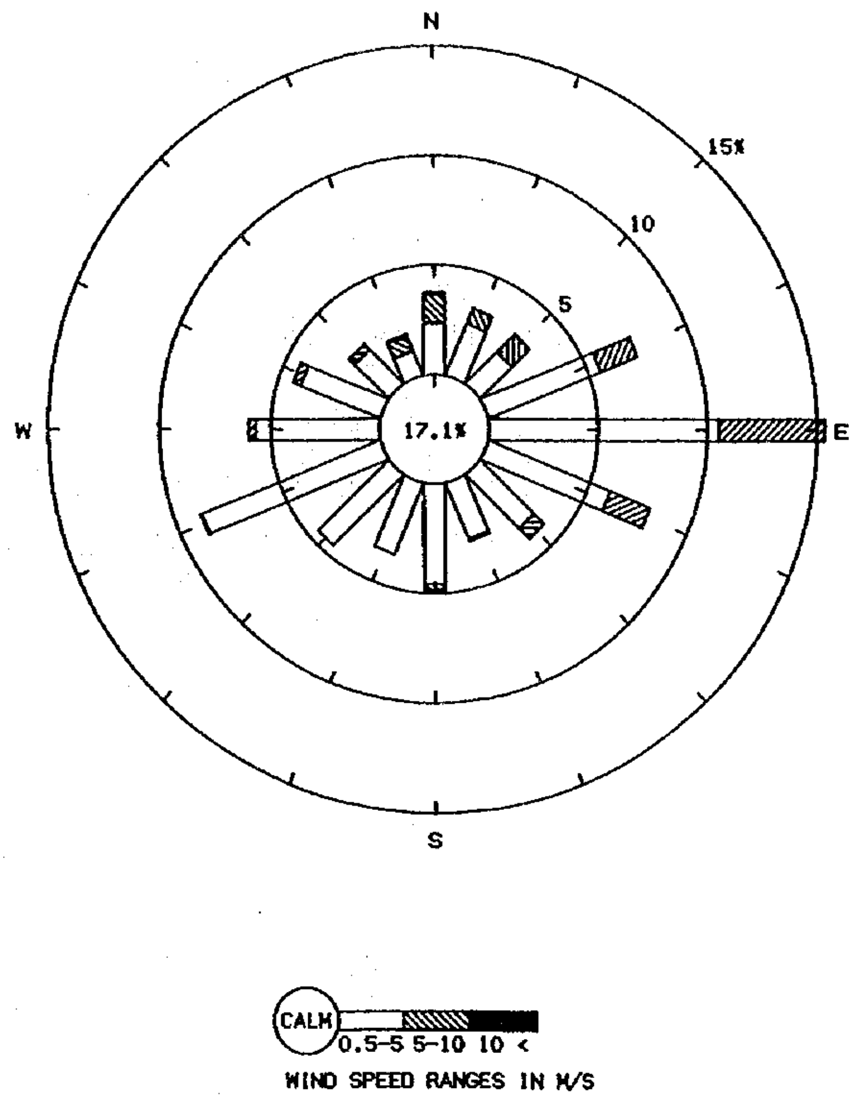


Figure 9-1-3 Wind Rose (source: JICA Report 1990)

(2) Topographical condition

The site for the Steel Complex shall be graded horizontally by taking into consideration the highest flood water level and the sea water level. For the site development work which includes the construction of an access road, it is important that the configuration of the land such as undulation and gradient is suitable.

The proposed site of the Steel Complex is situated on the existing coastal line. Behind the coastal line, there is a 300-m width flat land (with an elevation of 2-3 meters above the sea level) that is parallel to the coastal line. However, at the on-shore side, the elevation of land is almost the same as that of the sea level (0-1 m).

The elevation of half of the land of the proposed Steel Complex is very low (0-1 meters above sea level). Therefore it is necessary to fill such portion up to suitable ground elevation using the dredged soil obtain from port construction.

(3) Soil condition

Soil conditions at the Steel Complex project site is one of the most important factors for the design and construction of foundations, underground structures and berths. In order to construct rigid and stable foundations and structures for heavy equipment, and a bed for the stock yard which requires storage and handling of a large volume of raw materials and finished products, a stable and stiff sand, sandy soil or gravel subsoil strata is preferable.

Figure 9-1-4 shows the boring test results at Sohar port. At the proposed berth area, the soil profile shows that the subsoil consists of 8-m to 10-m thickness layer medium dense sand which forms the sea bed and a layer of more than 10-m thickness of sand stone with over 50 N-value . Since the medium dense sand layer would be dredged for securing the proper water depth of the new port, the proposed berth of the Steel Complex will be constructed on the sand stone layer which has adequate bearing capacity.

At the proposed Steel Complex site, the surface is made up of 10-m to 12-m thick layer of medium dense sand with 10-30 N-value. Below this layer, there are alternately stable and stiff siltstone and sandstone. Judging from the N-value of surface layers, it can be expected that there will be enough bearing capacity of equipment foundations of the Steel Complex. Moreover, it is necessary to examine the type of the foundation carefully as the filling work of 3-m to 4-m thickness are executed using dredged soil.

On the other hand, based on the topographic map received from MOC, there is soft clay called " Sabkha" on the surface layer of the offshore side of the proposed Steel Complex site. It is therefore necessary to take some measures against " Sabkha" .

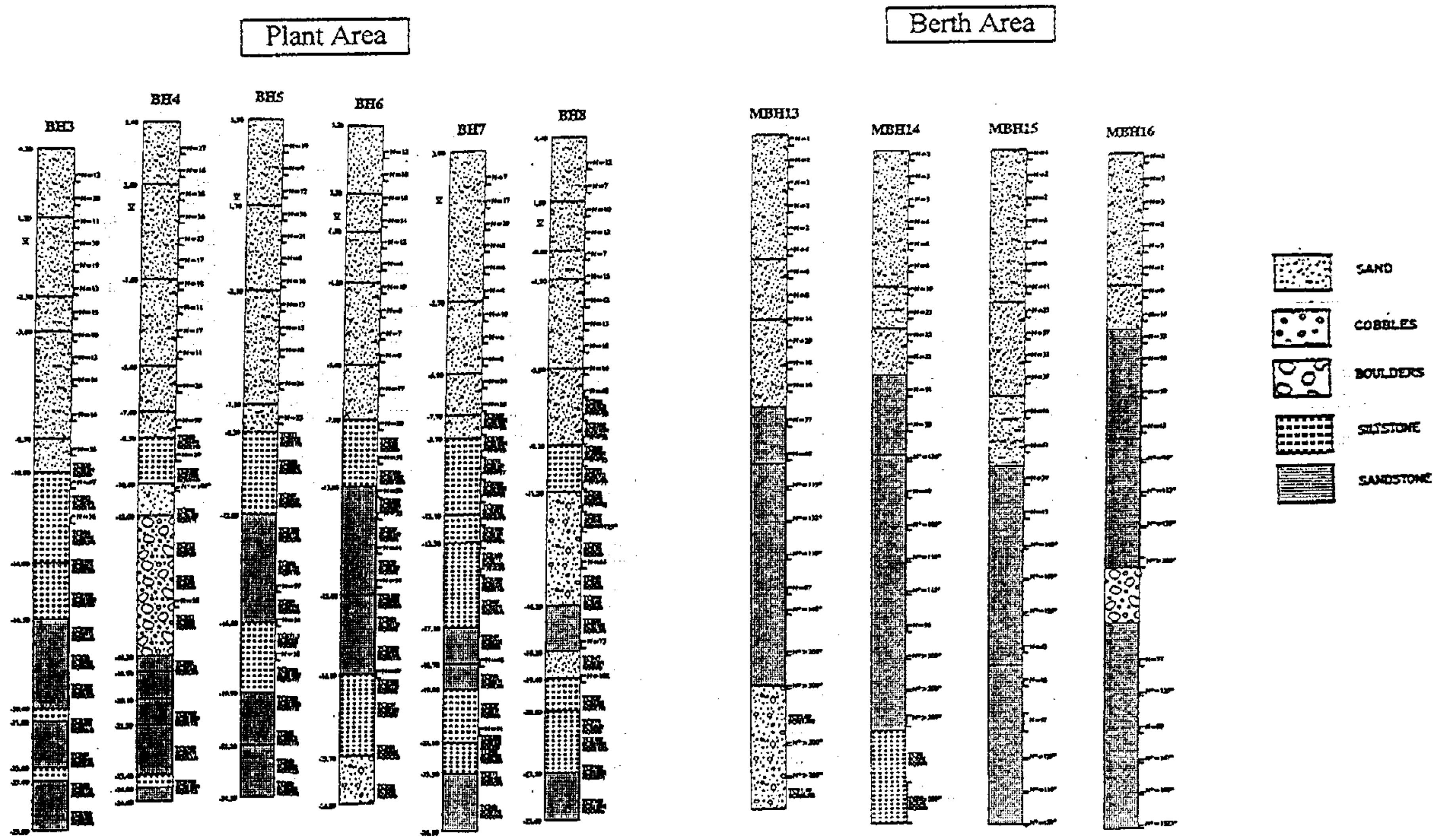


Figure 9-1-4 Boring Data in Sohar (Source: MOC)

(4) Sea condition

Sea condition is another important factor that should be considered in the design and construction of berth. The summary of sea conditions in Sohar are as follows:

1) Tidal level

Tidal observation was carried out by Japan International Cooperation Agency (JICA) in 1990. Tidal levels are shown in Figure 9-1-5.

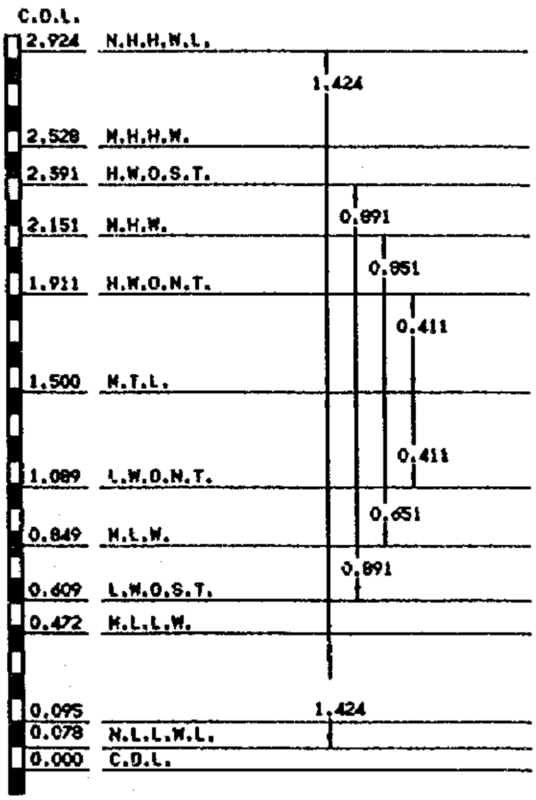


Figure 9-1-5 Tidal Level in Sohar (Source: JICA Report 1990)

2) Waves

By using wave records at Muscat and wind records at Sohar (Majis), the frequency distribution of wave directions and wave heights were estimated by JICA in 1990. The prevailing wave directions are northward and eastward. The predominant height of wave is less 0.4 m with occurrence at about 68%. (Figure 9-1-6)

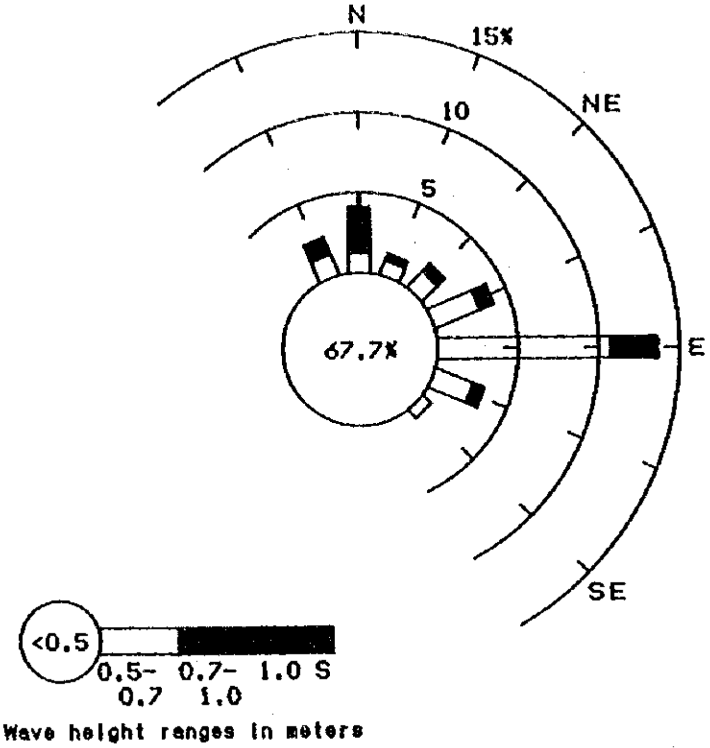


Figure 9-1-6 Wave Data in Sohar (Source: JICA Report 1990)

3) Tidal current

Tidal current observation was carried out at Sohar (Majis) by JICA in 1990. According to the JICA report, the tidal current velocity is less than 0.1 m/sec at about 2 meters above the seabed. Primary directions of tidal currents are northwestward and southeastward.

4) Drift sand

From the JICA report in 1990 it was found that the net rate of sand drift is about 12,000 m3/yr in northward direction, with gross rates of 18,000 m3/yr in the northward direction and 6,000 m3/yr in the southward direction. Since the rate is considerably low, no significant maintenance dredging will be required.

5) Earthquake

There is a moderate risk of earthquake in the northern part of Oman as compared with the southern part. However, the current regulation makes no reference to design that considers earthquakes and does not state and/or mention special allowance for earthquakes in the design of major structures. Therefore, seismic design work will not be required.

9.1.3 Site preparation

Based on the data on the present geographic conditions of the Steel Complex construction site, it is confirmed that the ground surface is almost flat over the area (ground levels vary from D.L 0 to +3 meters). The ground level will be made higher to DL +4.3 meters, the ground level set/required by the Sohar port construction work. For this purpose, the filling work of as thick as 3 meters should be done. Dredged soil from the port construction work by the government will be used as fill materials. In such case, only ground leveling work will be carried out by the Steel Complex project.

9.2 Social Conditions

9.2.1 Human resources

According to the General Census of Population in 1993, the total population in Oman was 2,018,074 and Al Batinah Governorate 564,677, and the economically active male population is 148,307. The study team heard from the Director of Sohar Industrial Estate that the population in Sohar is around 100,000. The Census shows that the population of boys aged between 10 and 15 in 1993 was about 139,000 (by educational attainment table), and by simple assumption, 5% (100,000/2,018,074) of them, approximately 7,000 boys, may be in Sohar.

From those figures, we do not see any problem on recruiting work forces for the Steel Complex since it will only need 1,200 workers at most, and it is also possible to recruit from outside Sohar.

9.2.2 Housing

It will be possible to build corporate houses and dormitories near to the Steel Complex. It will also be possible to obtain sufficient numbers of good level houses for rent. This is the answer from Sohar Development Office which works is under the Ministry of Housing. And they say Sohar is a developing city so it will not be necessary to worry about problems related to the Steel Complex employee's housing.

9.2.3 Hospital

There are two hospitals, Sohar Hospital and Wadi Hecbi Hospital, in Sohar. They have 481 beds and 115 doctors with 350 nurses. Besides the above, there are 57 doctors and 197 nurses in Wadi Aahin Health Center and Sohar Extended Health Center covering Sohar Wilayat. Therefore, the Steel Complex will not need to have a corporate clinic of its own even if the number of employees increases by 1,200. These medical institutions will be sufficient to conform to the needs of Steel Complex employees.

9.2.4 Schools

In the academic year 1997/1998, there are total 42 elementary, preparatory and secondary schools (38 governmental and 4 private) and 1,213 teachers in Sohar, and 27,801 students are studying. We do not see any outstanding problems concerning schools, because the government takes care of all school projects properly.

Chapter 10. RAW MATERIALS FOR THE STEEL COMPLEX

10.1 General

The raw materials required in a direct reduction (DR) process of iron oxide and an electric arc furnace (EAF) route of a steel making plant include iron ore (oxide pellets and lump ore), scrap and other auxiliary materials such as limestone cokes, ferro-alloys, aluminum and fluorite. Generally, a feasibility study is based on the principle that these raw materials are of local origin or production. However, in this study, the raw materials were classified into those to be locally procured in Oman and those to be imported, with consideration given to the present status of the resource researches and the developments being conducted in Oman.

As the result of this study, the raw materials were divided into three categories as follows, depending on supply sources:-

(1) Domestic supply

Limestone

(2) Domestic and importation, together

Steel scrap

(3) Importation

1) Iron ore (oxide pellets and lump ore)
2) Graphite electrodes
3) Refractories
4) Cokes (lump or breeze)
5) Ferro-manganese
6) Ferro-silicon
7) Aluminum (shot and bar)
8) Fluorspar

Although locally produced scrap is available in the domestic market, the quantities do not suffice for the Steel Complex so it was concluded that steel scrap would also be imported. Limestone is produced in Oman.

Typical standard quantities of the raw materials required for the Steel Complex of 1.2 million tons per year production basis are shown in Table 10-1-1.

Table 10-1-1 Main Raw Materials for the Steel Complex

(Unit: tons/y)

Raw Material		Quantity	Remarks
Iron ore	Oxide pellets	1,885,000 -1,320,000	Maximum ratio of lump ore will be
	Lump ore	0 - 565,000	30%
Steel scrap		98,900	Purchased steel scrap
Limestone		100,800	
Cokes (lump or breeze)		42,000	
Ferro-alloy	Ferromanganese	12,200	
	Ferro-silicon	5,300	
Aluminum		120	
Fluospar		120	

10.2 Iron Ore

In the Sultanate of Oman, there are iron oxide deposits in the northern part of the country which have the following reserves, according to a map "Potential Industrial Rock and Mineral Resources" obtained at Directorate of General of Minerals, MOCI in Salalah.

Deposit Name	Potential Reserves	Estimated Reserves	Indicated Uses
Ibra	125,000,000 tons	70,000,000 tons	Cement, Pigment
Hawshi	30,000 tons	3,000 tons	Pigment
Fanayt	100,000 tons	25,000 tons	Pigment

Although only the Ibra deposit has a big reserve, the iron content of the ore is said to be as low as around 48 %, which is not suitable for the Direct Reduction (DR) feed materials, unless it is processed to higher grade by concentration and agglomeration. Developing the deposit for steel making use is not planned for the present.

A feed suitable for blast furnace operation (other than sinter) is generally suitable for use by the direct reduction process. However, some feeds that are not suitable for the blast furnace, such as low silica oxide pellets and lump ore, can be processed by the direct reduction plant. As discussed in Chapter 5, the Steel Complex will adopt the gas -based Direct Reduction (DR) - Electric Arc Furnace (EAF) process for steel making. In the case of a DR-EAF process, higher ferrous content (lower slag constituents) in the iron oxide is preferred for efficient EAF steel making operation.

10.2.1 Characteristics of iron ore for DR process

The quality requirements of iron ore suitable for the process are in general as follows;

(1) Chemical composition

Since the gangues can not be separated from the iron ore in the DR process, it is obvious that a particularly strong demand must be placed upon the chemical composition of the iron ore. The principal requirements concerning chemical composition of iron ore are as follows.

Total Fe (iron)	:	67% or more (preferably)
P (phosphorus)	:	0.03% or less
S (sulfur)	:	0.025% or less

$(SiO_2 + Al_2O_3)/Fe \times 100$: 5% or less

When raw materials containing a high proportion of gangues are fed into the EAF, a large volume of slag will be produced, thus leading to an adverse influence on steel making efficiency and to an increase in unit consumption of electric power. To avoid these inconveniences iron ore with less gangues must be used.

Most recent operational experiences with the DR/EAF route indicate that up to 5% of slag to iron ratio, or $(SiO_2+Al_2O_3)/Fe \times 100$, are considered to be permissible.

It is well known that P and S are harmful for the quality of steel, thus they are restricted to within certain limits.

(2) Physical properties

General main requirements concerning physical properties are as follows;

1) Particle size:
   Pellets ; 9 mm - 16 mm, as main size fraction
   Lump ore ; 10 mm -35 mm, as main size fraction

2) Cold crushing strength: 250 kg/pellet

10.2.2 Supply source

As there are many sources of iron ore supply in the world, the quality of which can comply with above specification, this feasibility study shall be made on the assumption that all iron oxide to be used for DR plant shall be procured from abroad on the international competitive unit price basis and suitably blended in the Steel Complex before feeding to the DR plant .

The DR grade iron ore of major existing mines or suppliers in the world, which are being fed into DR plants and tested at a laboratory scale, are listed in Table 10-2-1. They have been evaluated with respect to the suitability for DR and free market availability to a DR plant.

Table 10-2-1 DR Grade Iron Ore of Major Existing Mines or Supplier

Country	Brand or Supplier's Name	
	Oxide Pellets	Lump Ore
Bahrain	GIIC	-
Brazil	CVRD Samarco	Ferteco MBR (Mutuca)
Chile	CMP	-
India	Kudremukh	-
Peru	Hierro Peru	-
Sweden	LKAB	-

10.2.3 Transportation

There are two main factors affecting the transportation cost (freight rates) for receivers of heavy and large bulk cargoes such as iron ore.

One is whether a large scale receiving port for large bulk cargo with unloaders is available. General required sea water depth in low tide (LTWD) for an iron ore vessel is as follows;

Type of vessel	Capacity	LTWD
a) Cape size	125,000 ton and more	16 - 20 m
b) Panamax	Less than 80,000 ton	10 - 16 m

The other is the location of the receiver's unloading port. Freight rates vary depending upon whether a loading port of following or return cargo is located near or distant from the unloading port of iron ore, and whether the chances to find succeeding or return cargoes are frequent or not.

Vessel size and freight rate adopted to this study are based on the conditions of Sohar port. However, an optimum vessel size and freight rate may be studied in detail at the time of preparing for an eventual supply contract of iron ore.

10.3 Steel Scrap

Steel scrap is one of the main raw materials for the EAF (Electric Arc Furnace) in the DRI (Direct Reduced Iron) - EAF process. Scrap will be consumed at about 150,000 t/y for the Steel Complex with 1,200,000 t/y reinforcing bar production. Scrap quality will require a low content of tramp elements such as copper, nickel, chromium, sulfur, phosphorus, etc. and gangue materials.

According to a study done for the MOCI (Ministry of Commerce and Industry) in August 1993 and the Export Statistics published in the Foreign Trade Statistics by the Royal Oman Police, it is said that:

> " A fair amount of scrap was accumulated and exported during the late 1980s from PDO (Petroleum Development Oman), the surge in construction in the early 1980s and a stockpile of discarded motor vehicles.
>
> At that time, no statistics existed to reveal the exact scale of the reserve or to reliably show the volume of regular occurrence, but, between March 1987 and June 1988 one contractor removed 30,000 tons of redundant steel scrap, between July 1988 and May 1990 the same company cleared only 3,500 tons. SPECO (Scrap Processing & Earthmoving Co. LLC.), the processor of steel scrap in Oman, had a monthly throughput which varied between 300 and 500 tons in 1993.
>
> It appears that all accumulation of PDO scrap was cleared by the end of the 1980s. This circumstance is not limited to PDO, but is a general phenomenon in Oman."

Table 10-3-1 shows steel scrap exports from 1987 to 1995 and Table 10-3-2 the destinations of these exports.

The above study mentioned that steel scrap in Oman had been cleared by the end of the 1980s and a little generation was expected, however, this steel scrap of 40,000 to 60,000 t/y is exported according to Table 10-3-1. Almost all of this could be utilized for the Steel Complex, if not exported.

During the first field survey, the Study Team found that 130,000 - 150,000 t/y of steel is imported to Oman and production of reinforcing bars is 70,000 t/y in the Sharq Sohar Steel Rolling Mills LLC. in Sohar. Considering that around five percent of materials will usually be scrapped during processing, scrap of approximately 10,000 t/y will be generated.

Furthermore, during the second field survey, the Study Team obtained information that steel scrap of approximately 50,000 t/y is now being exported, which could be available for the Steel Complex.

As the possible domestic steel scrap of 50,000t/y is not sufficient to the requirements of 150,000 t/y for the Steel Complex, 50,000 t/y of steel scrap should be imported. The remaining scrap of 50,000 t/y will be supplied as home scrap generated in the Steel Complex and is shown in Figure 5-3-1 (21,700 t/y + 26,400 t/y).

Table 10-3-1 Steel Scrap Exports

	Ton	RO.	RO./ton
1987	37,625	1,325,924	35.24
1988	42,051	1,335,138	31.75
1989	52,403	1,592,022	30.30
1990	63,201	2,088,933	33.05
1991	48,254	1,610,828	33.38
1992	40,005	1,390,374	34.76
1993	55,237	1,663,486	30.12
1994	54,855	1,871,398	34.12
1995	62,946	2,229,003	35.41

Source : MOCI

Note : Above figures from year 1987 to 1990 are based on "Foreign Trade Statistics 1990, Directorate General of Customs" and others "FOREIGN TRADE STATISTICS 1995".

Table 10-3-2 Steel Scrap Exports Destinations in 1995

	Ton	RO.	RO./ton
INDIA	4,272.000	132,501	31.02
LEBANON	20.190	1,690	83.70
PAKISTAN	8,528.550	380,758	44.65
SYRIA	48.020	1,890	39.36
IRAN	517.220	38,156	73.77
N. YEMEN	10.000	130	13.00
QATAR	5.000	1,740	348.00
U. A. E.	49,545.140	1,672,138	33.75

Source : MOCI

Note : Above figures are based on "FOREIGN TRADE STATISTICS 1995".

10.4 Burnt Lime and Limestone

10.4.1 Burnt lime

Burnt lime will be consumed in the electric arc furnace for slag formation after being calcined from limestone. Burnt lime consumption is approximately 50,000 t/y for the Steel Complex of 1,200,000 t/y reinforcing bar production. The burnt lime will require the following chemical properties with appropriate strength for the steel making process.

(1) CaO content : 90 % minimum.
(2) SiO_2 content : 4 % maximum.
(3) P content : 0.04 % maximum.
(4) S content : 0.03 % maximum.
(5) Ig. Loss : 3 % maximum.

A calcining plant to produce burnt lime is not existent in Oman.

10.4.2 Limestone

The burnt lime required for the steel making process is not available in Oman. Therefore, a calcining plant shall be installed inside or outside the Steel Complex. Even though it will be installed inside or outside the Steel Complex, limestone consumption will be approximately 100,000 t/y for the Steel Complex of 1,200,000 t/y rebar production. The limestone will require the following chemical properties with appropriate strength after being calcined for the steel making process.

(1) CaO content : 48 % minimum
(2) SiO_2 content : 2 % maximum
(3) P_2O_5 content : 0.1 % maximum
(4) S content : 0.10 % maximum

According to the information/data provided by the Directorate General of Minerals, MOCI, abundant limestone is available in all of Oman.

In the Salalah area, according to the information/data of the Directorate General of Minerals, Salalah branch of MOCI, there are two proposed deposits which the Study Team visited on the first field survey, The Titam and Uyun deposits. Those two deposits are 50 - 60 km from Raysut and located beyond the Green Area, about 2 km from the paved road.

Tables 10-4-1 and -2 show the limestone analysis of the Titam and Uyun deposits. Reserves are expected to be 50 million tons in Titam and more than 100 million tons in Uyun. The limestone analysis shown in Tables 10-4-1 and -2 will meet the chemical composition requirements for the steel making process and the limestone looks hard enough to be calcined to lumpy burnt lime.

Furthermore, information and literature (* 1) on Rakoob Limestone were provided by the Directorate General of Minerals, Salalah branch of MOCI during the first and second field surveys. It is situated very close to Raysut, about 17 km north west.

Rakoob limestone is a very high calcium limestone, with no overburden containing about 77.75 million tons of measured reserve. Chemical composition of samples is shown in Table 10-4-3 which will meet the requirements for the steel making process.

Unfortunately the deposit lies within the environmentally sensitive Green Area, where mining activity is presently prohibited, however, the Directorate General of Minerals, Salalah branch of MOCI commented that it is worth trying to get the approval of the high authorities and concerned departments (e.g. Ministry of Environment) to exploit it, if the deposit is to be available for the Steel Complex.

The limestone of these three deposits seems to be suitable for the steel making process, however, detailed tests are necessary at the implementation stage of this project

*1 Ministry of Petroleum and Minerals, Directorate General of Petroleum and Minerals, Governorate of Dhofar

RAKOOB LIMESTONE AND PRECEDING RECONNAISSANCE

Field Work by H. A. Qidwai and Mohed Ishag Khalifa, Reported by Mohed Ishag Khalifa, Department of Geological Survey and Exploration, Salalah, July 1996

In the Sohar area, information and literature (*2) furnished by MOCI during the first and second field surveys commented on Wadi Jizi limestone as follows;

- It lies about 30 km west of the town of Sohar.
- It is easily reached by paved road and then by truck.
- Overburden is not existent but the steep relief could pose exploitation problems, however, it has been being exploited.
- Reserves are estimated more than 500,000 t.
- Quality is good. X-ray fluorescent analysis is shown in Table 10-4-4, however should the limestone be considered as a potential resource, the analysis needs to be confirmed through systematic sampling followed by drilling.
- MOCI considers it is not suitable for the Steel Complex due to the small quantity of reserves.

*2 Sultanate of Oman, Ministry of Petroleum and Minerals, Directorate General of Minerals
M.P.M. GEOLOGICAL DOCUMENTS - Industrial Rocks and Minerals Deposits in the Sultanate of Oman -
J. P. Pasquet, Muscat 1995

Furthermore, the Study Team was informed of three other deposits, Ruwaydah, Wadi Salahi and Tertiary by the Directorate General of Minerals, MOCI during the second field survey. The Study Team visited Ruwaidah and Wadi Salahi along with Wadi Jizi.
Ruwaydah limestone is expected to contain high SiO_2 content. Therefore MOCI considers it is not suitable for the Steel Complex. Results of sample analysis are shown in Table 10-4-5.
Wadi Salahi limestone will have good quality and 2- 3 million tons of reserves. A new road less than 3 km long could easily be constructed from the existing paved road. MOCI considers it suitable for the Steel Complex. Table 10-4-6 shows results of sample analysis.
These two deposits are 50 - 60 km from Sohar.
Tertiary limestone is located in the Ibri area and is 200 km from Sohar. It will have good quality but is quite far from Sohar though connected by paved road. MOCI considers that use of it for the Steel Complex depends on economic factors.
In any events, limestone will be available in the Sohar area and detailed investigation and testing are necessary at the implementation stage of this project

In the Sharqiya area, literature (*3) furnished by MOCI mentions the following;

- There are two deposits, Salmiyah Limestone, south of Sur, and Exotic Limestone near Al Ashkharah.
- Analysis results of samples on Salmiyah Limestone have been very encouraging with most of the samples analyzed at >54.00% CaO. Reserves are huge. This limestone is suitable for cement manufacture as well as a filler provided some commercial testing be carried out. Considering transportation costs, the Muscat and Sur markets should be targeted.
- The exotic Limestone results are also very encouraging as it can be used for marble block and chips, as a filler in many industrial processes as well as for power generation if a coal based power generation plant comes on line in the Sharqiya area.

*3 INDUSTRIAL ROCKS AND MINERALS SURVEY SHRQIYA AREA Directorate General of Minerals, Ministry of Petroleum & Minerals 1996

Table 10-4-1 Examples of Limestone Analysis (Titam Deposit)

Unit: %

Sample No	$CaCO_3$	Fe_2O_3	Al_2O_3	MgO	MnO	Cr_2O_3	Ni	NaCl	SO_4	Moisture	Insoluble + SiO_2	L.O.I
MK96001	98.2	0.03	0.08	0.19	<0.005	<0.005	<0.005	0.02	<0.005	0.2	0.61	43.6
MK96002	97.5	0.06	0.10	0.22	<0.005	<0.005	<0.005	0.02	<0.005	0.3	1.71	43.6
MK96003	97.5	0.02	0.04	0.25	<0.005	<0.005	<0.005	0.02	<0.005	0.2	0.21	43.8
MK96004	96.8	0.02	0.06	0.22	<0.005	<0.005	<0.005	0.02	<0.005	0.3	1.06	43.4
MK96005	98.3	0.03	0.06	0.18	<0.005	<0.005	<0.005	0.02	<0.005	0.3	0.22	43.7
MK96006	98.5	0.02	0.06	0.18	<0.005	<0.005	<0.005	0.01	<0.005	0.2	0.66	43.5
MK96007	97.9	0.02	0.05	0.17	<0.005	<0.005	<0.005	0.01	<0.005	0.1	0.71	43.5
MK96008	98.6	0.01	0.04	0.12	<0.005	<0.005	<0.005	0.02	<0.005	0.1	0.49	43.5
MK96009	98.5	0.02	0.06	0.18	<0.005	<0.005	<0.005	0.02	<0.005	0.2	0.11	43.5
MK96010	98.1	0.01	0.06	0.19	<0.005	<0.005	<0.005	0.02	<0.005	0.2	1.01	43.8
MK96011	97.1	0.01	0.05	0.17	<0.005	<0.005	<0.005	0.02	<0.005	0.2	0.75	43.4
MK96012	98.6	0.01	0.05	0.16	<0.005	<0.005	<0.005	0.02	<0.005	0.2	0.55	43.5
MK96013	98.3	0.01	0.05	0.18	<0.005	<0.005	<0.005	0.02	<0.005	0.1	0.61	43.4
MK96014	99.0	0.01	0.05	0.16	<0.005	<0.005	<0.005	0.01	<0.005	0.1	0.21	43.5
MK96015	97.3	0.03	0.08	0.17	<0.005	<0.005	<0.005	0.01	<0.005	0.1	0.47	43.3
MK96016	98.1	0.02	0.05	0.14	<0.005	<0.005	<0.005	0.01	<0.005	0.1	0.34	43.4
MK96017	98.0	0.02	0.06	0.14	<0.005	<0.005	<0.005	0.01	<0.005	0.1	0.28	43.3
MK96018	97.6	0.02	0.05	0.28	<0.005	<0.005	<0.005	0.01	<0.005	0.1	0.22	43.7
MK96019	98.1	0.01	0.05	0.18	<0.005	<0.005	<0.005	0.01	<0.005	0.1	0.21	43.0

Source: Salahla Branch of MOCI (Minerals)

Table 10-4-2 Examples of Limestone Analysis (Uyun Deposit)

Unit: %

Sample No.	$CaCO_3$	Fe_2O_3	Al_2O_3	MgO	MnO	Cr2O3	Ni	Nacl	SO_4	Moisture	Insoluble + SiO_2	L.O.I
U-1	96.8	0.30	0.12	0.18	<0.005	<0.005	<0.005	0.01	<0.005	0.3	0.75	43.4
U-2	98.0	0.09	0.07	0.13	<0.005	<0.005	<0.005	0.01	<0.005	0.2	0.41	43.7
U-3	98.0	0.06	0.06	0.15	<0.005	<0.005	<0.005	0.02	<0.005	0.2	0.34	43.8
U-4	98.5	0.03	0.04	0.09	<0.005	<0.005	<0.005	0.01	<0.005	0.2	0.25	43.7
U-5	98.3	0.04	0.05	0.17	<0.005	<0.005	<0.005	0.01	<0.005	0.2	0.46	43.8
U-6	98.2	0.03	0.04	0.10	<0.005	<0.005	<0.005	0.01	<0.005	0.2	0.29	43.7
U-7	98.5	0.03	0.05	0.10	<0.005	<0.005	<0.005	0.01	<0.005	0.2	0.15	43.8
U-8	98.1	0.03	0.05	0.11	<0.005	<0.005	<0.005	0.01	<0.005	0.2	0.27	43.7
U-9	98.5	0.03	0.25	0.13	<0.005	<0.005	<0.005	0.01	<0.005	0.1	0.24	43.8
U-10	98.3	0.03	0.05	0.16	<0.005	<0.005	<0.005	0.01	<0.005	0.2	0.26	44.0
U-11	98.2	0.04	0.04	0.09	<0.005	<0.005	<0.005	0.01	<0.005	0.2	0.05	43.8

Source: Salahla Branch of MOCI (Minerals)

Table 10-4-3 Examples of Limestone Analysis (Rakoob Deposit)

Unit: %

Sample No.	$CaCO_3$	Fe_2O_3	MgO	MnO	Na_2O	K_2O	Moisture	Insoluble
L1-1	98.1	0.027	0.112	0.003	0.023	0.004	0.4	0.71
L1-2	99.5	0.015	0.128	0.003	0.022	0.004	0.2	0.18
L1-3	99.9	0.032	0.113	0.003	0.025	0.005	0.2	0.52
L1-4	97.6	0.062	0.259	0.008	0.030	0.009	0.3	0.81
L1-5	98.9	0.070	0.234	0.006	0.025	0.009	0.2	0.52
L1-6	99.2	0.020	0.187	0.004	0.029	0.004	0.3	0.29
L1-7	98.9	0.018	0.197	0.004	0.022	0.004	<0.1	0.25
L1-8	98.7	0.041	0.191	0.007	0.024	0.005	0.3	0.34
L1-9	97.2	0.093	0.224	0.007	0.027	0.010	0.2	0.64
L1-10	99.3	0.034	0.186	0.006	0.027	0.005	0.3	0.30
L1-11	99.3	0.042	0.219	0.004	0.025	0.009	0.2	0.29
L1-12	99.0	0.036	0.184	0.004	0.020	0.007	0.3	0.46
L1-13	99.6	0.030	0.170	0.003	0.027	0.005	0.3	0.40

Source: Salahla Branch of MOCI (Minerals)

Table 10-4-4 Examples of Limestone Analysis (Wadi Jizi Deposit)

Unit: %

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	MnO	P_2O_5	L.O.I.
<0.50	<0.20	<0.05	55.50	0.50	<0.20	<0.05	<0.05	<0.02	0.06	43.40

Source: MOCI (Minerals)

Table 10-4-5 Examples of Limestone Analysis (Ruwaydah Deposit)

Unit: %

1	54.6	0.17	0.21	0.01	0.01	0.02	1.55	43.07	0.99	<0.01	0.04
2	55.0	0.16	0.23	0.01	0.02	0.03	1.65	42.94	1.29	<0.01	0.06
3	52.9	0.75	0.38	0.02	0.08	0.03	2.87	42.15	2.37	0.05	0.05

Source: MOCI (Minerals)

Table 10-4-6 Examples of Limestone Analysis (Wadi Salahi Deposit)

Unit: %

Sample No	CaO	Fe_2O_3	MgO	MnO	K_2O	Na_2O	Insoluble + SiO_2	L.O.I	SiO_2	P_2O_5	S
1	52.8	0.24	0.65	0.02	0.01	0.03	2.88	42.45	2.73	0.01	0.05
2	54.2	0.17	0.39	0.03	0.01	0.03	2.48	42.88	1.73	0.01	0.04
3	53.8	0.19	0.36	0.02	0.01	0.03	1.73	42.88	1.49	0.01	0.07
4	53.2	0.14	0.46	0.01	0.01	0.03	3.23	42.41	2.91	<0.01	0.04
5	53.2	0.32	0.41	0.03	0.01	0.03	3.10	42.29	2.86	0.01	0.08
6	55.1	0.13	0.39	0.01	0.01	0.03	0.53	43.46	0.42	<0.01	0.08
7	41.7	0.13	0.22	0.01	0.04	0.03	22.90	33.76	22.05	<0.01	0.08

Source: MOCI (Minerals)

10.5 Other Auxiliary Materials

10.5.1 Ferro-manganese (Fe-Mn)

Ferro-manganese is consumed in the electric arc furnace for alloying. Ferro-manganese consumption will be approximately 12,200 t/y for the Steel Complex of 1,200,000 t/y reinforcing bar production. The ferro-manganese will require the following chemical properties and size for the steel making process.

(1) Mn content : 73 - 78 %
(2) C content : 7.0 % maximum
(3) Si content : 3.0 % maximum
(4) P content : 0.40 % maximum
(5) S content : 0.02 % maximum
(6) Size : lump, 25 - 60 mm

Ferro-manganese is not being produced in Oman and there is no plan to construct a ferro-manganese production plant. It must be imported.

10.5.2 Ferro-silicon (Fe-Si)

Ferro-silicon is consumed in the electric arc furnace for alloying. Ferro-silicon consumption will be approximately 5,300 t/y for the Steel Complex of 1,200,000 t/y rebar production. The ferro-silicon will require the following chemical properties and size for the steel making process.

(1) Si content : 75 - 80 %
(2) C content : 0.2 % maximum
(3) P content : 0.05 % maximum
(5) S content : 0.02 % maximum
(6) Size : lump, 25 - 75 mm

Ferro-silicon is not being produced in Oman but there is a plan to construct a ferro-silicon production plant at the preliminary stage. It must be imported until such a plant is in operation.

10.5.3 Fluorspar (CaF_2)

Fluorspar is consumed in the electric arc furnace in which slag is generated during the steel making process. Slag viscosity is improved by adding fluorspar. Consumption will be approximately 120 t/y for the Steel Complex of 1,200,000 t/y reinforcing bar production. The fluorspar will require the following chemical properties and size for the steel making process.

(1) CaF_2 content : 70 % minimum
(2) SiO_2 content : 20 % maximum
(3) Size : lump, 10 - 50 mm

Fluorspar is not being produced in Oman and there is no plan to construct a fluorspar production plant. It must be imported.

10.5.4 Coke

Coke is consumed in the electric arc furnace as a carbon source in lump form and for the carbon injection process in fine form. The carbon injection process is an advanced operating technique for generating foamy slag. Coke consumption is approximately 42,000 t/y for the Steel Complex of 1,200,000 t/y reinforcing bar production. The coke will require the following chemical properties and size for the steel making process.

(1) C content : 87 % minimum
(2) S content : 1 % maximum
(3) Volatile and ash : 7 % maximum
(4) Size : lump (10 - 50 mm) and fines (under 3 mm)

Coke is not being produced in Oman and there is no plan to construct a coke production plant. It must be imported.

10.5.5 Aluminum

Aluminum in bar form is consumed in the electric arc furnace for de-oxidation. Consumption will be approximately 120 t/y for the Steel Complex of 1,200,000 t/y reinforcing bar production. The aluminum will require the following chemical properties and size for the steel making process.

(1) Al content : 99.9 %
(2) Shape and weight : 1 kg bar

Aluminum is not being produced in Oman at present. An aluminum smelter is under study. It is likely to be in production by the year 2001. Therefore aluminum will be imported until it is actually in production.

10.5.6 Graphite electrode

Graphite electrodes are used in the electric arc furnace for introducing current into the charged materials, scrap and DRI. Consumption will be approximately 23,000 t/y for the Steel Complex of 1,200,000 t/y reinforcing bar production.

The electrodes are of so called UHP (ultra-high-power)-use and UHP electrodes are usually produced in Europe, USA and Japan.

Graphite electrode is not being produced in Oman and it must be imported.

10.5.7 Refractories

Many kinds of refractories for steel making are used in high temperature furnaces, steel ladles, etc. These are, for example, basic and alumina silicate bricks (for furnace wall and ladles), ramming materials (magnesia: for furnace hearth lining), gunning materials (magnesia: for furnace slag line repair) and fettling materials (soft burned dolomite: for furnace slag line repair). Refractories consumption will be approximately 18,400 t/y for the Steel Complex of 1,200,000 t/y reinforcing bar production and high quality products are required for the steel making process.

Refractories are not being produced in Oman. The Ministry of Commerce and Industry conducted a study for the production of magnesia, however, this project has not been developed and is not expected to be implemented in the near future. Refractories must be imported.

Chapter 11. IMPLEMENTATION PLAN

11.1 Project Schedule

The overall implementation schedule for the Steel Complex project is shown in Figure 11-1-1.

The start-up date of the Steel Complex is scheduled to be July 1, 2004. The total construction period from basic engineering to start-up of the project is estimated at 54 months and the period of construction for major plants from CIF contract to start-up is set at 36 months. Other ancillary facilities shall be implemented with proper timing for start-up of the Steel Complex.

During construction, management's attention and control shall be required in the following three stages. Activities and events in each stage are stated below.

11.1.1 Preparation stage

At this stage, the basic engineering, which includes such work as review of the feasibility study, environmental impact assessment (E.I.A), overall implementation schedule, organization of management and the operating plan are conducted.

When construction of the new steelworks has been decided and approved by the owner and relevant authorities, project organization shall be established and contractual strategies shall be made.

11.1.2 Bidding stage

The project is executed by contracts concluded between the project owner and contractors. Inadequate content of the bidding and contract documents, inadequate bidder qualifications or bid management will cause serious damage to the following contract performance and administration.

11.1.3 Construction stage

Construction administration shall involve a correction of processes and schedule, a series of responses to events and control of the project. Progress payments, record keeping, claims and change orders are common to all contract administration.

Contract administration begins with the signing of contractual documents, continues throughout the performance period, and ends with the formal termination of the contractual relationship.

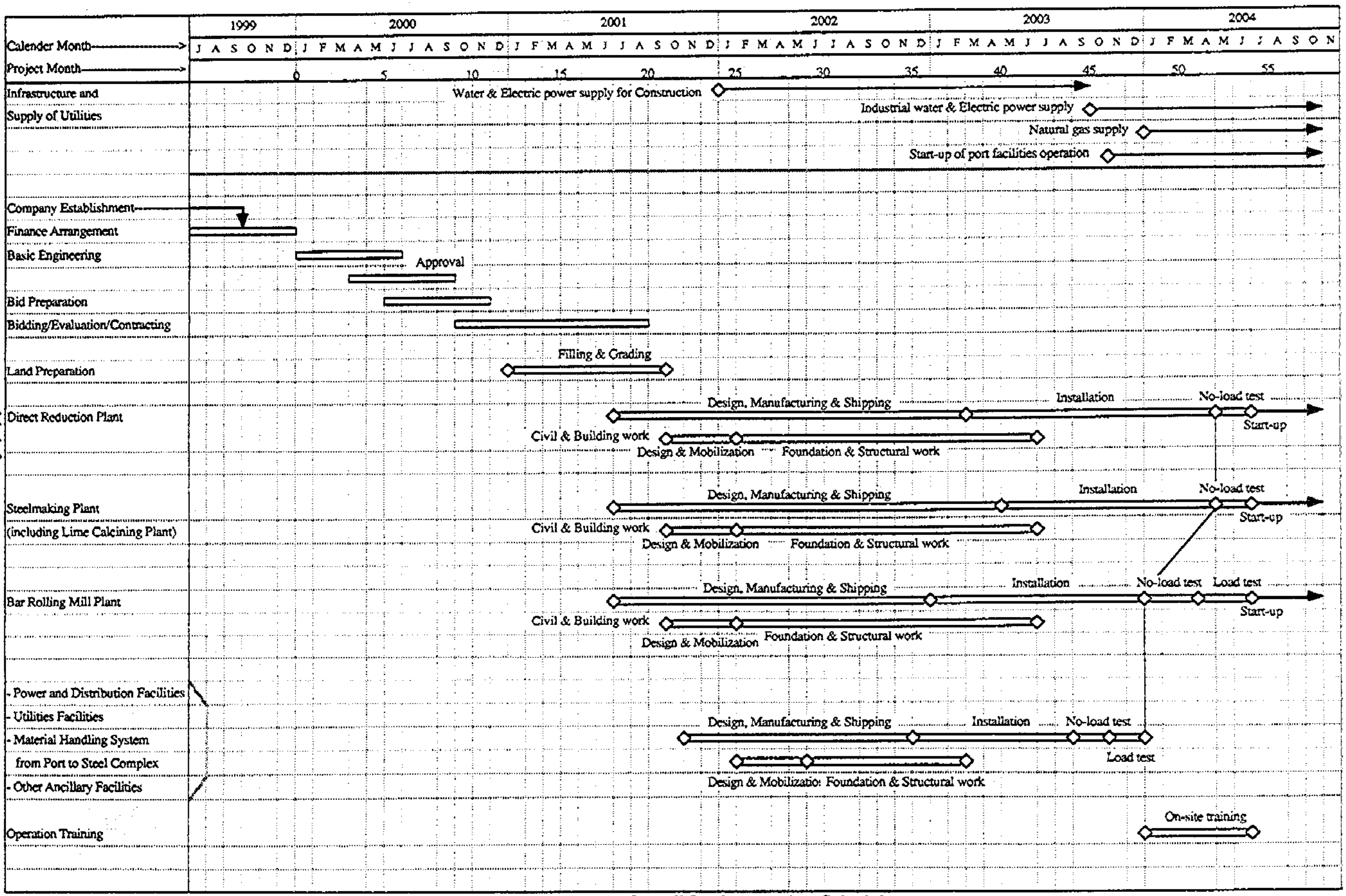


Figure 11.1.1 Overall Implementation Schedule

11.2 Establishment of the Company

11.2.1 Role and function of the Company

Once the viability of the Steel Complex Project is confirmed, it is required to establish a business entity (the Company) carrying out the investment and operation of the Steel Complex.

The role and function of the Company are as follows at each stage.

(1) Promotion stage

At this stage, usually a few, limited founders will organize the Company at a nominal capital as a promotion Company.

To prepare the bankable feasibility study report by appointing a reliable and competent financial advisor, to invite equity participant (shareholders), and to arrange required loans;

bankable FS report includes the following;

- confirmation and/or draft contracts of required utilities (natural gas, water, electricity and the infrastructure) with price formula or schedule at a definite time schedule
- confirmation of readiness to obtain approvals from governmental authorities concerned in Oman
- confirmation and/or draft contracts of providing managerial and operational assistance by a reliable and competent steel company or companies in order to assure and maintain the satisfactory production level
- confirmation and/or draft contracts of marketing or marketing cooperation with reliable and competent trading company or companies
- confirmation and/or draft contracts of related plant supply and construction
- confirmation of intention of equity participants to cover the planned equity capital.

Based on the bankable FS report, required loan financing will be able to arranged.

(2) Transformation from promotion company to substantial operating company

Once the above-mentioned confirmations and finance arrangement are ready, the Company, which is the substantial entity to execute the Steel Complex project, is transformed from the promotion company or newly established on the basis of the shareholders agreement and articles of association.

Upon establishment, the Company will enter into contracts with concerned parties in accordance with the confirmations and draft contracts mentioned above.

(3) Construction stage

The major functions of the Company at this stage are:

- contract awards of plant supply and constructions
- administration of the plant construction
- recruiting of employees for overseas and in-plant training as planned
- control of funds and expenditures

11.2.2 Shareholding structure of the Company

In consideration of the objectives of the Company (industrialization and human resource development in Oman) and the privatization policy of Oman, it is advisable and indispensable that the following shareholders will involved in the Company.

(1) Omani leading private entities
(2) Foreign companies who can undertake the technology transfer for the engineering, operation, management and marketing of the most efficient steel complex.
(3) Omani governmental authorities or investment institutions

11.3 Organization and Personnel

11.3.1 Organization

An organization plan of this project is charted in Figure 11-3-1. This organization is made under the following consideration based on experiences of similar steel plant in Arab countries.

- Main raw material receiving from bulk carriers and product loading onto cargo ships are included in the company organization as one section in Production Department.
- Top Management Affairs section is positioned in the place directly controlled by the Managing Director whose main jobs will be Board of Directors affairs and Secretarial matters.
- Environmental Control section is positioned in the place directly controlled by General Manager.
- The quality section is also positioned in the place directly controlled by General Manager.
- The computer section is positioned in Production and Technical Control Department.

The top of the organization is the Chairman of Board who controls the board as a representative of the board of directors and decides management matters.
The Managing Director supervises the day-to-day running of the company's business through the General Manager.
The General Manager has all the necessary authorities and powers delegated to him by the MD to achieve the objectives of the company.
Under the GM, there are 7 departments and 29 sections in the company organization, and 2 Deputy General Managers will be allocated as staff to assist the GM.

11.3.2 Manpower requirement

The required manpower in the stage where production work is stabilized, is shown in Table 11-3-1. The required manpower is 1,239 persons in total. This is made under the following consideration. Workers such as office boys are not counted in the table.

- Each plant will be basically operated by 4 crews in a 3-shift operation.
- Raw material receiving and product loading jobs at the port will be done by the company and will also be done by 3-shift operation.
- Maintenance work will basically be done by the company work force.
- Intra-works transportation and warehouse jobs are counted separately as shift work or

work according to production work necessity.

- There will be no firefighting cars and ambulances in the company, so there are no drivers included for such cars.

11.3.3 Recruitment and training

Organization of integrated steel works consists of various kind of specialists not only in technical fields but also in financial, administrative, procurement, etc. Financial experts, procurement staff, etc. are, however, not exclusive to steel works but common to any industry in general. There are high education courses for such specialists already in Oman and many Omani professionals have been fully doing their jobs. Therefore we would mainly describe here engineers and technicians.

(1) Recruitment

1) Experienced applicants

As there is no integrated steel works in Oman so far, it is necessary to recruit a certain number of experienced engineers and skilled workers from abroad. Department managers, Section managers and Assistant section managers of Production department, Maintenance & Utility department and Production & Technical control department should be headhunted from foreign companies. At the same time, the Foreman, the Assistant foreman and a skilled work force in each production plant should be recruited from foreign steel mills.

Section managers (or candidates) for each plant and Maintenance & Utility dept. should be recruited at the stage of plant designing, around 2 years prior to the start-up of production, so that they could join the actual construction job as on the job training.

Other personnel should be recruited at least 6 months prior to the start-up of production.

2) Newly graduate applicants

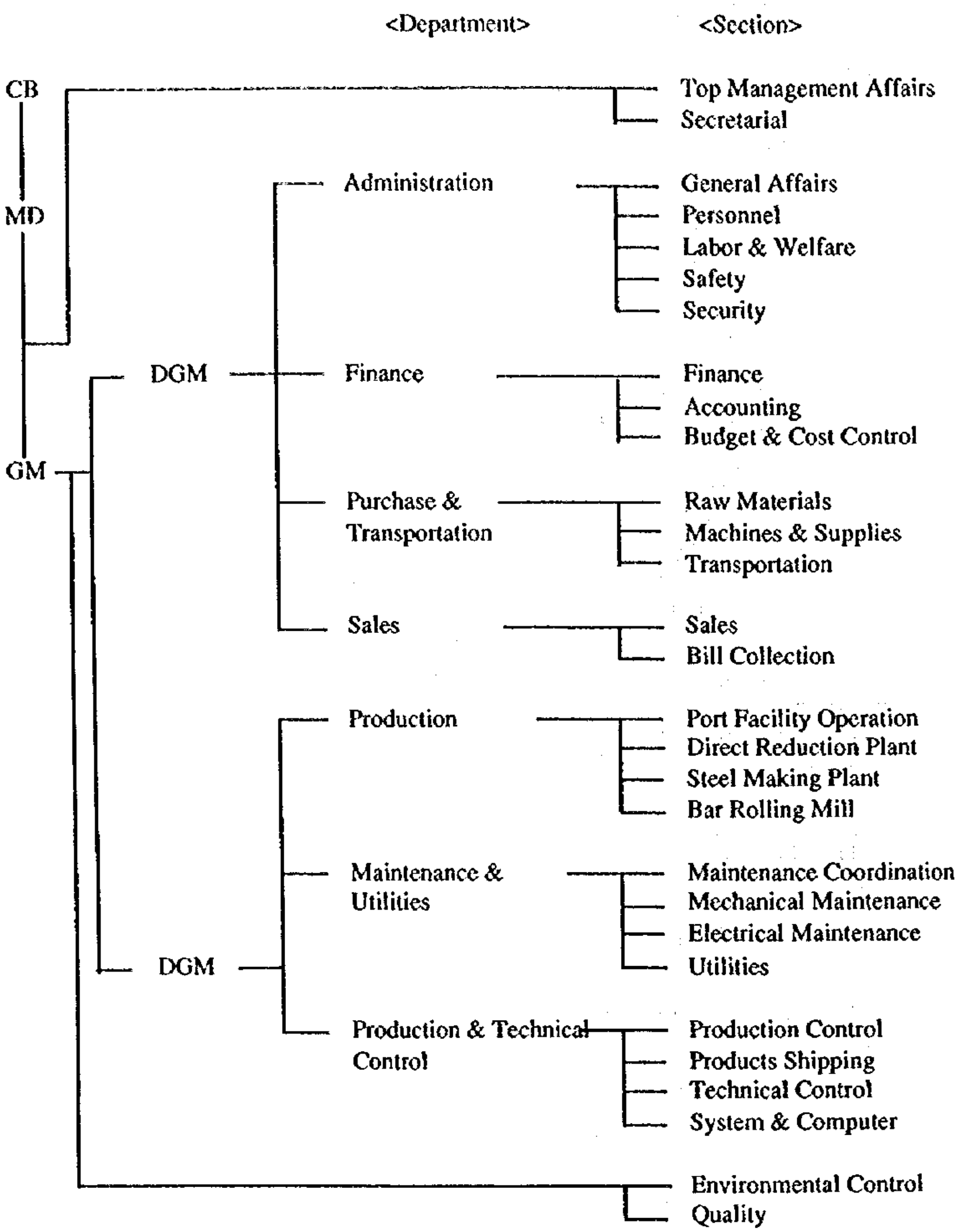
As for engineers in Production department, graduates of metallurgical or mechanical engineering course will hold most portion, and those of chemical engineering course will be necessary for some part of DRP and LCP.

As for engineers in Maintenance & Utility dept., graduates of mechanical engineering course are to be assigned to MM and those of electrical engineering course to EM. In Utility section, graduates of mechanical engineering course and of chemical engineering course will be necessary.

Engineers in TC and Quality section will be as same as those in PRD. Engineers in Environmental Control section will also be suitable for chemical engineering.
In the case of technicians, qualification need not be very strict as for engineers in PRD. It would be better, however, if they have some extent of knowledge about any one of engineering courses.
In MUD, even applicants for technician courses should have qualifications from a vocational college for the field they wish apply to.

(2) Training

The purpose of training is to let new employees acquire enough skill to execute their jobs in the plant as soon as possible.
Section managers (or candidates) for each plant and Maintenance & Utility dept., who are recruited 2 years prior to the start-up, can get some knowledge from on the job training.
For other members who would join 6 months prior to the start-up, training will begin with lectures, and sometimes they will go to the site and observe installation work.
Some qualified trainees including Section managers (or candidates) would go abroad and observe similar integrated steel works as overseas training.



Note: CB/ Chairman of Board; MD/ Managing Director
GM/ General Manager, DGM/ Deputy General Manager

Figure 11-3-1 Organization Chart

Table 11-3-1 Manpower Requirement

DEPT	Section	Sub Section	CB	MD	GM	DGM	DM	SM	ASM	E&SP	F	AF	W	Total
	TMA		1	1	1	2		1	1	1				8
	Secret.							1	1	2				4
AD							1	5	5	10	2	8	12	43
FD							1	3	3	6				13
PTD	RM						1	1	1	2	1	1	2	9
	MS							1	1	1	1	1	4	9
	Transp.							1	1	3	3	14	44	66
	Sub-total	(PTD)					1	3	3	6	5	16	50	84
SD	Sales						1	1	2	4				8
	Bill col.							1	1	4				6
	Sub-total	(SD)					1	2	3	8				14
PRD	Port faci.						1	1	1	1	1	3	12	20
	DRP	DRP						1	1	3	5	16	28	54
		Material Handling								1	4	8	20	33
	SMP	LCP							1	1	4	5	16	27
		EAF						1	1	2	8	21	80	113
		CCM							1	2	8	26	117	154
	BRM							1	1	3	5	21	247	278
	Sub-total	(PRD)					1	4	6	13	35	100	520	679
MUD	MC						1	1	1	3		1	2	9
	MM	Port						1	1		1	4	4	11
		DRP							1	1	1	4	9	16
		SMP							1	2	1	6	16	26
		BRM							1	2	1	5	15	24
		M. Repair							1	3	2	3	19	28
	EM	Port						1	1		1	4	4	11
		DRP							1	1	1	4	9	16
		SMP							1	2	1	4	16	24
		BRM							1	1	1	4	15	22
		Power distr.							1	1	1	4	12	19
		E. Repair							1	2	2	3	15	23
		Instrument.							1	2	1	3	7	14
	Util.							1	1	2	3	10	41	58
	Sub-total	(MUD)					1	4	14	22	17	59	184	301
PTCD	PC						1	1	2	2				6
	PS							1	2	4	1	5	14	27
	TC							1	1	3				5
	Sys.&Computer							1	1	3				5
	Sub-total	(PTCD)					1	4	6	12	1	5	14	43
	Environmental C.							1	1	1	1	1	1	6
	Quality							1	1	2	2	6	32	44
Grand total			1	1	1	2	7	29	44	83	63	195	813	1,239

AD	:	Administration Department
FD	:	Finance Department
PTD	:	Purchase and Transportation Department
RM	:	Raw Material
MS	:	Machine and Supplies
SD	:	Sales Department
PRD	:	Production Department
MUD	:	Maintenance and Utilities Department
MC	:	Maintenance Coordination
MM	:	Mechanical Maintenance
EM	:	Electrical Maintenance
PTCD	:	Production and Technical Control Department
PC	:	Production Control
PS	:	Product Shipping
TC	:	Technical Control
TMA	:	Top Management Affairs
DM	:	Department Manager
SM	:	Section Manager
ASM	:	Assistant Section Manager
E & SP	:	Engineer & Specialist
F	:	Foremen
AF	:	Assistant Foreman
W	:	Worker

11.4 Management System

11.4.1 Production control system

(1) General

Smooth and effective production activity will be promoted by a proper production plan and production control. Preparation of a production plan, instruction, progress control, result control, etc. are included in this system.

A level 3 control system, which means a computer aided production control system throughout the integrated steel works, will be constructed when and after production activities in the steel works are fully stabilized.

(2) Organization

A production control section will be put in the company organization to take charge of production planning and production control.

Organization and personnel is shown in Table 11-4-1.

Table 11-4-1 Organization and Personnel of Production Control Section

SM	ASM	Specialist	Foreman	Assistant foreman	Worker	Remarks
1	2	2	-	-	-	Planning

(3) Production plan

The production plan is an activity plan for each plant and section, and generally, an annual, semi-annual and monthly plan are prepared. The production plan must be made by reviewing following items.

The sales plan
production conditions
The repair plan
manpower conditions
The purchase plan for raw materials and utilities

These items are controlled by different departments/sections, so it is very important for the Production control section to have close contact with all departments/sections, and to coordinate and settle these matters.

- The annual production plan is the plan for one fiscal year, for example, January through December and the semi-annual plan for January through June or July through December. These are mainly utilized for repair plans, purchase plans raw materials, man power plans as well as sales plans.
  The semi-annual plan is designed for the review of the remaining half of the annual plan by adjusting it to new production conditions based on the result of the last half.

- The monthly production plan is determined by modifying the amount initially projected in the annual or semi-annual plan based on the actual results in the preceding months.
  The amount of production in the monthly plan will be further developed into daily amounts of production, which will be used for daily production control.

(4) Production control

Production control means to perform the management of material distribution in a plant and among plants according to the production plan. The purpose of production control is to smoothly promote production activities from order acceptance up to product shipment, to pursue high efficiency, high yield and low cost, and consequently to contribute to the improvement of the enterprise revenue.
The following are to be performed as production control activities.

- The Production control section prepares the instruction document for production according to the daily production amount, by which the details of the daily production contents of each plant are instructed in concrete.

- The Production control section checks the instruction document for production with prompt reports and performs progress control.
  Moreover, the Production control section performs actual result control by means of monthly reports and offering of information to other sections and also the actual results are reflected on the next plans.

- The Production control section consults with related sections and promptly adopts proper measures in case of abnormalities in production.

11.4.2 Quality control

(1) General

The object of quality control is to satisfy customers and ensure their satisfaction. Quality control management is required from the raw material reception to the final shipping all through DRP, LCP, SMP and BRM with full consistency. Quality control management is, therefore, to be assigned as a part of the activities of each plant.
The above individual managerial activities should further be controlled by a centralized authority, and this centralized authority will be assigned to the Technical control section.
Also these activities need to be standardized for maintaining product quality.
Furthermore, quality assurance to outside customers such as analysis, inspection and issuing of mill sheet will be done by the Quality section which is directly controlled by the GM.

(2) Organization

To cover from raw material reception to the final product shipping, necessary personnel should be assigned to each plant and sampling facilities must be installed for this purpose.
Technical control section will be set up in the company organization as a centralized authority, and take charge of the following.

- Issuance of the Technical Standard upon which each Technical Standard issued by each Section is based
- Supervision of Technical Standards issued by each Section
- Document control of all the issued Technical Standards
- Product design

Quality section will take charge of the followings.

- Analysis and inspection
- Issuance of Inspection Certificate

Organization and personnel on Technical Control section is shown in Table 11-4-2. The same as the Quality section as described in 6.9 Analysis and Inspection.

Table 11-4-2 Organization and Personnel of Quality Control

SM	ASM	Engineer	Foreman	Assistant foreman	Worker	Remarks
Technical control 1	1	3	-	-	-	Technical control

(3) Standards

In order to properly maintain the in-company technical and quality levels, all sections and all members of each plant and section need to carry out the production by following the fixed standards.
The standards are classified into the following two;

1) Technical Standard
2) Operational Standard

- Technical Standard

Technical Standard is provided to stabilize the technical level at each section. This means that whoever carries out the production operation by following the Technical Standard, the same quality product is made.
Technical Standard specifies necessary technical matters to carry out the standardized operations.
Technical Standard is issued by each section, and is registered as a branch of all-company standard system. The contents of Technical Standard are to be indoctrinated to all the employees who are engaged in an actual production operation.
Technical Standards are collectively controlled by Technical control section for the purpose of maintaining the technical level so that the product quality always can satisfy the up-to-date customers' requirements.

- Operational Standard

Operational Standard provides the detailed operational instruction, which is particular at an individual plant as an operation manual.
Plant workers are to operate, adjust, inspect and maintain the facilities of the plant by following the Operational Standard.

Operational Standard is issued and controlled by each section. Each section is responsible for the maintenance, and the revision of Operational Standard to fully catch up with the operational change and improvement. Each section is also responsible for the training of the plant workers, so that the skill of each worker is maintained at a certain level, and that the deviation of the skill among the workers is minimized.

(4) Inspection Certificate

For those products whose quality is guaranteed by the Company, the Inspection Certificate is issued to each Purchaser and to each order.
Inspection Certificate is issued, signed by Quality section manager, for the purpose to guarantee the quality of products, so that the purchaser is able to use them with a sense of security. An Inspection Certificate certifies that the products fully satisfy the requirements provided by any established Standard and/or Customer specification, by indicating the technical results of the in-company inspection and testing such as chemical composition, mechanical properties, dimension, etc. by heat-wise and size-wise.

Chapter 12. ENVIRONMENTAL ASSESSMENT

The process planned to be adopted by the Steel Complex of this Study consists of a direct reduction plant (DRP), electric arc furnaces (EAF) and a bar rolling mill plant (BRM).
The integrated steel production process is new to Oman, therefore, it is necessary to assess the environmental pollutants which will be generated from the Steel Complex and to properly estimate the impact on the environment.
To judge the environmental conditions after the installation of the Steel Complex, as an environmental assessment, the Study Team surveyed the present environmental situation at the proposed site, and then calculated the distribution of pollutants using a simulation based on surveyed data and predicted pollutant volume emitted from the new Steel Complex.

The results of the calculations were verified to be within the allowances accorded by Oman's environmental laws and regulations for items defined by Oman. The results were verified to be within the allowances accorded by WHO's guide line of environmental standard for items which have not been determined yet in Oman.

12.1 Present Environmental Situation

The Study Team visited the Ministry of Regional Municipalities and Environment and some companies at proposed site to investigate environmental issues for this study.

12.1.1 Environmental laws

(1) Laws and regulations

The basic environmental protection law called "Law on the conservation of environment and prevention of pollution for Royal Decree 10/82", was issued on February 9, 1982 in Oman. This law states general provisions, definitions, conservation of environment, prevention of pollution, application of the law, and punitive measures and penalties.
Thereafter, some regulations were issued as amendments to Royal Decree 10/82.

Concerning air pollution, the regulations for air pollution control from stationary resources were issued on May 17, 1986. These regulations concern noxious or offensive substances and standards for emission of grit and dust, and are listed by type of works.
Concerning water pollution, the regulation for wastewater re-use and discharge were published on June 13, 1993. As for marine pollution, the regulations are under study

and will be determined in the near future.
Concerning the management of waste, two regulations composing the regulations for the management of hazardous waste and the regulations for the management of solid, non-hazardous waste were issued on February 2, 1993.
Concerning noise pollution, the regulations for noise pollution control in the public environment were issued on March 20, 1994.
These regulations provide the limits for noise generated in districts with industrial plants.

1) Air pollution

At present, there is no steel works in Oman, therefore standards for emissions from steel works do not exist.
Standards for related works prescribed by the regulation of 5/86 are shown in Table 12-1-1 for reference. The law for the environmental quality standard has not been found.

Table 12-1-1 Standards for Emission of Grit and Dust

Works	Item	Standard Value
Cement	Particulates	0.100 g/m^3
	Hydrogen sulphide	nil
Copper	Total particulates	0.200 g/m^3
	Copper compounds, as copper	0.100 g/m^3
	Zinc compounds, as zinc	0.100 g/m^3
	Cadmium compounds as cadmium	0.020 g/m^3
	Lead its compounds as lead	0.030 g/m^3
Incineration	Hydrogen chloride	0.200 g/m^3
	Hydrogen fluoride	0.100 g/m^3
	Oxides of nitrogen as calculated NO_2	0.200 g/m^3
	Hydrogen sulphide	5 p.p.m. v/v
	Total Particulates	0.100 g/m^3
Power Plants	Particulates from coal or oil firing	0.100 g/m^3

Source : Ministerial Decision 5/86

2) Noise

Table 12-1-2 shows the limits for noise generated from industrial plants as prescribed by the regulation of 80/94.

Table 12-1-2 Limits for Noise Generated from Industrial Plants

Unit (dB)

Type of District	A	B	C
Rural residential recreational	45	40	35
Suburban residential	50	45	40
Urban residential	55	50	45
Urban residential with some workshops or business; city hub.	60	55	50
Industrial and commercial	70	70	70

Source : Ministerial Decision 80/94

Note ; A: Workdays- daytime, after 7 a.m. up to 6 p.m.

B: Workdays-evenings, after 6 p.m. up to 11 p.m.

C: Holidays and Nights, after 11 p.m. up to 7 a.m.

3) Water pollution

There are regulations for wastewater reuse and discharge. However, waste water from the Steel Complex is planned to be discharged into the sea, therefore the standards and specifications of the regulations mentioned above are not described here.

(2) Environmental impact assessment (EIA)

Owners of new sources of work must submit an Environmental Impact Statement (EIS) to the Ministry and obtain an Environmental Impact Assessment (EIA) 2 months before starting a project. The term, Environmental Impact Statement (EIS), refers to a document which summarizes the Environmental Impact Assessment (EIA) Study which will be defined as follows.

A formal EIA should include but not be limited to:

- Project detail description
- Data gathering for environmental baseline definition and forecasting of impacts
- Prediction of impacts both physical and socio-economic/comparison of alternatives/cost benefit analysis

- Proposing mitigation measures
- Risk assessment
- Proposing monitoring and follow-up activities

12.1.2 Current situation

At present, there are no remarkable environmental problems at the proposed site for the Steel Complex due to limited industrial activity and geographical conditions.
Environmental laws and regulations have not been systematically implemented at present.
However, some amendments have been undertaken by relative authorities.
Under these conditions, except for a few individuals and companies, interest in environmental pollution seems to be generally very low.

12.2 Environmental Control for the Steel Complex Project

To determine environmental conditions after installation of the Steel Complex, as an environmental assessment, the Study Team calculated the distribution of pollutants using a simulation based on surveyed data and predicted pollutant volume emitted from the Steel Complex.

12.2.1 Air pollution

The major factors which will affect air quality depend on the process and natural resources used in the Steel Complex.
The planned process consists of a direct reduction plant (DRP), electric arc furnaces (EAF) and bar rolling mill plant (BRM). The main natural resources are iron ore and natural gas.
Such pollutants as NOx, SOx, and dust can be considered scarce in the ambient air.
Generally at steel plants, the origins of the sulfur which can be converted to sulfur dioxide(SO_2) are the oil and/or natural gas fuel, and the natural gas or coal reducing agent.
This plant will use only natural gas as both fuel and reducing agent, not coal with its high sulfur content.
The sulfur content of natural gas is 0.5 ppm, very low. The sulfur content of the other resources, such as lump ore and pellet, is even less. Therefore, the total generated amount of SOx at this plant will be very small.

In steel plants, NOx is generated at the facilities where fuel burns. In this plant, NOx is generated mainly at the DRP reformer, EAF and the reheating furnace of the BRM. By using natural gas, total generated NOx will be low compared with traditional integrated steel plants.

Concerning dust, generation at the EAF is of rather high probability, but it is easy to prevent dust diffusion from the stack by installing a sufficient capacity dust collector.

(1) Estimated exhaust pollutants

Table 12-2-1 shows the estimated emission of air pollutants which will be generated from the planned plant, and Table 12-2-2 shows the facilities design for exhaust gas handling and the gas characteristics.

Table 12-2-1 Estimated Air Pollutant Emissions

Process	Facility	NOx		SOx		Dust	
		mg/Nm³	kg/hr	mg/Nm³	kg/hr	mg/Nm³	kg/hr
DRP	Reformer	69.0	46.92	2.4	1.63	2.1	1.42
	Shaft	-	-	-	-	7.9	-
SMP	EAF	7.4	15.53	2.3	4.95	5.0	10.5
BRM	Reheating furnace	205.4	14.99	1.1	0.08	-	-

Table 12-2-2 Exhaust Gas Facilities Design

Process	Facility	Stack		Exhaust gas	
		height (m)	diameter (m)	volume (Nm³/hr)	temperature (°C)
DRP	Reformer	40	5.4	680,000	300
SMP	EAF	20	6.1	2,100,000	90
BRM	Reheating furnace	50	3.5	73,000	250

12.2.2 Noise

Noise pollution at the Steel Complex will occur at the DRP, EAF, BRM and the air compressor of the air separator. The estimated noise levels at the Steel Complex is shown in Table 12-2-3.

Table 12-2-3 Estimated Noise Levels

Pollutant	Process	Facility	Value (dB)
Noise	DRP	Blower Area	95 - 105
	SMP	EAF	105
	BRM	Mill	105
	Utility	Air Compressor	95

12.2.3 Waste water

The great part of waste water which will be discharged into the sea from the Steel Complex is sea water. Sea water will be used as the cooling agent of the heat exchanger. Therefore, sea water discharged into the sea after passing through the Steel Complex will rise 7 degrees centigrade above ambient receiving sea water temperature, but will not give any contamination.

A small part of these water comprises blow down water from the processes.

A proper water treatment system will be installed leading to clean discharge water.

(1) Estimated values of waste water

The estimated values of the waste water to be discharged into the sea are shown in Table 12-2-4.

Table 12-2-4 Estimated Discharged Waste Water

Sea Water	Quantity	25,000 m^3/h
	Temperature	7.0 deg.C above ambient receiving sea water temperature
Blow Down Water	Quantity	Negligible quantity
	TDS	< 500 mg/l
	SS	< 50 mg/l

12.2.4 Solid waste

The basic concept for treating by-products and waste is re-use (as far as possible) by both the Steel Complex and outside users. Only that waste which cannot be re-used is discarded.

Methods of re-use are;

1) as raw materials for this steel plant
- oxide fine for the pelletizing plant
- scrap for the EAF

2) as raw materials for outside users
   - oxide fine, sludge and scale for cement companies which use them as sources of iron
   - waste oil for oil companies which refine waste oil
   - slag for road bed material and reclamation work

The followings are to be discarded, and they have no effects on environment.

- EAF slag, Lime fines, DRP cake, EAF dust, and SMP waste brick

Kinds and quantities of waste generated from each plant and their treatment methods are shown in Table 12-2-5.

Table 12-2-5 Solid Waste Generation and Treatment

Materials	Generated from	Treatment	Quantity (t/y)
Mill scale	SMP, BRM	Sell to cement companies	15,600
SMP slag	EAF	Discard	204,000
Oxide fines	DRP, EAF	Sell to cement companies, Pelletizing plant	48,000
Lime fines	LCP	Discard	10,510
DRP cake	DRP	Discard	53,500
EAF dust	EAF	Discard	20,800
SMP waste brick	EAF	Discard	1,600
Sludge	WTP	Sell to cement companies, and others	2,000

12.3 Assessment

For the environmental assessment of the Steel Complex, the Study Team estimated the effects to the surrounding area by simulation of typical parameters.

12.3.1 General

The general area around the site is shown in Figure 12-3-1.
The site is located in 20 km north west of Sohar, and Sohar, which has a population of 100 thousand, faces the Gulf of Oman and is located 250 km north west of Muscat.
The site is situated on the beach with few residences and a small industry estate lying in the neighborhood.
There is no heavy industry around the site at present.

Regarding temperature, the annual mean is 27.1 °C, maximum monthly mean, 31.2 °C, and minimum monthly mean, 21.9 °C.
Relative humidity is 73 %, and annual total rainfall is 244 mm.
The predominant wind direction is east in winter and west in summer.
Mean scaler wind speed is 5.0 knots.

12.3.2 Simulation

Considering the characteristics of the Steel Complex, the items to be simulated are as follow;

- Air pollution: NOx, SOx, Dust, Noise
- Water pollution (sea discharge): Hot waste water

(1) Ambient Environmental Data

From the data in chapter 12-2, the basic ambient environmental data is shown in Table 12-3-1 for air, Table 12-3-2 for noise and Table 12-3-3 for sea water.

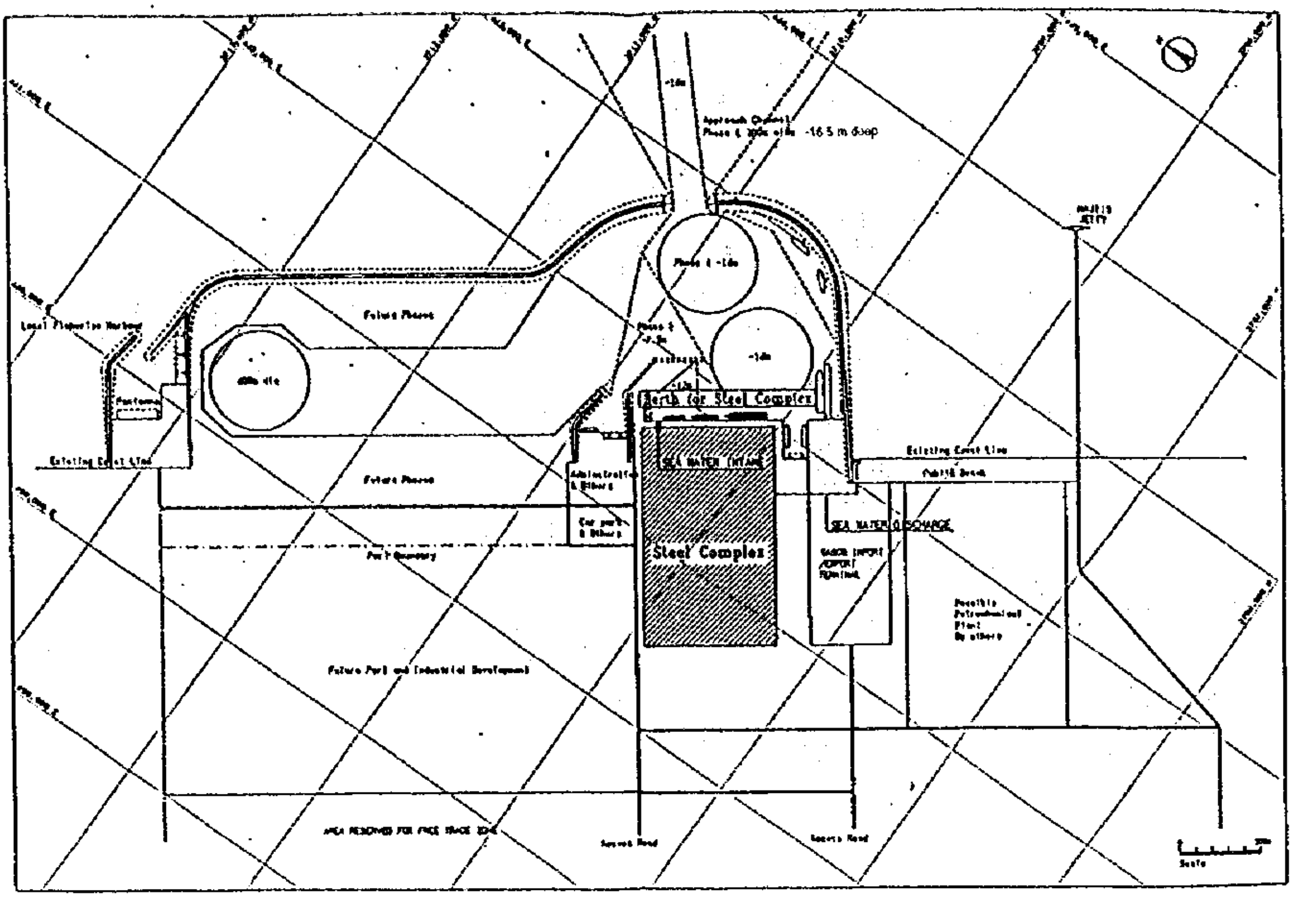


Figure 12-3-1 The General Area around the Site

Table 12-3-1 Air Emission Data for Simulation

Element	NOx			SOx		Dust
Plant	DRP	SMP	BRM	DRP	SMP	
Facility	Reformer	EAF	Reheating furnace	Reformer	EAF	
Emission value (mg/Nm^3)	69.0	7.4	205.4	2.4	2.3	5.0
Exhaust gas						
volume (Nm^3/hr)	680,000	2,100,000	73,000	680,000	2,100,000	
temperature (deg.C)	300	90	250	300	90	
Stack						
height (m)	40	20	50	40	20	
diameter (m)	5.4	6.1	3.5	5.4	6.1	

Concerning NOx, the emission value for all plants were applied. Concerning SOx, the values for the DRP reformer and the EAF, because the contribution ratio of these facilities emissions is high.

Concerning dust, the major emitting facilities is EAF.

Table 12-3-2 Estimated Noise Levels for Simulation

Plant	Generating facility	Noise level (dB)
DRP	Reformer	100
SMP	EAF	105
BRM	entire mill	105
Utility	Air compressor	95

Table 12-3-3 Estimated Discharge Water for Simulation

Parameter	Value
Temperature	7 deg.C above ambient receiving sea water temperature
Water quantity	25,000 m^3/hr

Details of the methods of simulation are described in Appendix A12-1.

12.3.3 Simulation results

(1) Ambient air quality

1) NOx

The distribution of NO_2 during operation is shown in Figure 12-3-2.

NO_2 emissions from the Steel Complex will contribute 0.11 $\mu g/Nm^3$ at maximum (annual mean) to ambient air quality, and this value will show at the plant boundary.

2) SOx

The distribution of SO_2 during operation is shown in Figure 12-3-3.

SO_2 emissions from the Steel Complex will contribute 0.017 $\mu g/Nm^3$ at maximum (annual mean) to ambient air quality, and this value will show at the plant boundary.

3) T.S.P.(Dust)

The distribution of T.S.P. during operation is shown in Figure 12-3-4.

Dust emissions from the Steel Complex will contribute 5.77 $\mu g/Nm^3$ at maximum to ambient air quality, and this value will show at the plant boundary.

(2) Noise

The distribution of noise levels during operation is shown in Figure 12-3-5.

Noise levels at the plant boundary are shown in Table 12-3-4.

The noise levels at all points are under 59 dB, within limits. (Limits 70 dB)

Table 12-3-4 Plant Boundary Noise Levels

Point	Plant and facility				Entire plant operation
	DRP Shaft	SMP EAF	BRM Rolling mill	Utility Air compressor	
A	38	44	< 30	32	45
B	31	54	42	50	55
C	< 30	47	47	43	51
D	< 30	42	47	35	49
E	< 30	52	51	< 30	55
F	45	50	35	30	51

(3) Sea water quality

The distribution of the sea water temperature which is increased by the waste water from the Steel Complex during operation is shown in Figures 12-3-6.
The contribution of the waste water from the Steel Complex to sea water quality will have little effect on the environment of sea, fishing and the ecological system.

NO_2

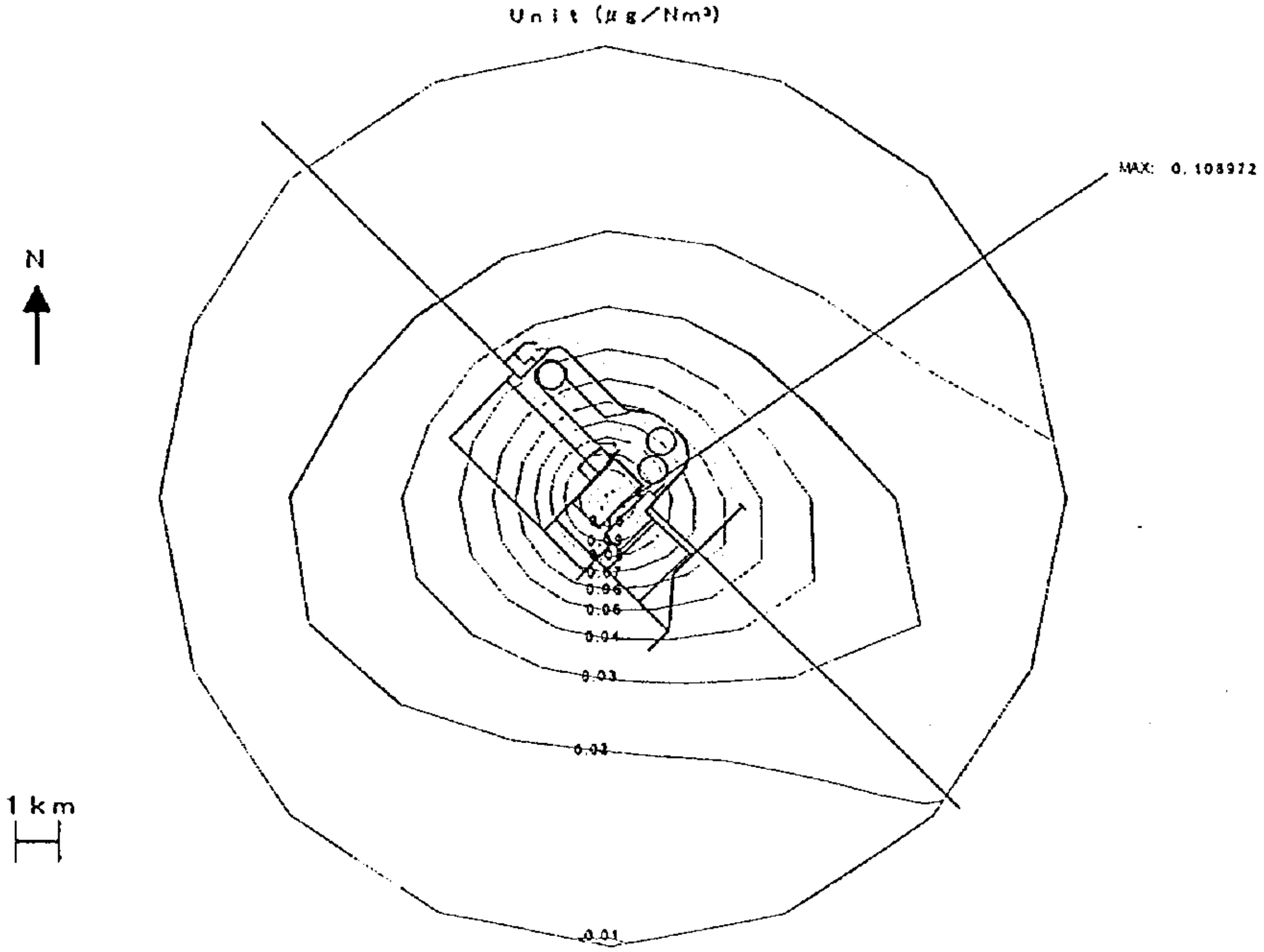


Figure 12-3-2 Predicted NO_2 Distribution Pattern

SO_2

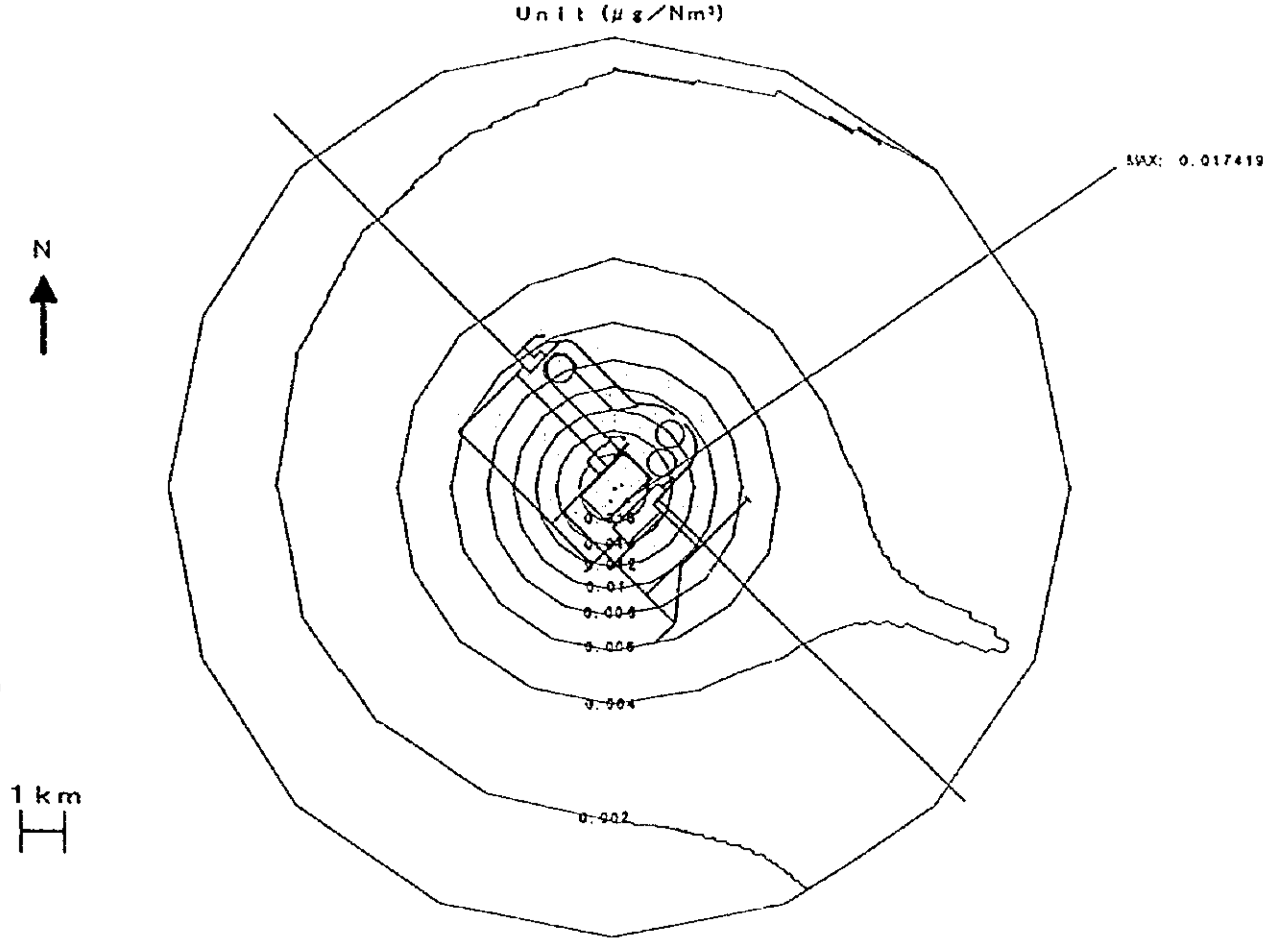


Figure 12-3-3 Predicted SO_2 Distribution Pattern

T.S.P.

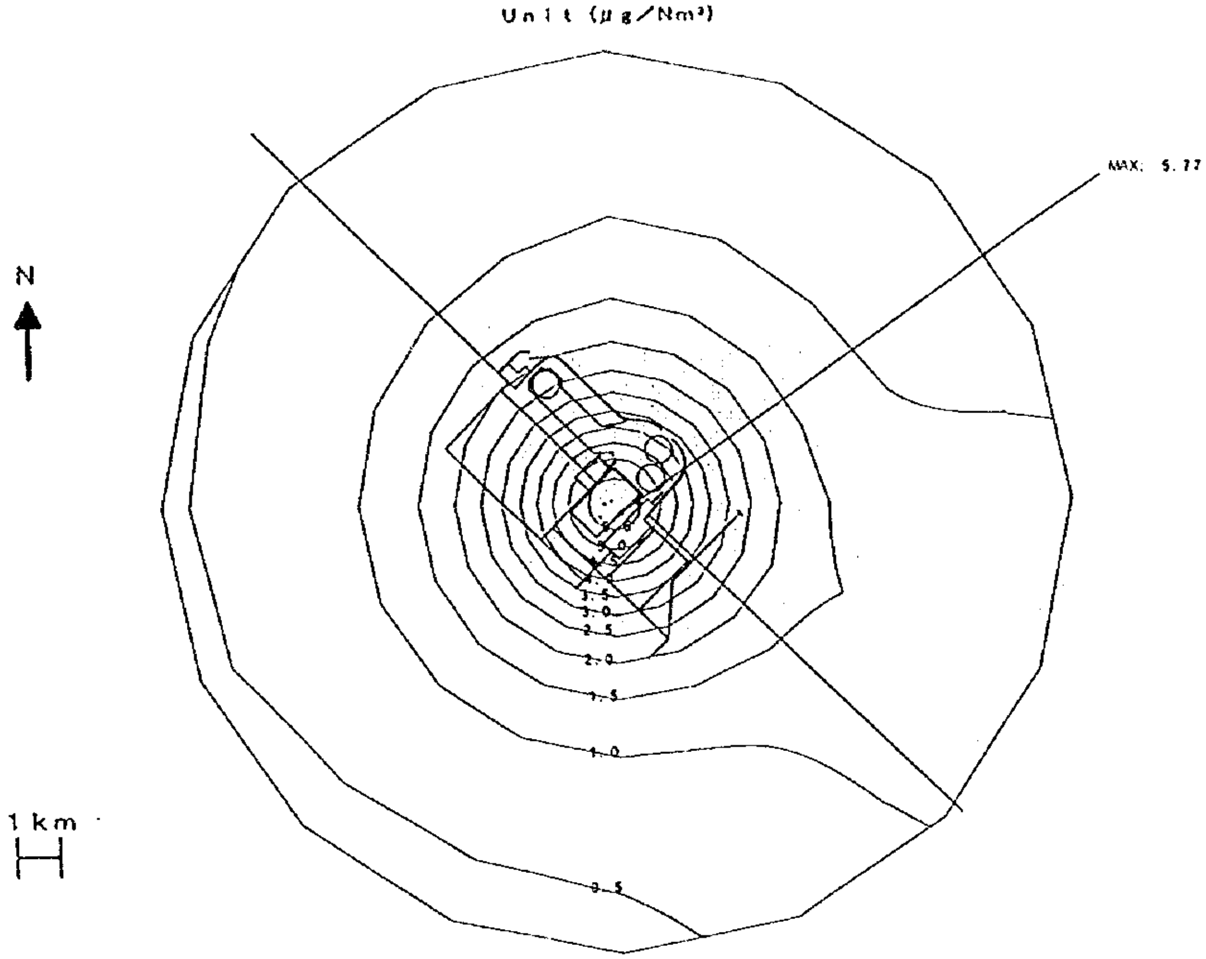


Figure 12-3-4 Predicted T.S.P. Distribution Pattern

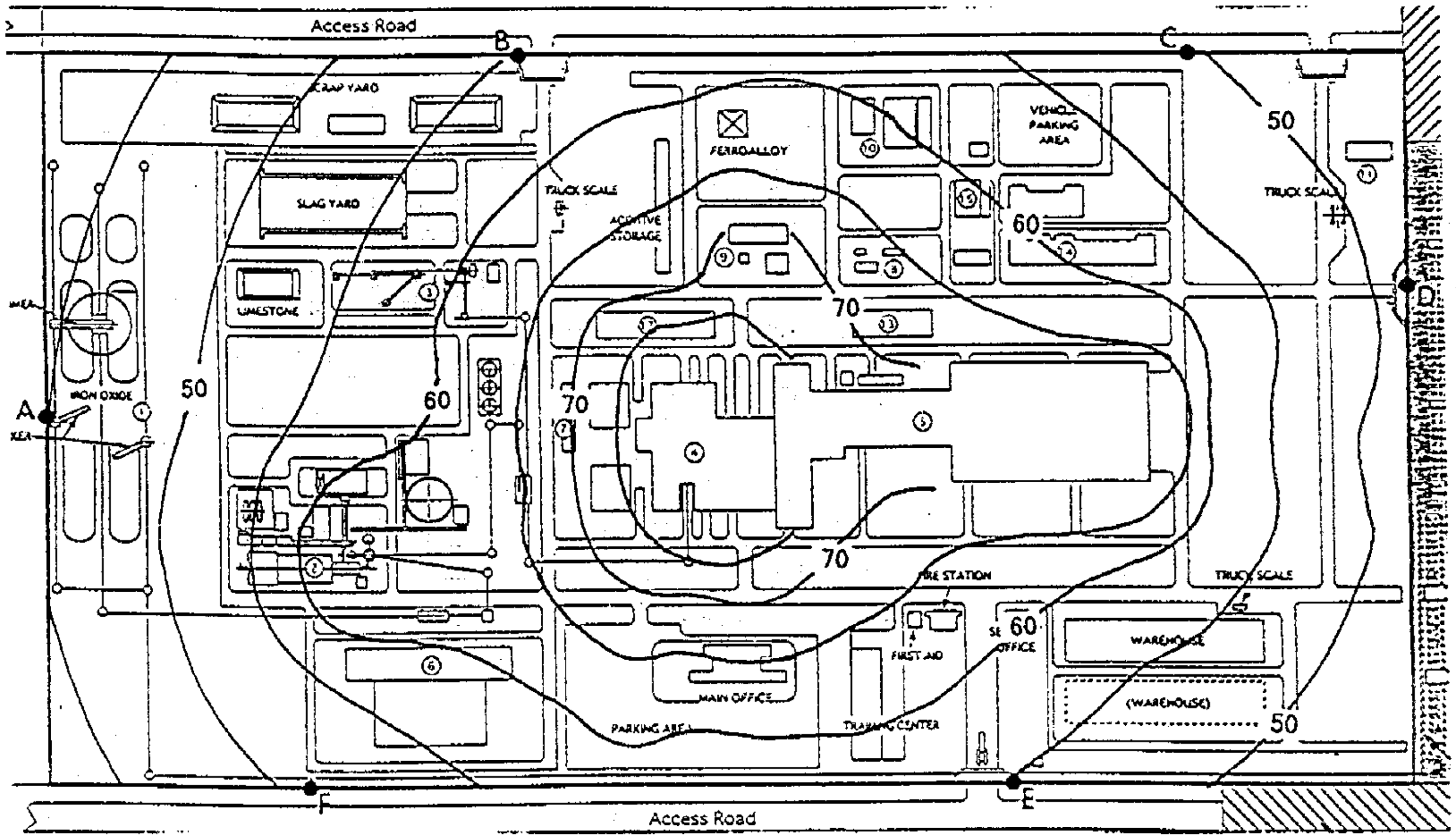


Figure 12-3-5 Predicted Noise Level Distribution Pattern

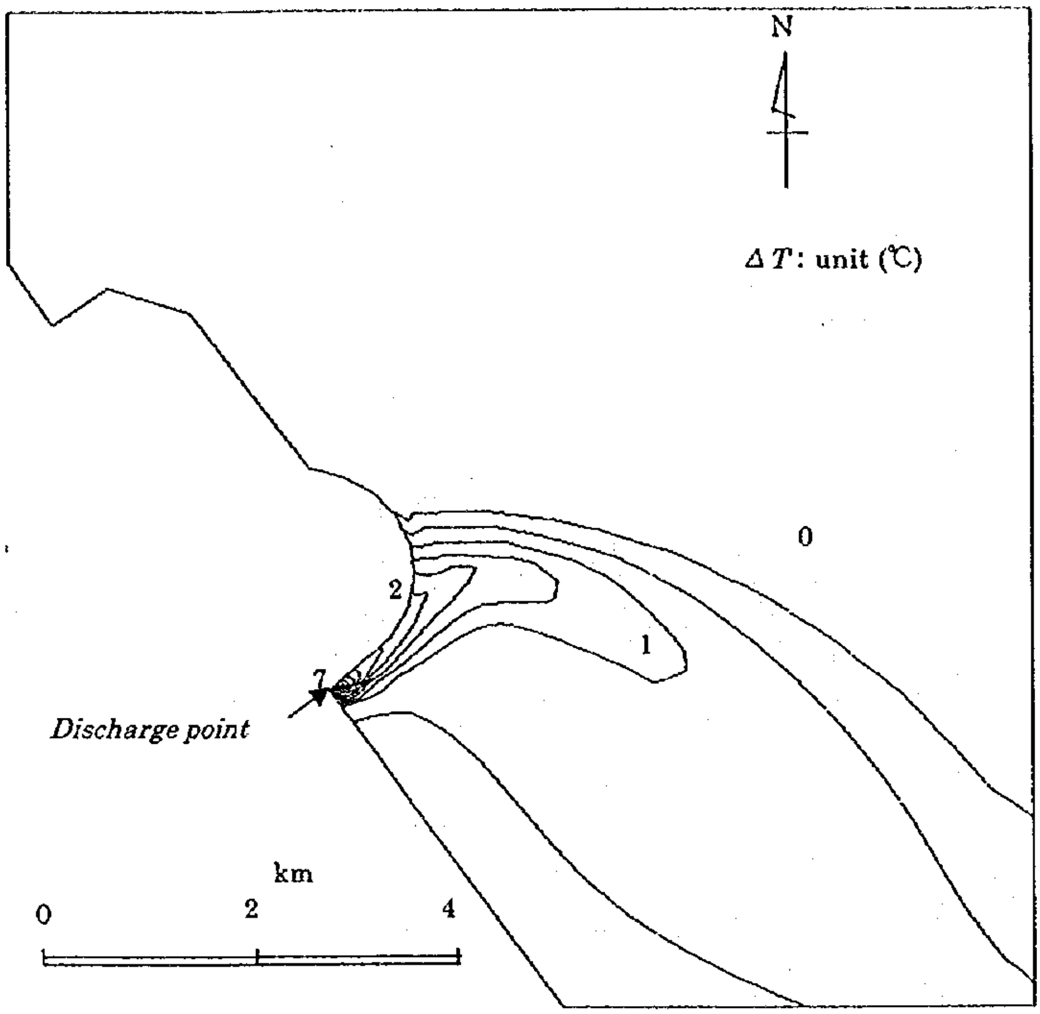


Figure 12-3-6 Predicted Seawater Temperature Pattern

(4) Evaluation

The results mentioned above are summarized in Table 12-3-5.

Table 12-3-5 Evaluation

Parameter		Contribution*	Limit
Air Quality ($\mu g/m^3$)	NO_2	0.11	150**
	SO_2	0.017	40-60***
	T.S.P.	5.77	60-90***
Noise (dB)		max. 58.5	70****

Note: * Maximum value (in the case of air quality, at ground level)

WHO's standard: ** Annual mean

*** Daily mean

**** Omani regulation (Ministerial Decision 80/94)

12.3.4 Environmental impact assessment

An environmental impact assessment was conducted on the principle pollutants NOx, SOx and dust as well as noise which can be expected to be emitted from the Steel Complex with reference to the following standards.

- Environmental standards

  Comparing of the pollution levels, calculated by simulation using data from the site and the predicted emissions levels from the Steel Complex, with national standards and WHO's guideline for emission control.

As a result of the assessment, the emissions value from the Steel Complex and environmental pollution near the site will be within the limits of the above mentioned standards.
Therefore, it can be said that pollution will be kept within the limits of national standards provided the Steel Complex is constructed equipped with the environmental control systems described in this report.

Chapter 13. ESTIMATION OF CAPITAL INVESTMENT

13.1 Estimation Basis

The estimation of the capital investment cost is based on the following .

(1) The estimation is made at the current price level as of October 1998, where normally anticipated inflation during the promotion and construction period is taken into consideration.

(2) The plant construction schedule is based on the Implementation Schedule.

(3) The scope of the capital investment is according to the battery limit and technical specifications of the Steel Complex defined.

(a) The electric power is supplied by the Power Company to the substation of the Steel Complex.

(b) It is assumed that the port and berths required by the Steel Complex are to be constructed by the government authorities.

(c) It is assumed that Accommodation for all the employees will be secured on a rental basis.

(d) All contracts for this project will be made through limited tender and under the single responsibility of a reliable company or consortium to secure the shortest possible construction time schedule and as planned.

The total plant construction cost (without power plant) is estimated at US$ 665 million, of which a breakdown is shown in the following table.
The total plant construction cost (with power plant) is estimated at US$ 805 million.

Table 13-1-1 Breakdown of the Capital Investment

	(US$ '000)
DR Plant	150,000
Rolling Mill Plant	90,000
Steel Making Plant	105,000
Others	123,000
Equipment cost total	468,000
Installation	50,000
Civil & building works	110,000
Land preparation	5,000
Owner's engineering	12,600
Contingency	19,400
Total	665,000

Notes: 1. Installation cost includes customs clearance and inland transportation cost of equipment.

2. Import duty is assumed to be exempted according to the Law.

3. Land rental fee

   land area 1,228,000 m^2 x unit land rental fee RO. 0.1/m^2-year = RO 122,800/year (US$ 319,000/year)

   (The above land area includes the berth area exclusively used by the Steel Complex.)

   However, it is assumed that the land rental fee is exempted until the Steel Complex starts up.

4. Equipment cost : CIF Sohar including supervisory services

5. Other equipment costs include unloading/loading facilities, material handling facilities, electric sub-station, utilities facilities, lime calcining plant, maintenance shop, in-works transportation facilities.

6. Owner's engineering cost is assumed at 2% of the total plant construction cost.

7. Contingency : 3% of the plant construction cost is taken into account.

Chapter 14. ESTIMATION OF PRODUCTION COST

14.1 Cost Calculation Method

(1) Process-wise cost accounting is adopted.
Production process: Direct Reduction Plant - Steel Making Plant - Bar Rolling Mill Plant
Semi-finished and finished products: DRI - Billet - Bar

(2) Variable costs and fixed costs for each process are classified as follows:

Classification of Variable Cost and Fixed Cost

Variable cost
- Raw material costs
- Supply costs such as refractories and other manufacturing supplies
- Utility costs

Fixed costs
- Labor costs
- Depreciation costs
- Maintenance & repair costs
- Sales & general expenses

14.2 Calculation of Production Costs

14.2.1 Estimation basis

(1) Production cost is estimated in US dollars with the constant price level of the year 1998.

(2) The present conversion rate of RO. to US dollar is adopted.

1 US dollar = RO. 0.3846 (RO. = US$ 2.60)

14.2.2 Raw materials and supplies cost

Costs of raw materials and supplies are estimated by the following procedures as shown in the Table 14-2-1 and are used for the financial projections.

(1) The unit prices of raw materials and supplies are estimated in consideration of international market and local market.
In case of import, custom clearance charge and handling charges are to be added on estimated CIF cost of each material and supply.

Table 14-2-1 Unit Prices of Raw Materials and Supplies

	Unit Price (US$/Ton)
Imported	
Iron oxide pellets	46.16
Fe Mn	500.0
Fe Si	650.0
Fluorspar	175.0
Graphite electrode	3,400
Domestic	
Steel scraps	120.0
Lime stones	13.0

Notes : 1) Prices of imported goods consist of CIF and other charges.
It is assumed in the financial analysis that the import duty on materials and supplies are exempted.
(According to the law and regulations, the import duty of 5% is exempted for the initial 5 operational years and may be exempted for another 5 years.)
2) Prices of domestic goods include local transportation cost.

(2) Unit consumption of raw materials and supplies are summarized from Chapter 6 APPLICABLE TECHNOLOGY FOR THE STEEL COMPLEX in the following table.

Table 14-2-2 Production Yield and Unit Consumption

Item	(Unit)	Unit Consumption
1) DRP		
Iron oxide pellets	(t/t-DRI)	1.450
Electric power	(kWh/t-DRI)	100.0
Natural gas	(MMBTU/t-DRI)	9.92
Industrial water	(m3/t-DRI)	0.3
2) LCP		
Lime stone	(t/t-BL)	2.000
Natural gas	(MMBTU/t-BL)	3.68
3) SMP		
Steel yield	(%)	85.5
Billet yield	(%)	97.0
DRI/Scrap ratio	(%)	89.8:10.2
Burnt lime	(kg/t-BT)	42.0
Fe Mn	(kg/t-BT)	10.2
Fe Si	(kg/t-BT)	4.4
Graphite electrode	(kg/t-BT)	1.9
Electric power	(kWh/t-BT)	695.0
Natural gas	(MMBTU/t-BT)	0.12
Industrial water	(m3/t-BT)	0.4
4) Bar		
Product yield	(%)	97.0
Electric power	(kWh/t-Bar)	90.0
Natural gas	(MMBTU/t-Bar)	1.10
Industrial water	(m3/t-Bar)	0.10

Note) DRI: direct reduction iron, BT: billet

14.2.3 Utilities cost

The present unit price of electricity for industrial use in Oman is RO 0.016 (US$ 0.0416)/kWh and the unit price of natural gas presently indicated is not less than US$ 0.8/MMBTU.
The results of financial analysis by applying these unit prices (electricity: US$ 0.0416/kWh, natural gas: US$ 0.8/MMBTU) is 11.02 % of IRR as shown in detail as the Original Case, which shows non-feasibility of the Steel Complex Project commercially.

On the other hand, electricity and natural gas prices in the neighboring countries of the Gulf Region are as shown in the table below.
One of the essential factors in the competitiveness and commercial viability of the Steel Complex Project is cost of energy (electricity and natural gas) in addition to the market and production efficiency (modern, efficient plant equipment and production technology). Therefore, it is necessary to ensure that the level of energy costs for the Steel Complex Project is comparable to those for the existing and possibly future steel companies in the neighboring countries. Otherwise, it would be difficult for this Project to attract the interest of investors and/or financiers.

It is advisable for the purpose of industrialization in Oman to supply energy at a competitive cost level to a large scale of industrial project like this Steel Complex Project.
The Steel Complex is a large electricity consumer and its consumption is rather stable irrespective of summer or winter, and daytime or night time, which will contribute to higher operation rate of power plant.

Therefore, referring to the level of energy costs in the neighboring countries, the financial analysis in this Report adopts the following assumptions for costs of natural gas and electricity as the Recommended Case.

<u>Recommended Case</u>

Natural gas : US$ 0.6/MMBTU
Electricity : US$ 0.025/kWh

In addition, in order to assess the impact of energy costs on the feasibility of the Project, sensitivity analyses are done on the following cost levels of natural gas and electricity.

Natural gas : US$ 0.65/MMBTU, US$ 0.7/MMBTU, US$ 0.75/MMBTU, US$ 0.8/MMBTU
Electricity : US$ 0.02/kWh, US$ 0.03/kWh

Table 14-2-3 Energy Cost in the GCC countries and other Oil-producing countries

Country	Electricity (US$/kWh)	Natural gas (US$/MMBTU)
Venezuela	0.018	0.60
Iran	0.010	0.20
Saudi Arabia	0.013	0.50
UAE	0.020	0.50
Qatar	0.020	0.50
Bahrain	0.03	0.75
Kuwait	0.005	0.50
Egypt	0.024	0.76

Also at the Recommended Case, it is assumed that electricity will be supplied to the Steel Complex by a private power company to be newly established by the following reasons.

i) The power plant operation and power supply business needs special, indigenous technology and know-how, which are quite different from steel companies.

ii) In order to secure investors and finance a private-based independent power project, it is the most important key factor that an overseas, experienced power company or companies take leadership in promoting and establishing the power project. Such power companies can continue to keep the stable operation and maintenance of the power plant.

iii) If the Steel Complex Project includes a power project, the total investment cost becomes much larger, and furthermore it is necessary to organize investors and financiers which might have interest both or either in the two kinds of projects of quite different industries. Then, it would be very complicated and difficult to ensure smooth and successful finance arrangements.
It is a very rare case that an electric-arc-furnace steel mill has its own power plant to serve all its power requirements.

iv) Although this Steel Complex Project is a large scale electricity consumer which will be one of the base loads and therefore attractive for an IPP (independent power producer) project, it is very difficult for an independent power plant exclusive for the Steel Complex to cope with the fluctuation of electricity consumption in the electric arc furnace. In order to cope with such fluctuation, it is indispensable and essential to secure a larger short-circuit break capacity: inter-connection with a large electricity network as a back-up power.

v) For the above purpose it is highly recommended that the Steel Complex be supplied with electricity by the IPP Project being promoted for the industrialization and regional development of the Sohar area.

vi) It is expected that the above IPP Project, which covers the power requirements for not only the Steel Complex but also other projects, can enjoy a higher efficiency in investment and power generation cost according to the scale of merit.

vii) It is considered possible that the IPP Project can supply electricity at a price of US$ 0.025/kWh provided that natural gas is supplied at US$ 0.6/MMBTU and a combined cycle gas turbine system is applied.

(1) The following unit price of electricity, natural gas and water is applied in the Recommended Case of this Report in addition to the Original Case.

(Purchase Prices of Utilities)

Original Case

Natural gas:	US$ 0.8/MMBTU
Electricity:	US$ 0.0416/kWh

Recommended Case

Natural gas:	US$ 0.6/MMBTU
Electricity:	US$ 0.025/kWh

Industrial water : assumed that the Steel Complex has its own desalination plant.

(2) Consumption of utilities are assumed in the following.

Electricity:	1,050.9 kWh/ton of steel bar
Natural gas:	12.31 MMBTU/ton of steel bar
Industrial water:	0.85 Nm^3/ton of steel bar

14.2.4 Labor cost

The unit labour cost by job category including salaries, wages, bonuses, welfare expenses and other expenses related to the employees is estimated as shown in the Table 14-2-4 in consideration of the present level in Oman industries.

Table 14-2-4 Unit Price of Labor

	Labour cost (US$/person-year)
General Manager	75,000
Department Manager	50,000
Section Manager	30,000
Assistant Section Manager	24,000
Engineer and Specialist	22,000
Foreman	15,500
Assistant Foreman	12,400
Worker and Clerk	10,000

Based on the manpower requirement for the Steel Complex mentioned in Chapter 11.3, the annual labour cost is estimated as shown in the Table 14-2-5.

Table 14-2-5 Annual Labour Cost for the Steel Complex

Item	Number	Unit labour cost (US$/person-year)	Labour cost (US$ '000/year)
CM & MD	2	100,000	200
GM	1	75,000	75
DGM	2	60,000	120
DM	7	50,000	350
SM	29	30,000	870
ASM	44	24,000	1,056
E & SP	83	22,000	1,826
F	63	15,500	977
AF	195	12,400	2,418
W & CL	813	10,000	8,130
Total	1,239	12,497	16,022

14.2.5 By-products cost

The price of return scrap recovered from SMP and RMP is assumed to be equal to the price of purchased scrap.

For the sales of scale, lime fine and other by-products, the transfer and disposal costs are assumed to be equal to the sales price.

Therefore, the sales amount and transfer and disposal costs are not calculated.

14.2.6 Repair costs and special repair costs

US$ 10 per ton of products (steel bars) is assumed to be the annual repair and maintenance cost in consideration of experiences of similar steel plants.

14.2.7 Depreciation

The fixed assets are classified into eight categories and the depreciation is calculated by straight line method with the depreciation period as shown in the following table.
In the financial analysis, the fixed assets in aggregate are depreciated over 17 years equally.

List of Categories and Depreciation Period for Fixed Assets

(Unit: Year)

Categories	Depreciation period
Manufacturing plant	15
Auxiliary plant	15
Factory building	33
Office building and company house	50
Vehicle	5
Tool	4
Furniture and office equipment	10
Land	nil

14.2.8 Sales and general expenses

Sales and general expenses such as land rent, jetty usage fee, management, technical assistance fee, insurance premium and other miscellaneous expenses are estimated.

(1) Land rental

The land rental fee is estimated at US$ 319,000 per year.
(1,828,000 m^2 x R0. 0.1/m^2-year)

(2) Jetty usage fee

The usage fee of the jetty area is estimated at US$ 2,420,000 per year according to the following calculation.

1) Construction cost (to be done by the Government): US$ 27.8 million
2) The annual fee is set so as to get IRR of 6% for the period of 20 years.

(3) Insurance premium for the plant equipment

The annual insurance cost for the plant equipment is assumed at 0.1 % of the total plant construction cost.

US$ 665 million x 0.1 % = US$ 665,000 per year

(4) In-works transportation and sub-contract works

The annual in-works transportation and sub-contract works are estimated at US$ 1 per ton of products (steel bars).

US$ 1/t x 1,164,000 t/y = US$ 1,164,000 per year

(5) Sales expenses and commissions

In order to secure constant and stable customers and markets, it is necessary to appoint foreign and local sales agents.
The sales related expenses and sales commission is assumed to be 1.5% of sales in the financial analysis.

(6) Technical, management assistance cost and expenses

In order to secure a smooth start-up ,to reach the earliest full production level and to keep a stable and high production level, it is essential to introduce technical and managerial assistance through stationing experienced personnel of advanced, overseas steel companies at the Steel Complex.

The number of personnel for the technical and managerial assistance is estimated in the following table, where the number is assumed to decrease according to the progress of technology transfer.

Table 14-2-6 Estimated Number of Personnel for the Technical & Managerial Assistance

Year after the start-up	1 - 3	4 - 5	6 - 7	8	9 - 20
No. of personnel	40	35	30	25	10

Fees and related expenses are estimated at US$ 22,000 per man-month.

(7) Miscellaneous expenses

The miscellaneous expenses are estimated to be 5% of the labour cost.

US$ 16,000,000/y x 5% = US$ 800,000 per year

(8) Sales and general expenses mentioned in this section are included in the Other Expenses of the Fixed Cost at Profit & Loss Statements of the financial analysis.

14.3 Production Plan

14.3.1 Production plan

The production plan is planned as follows.

Table 14-3-1 Production Plan

(Unit: tons)

Products	1st year	2nd year	3rd year and after
DRI	910,000	1,186,900	1,300,000
Billets	840,000	1,095,000	1,200,000
Steel Bars	814,800	1,062,700	1,164,000
(Operation rate)	(70.0%)	(91.3%)	(100%)

Chapter 15. FINANCIAL ANALYSIS

15.1 General

Financial analysis includes,

(1) Analysis based on the following financial statements:

1) Production cost per ton of steel bar
2) Profit and loss statement
3) Cash flow
4) Balance sheet

(2) Evaluation of the investment fund efficiency based on the IRR (internal rate of return) using the discounted cash flow method

(3) Sensitivity analysis

15.2 Precondition for Financial Analysis

15.2.1 Financial project period (Project life)

Financial projection covers the period of 20 years from the start-up of the Steel Complex. Financial projection year is calendar year basis, that is, from January through December.

15.2.2 Fund requirements and fund raising

(1) Fund requirements

Funds required for the Steel Complex are as follows:

1) Capital investment

The payment schedule of the capital investment, estimated in line with the construction schedule described in the Implementation Schedule, is estimated in the following table.

Table 15-2-1 Payment Schedule of the Capital Investment

(Unit: US$ 1,000)

Year	-3	-2	-1	Total
Equipment cost	99,700	192,000	181,300	468,000
Installation cost		20,000	30,000	50,000
Civil & building cost	52,500	42,000	10,500	105,000
Land preparation	5,000			5,000
Owner's engineering	4,200	4,200	4,200	12,600
Contingency	4,850	7,800	6,750	19,400
Total	166,250	266,000	232,750	665,000

Notes: (a) Installation cost includes customs clearance and inland transportation cost of equipment.

(b) Contingency is allocated by year according to the payment of equipment cost, installation cost and civil and building cost.

2) Pre-production cost

The pre-production cost is estimated as follows:

	(US$ '000)
Labor cost	18,000
Temporary office rental and office expenses	2,400
Fee and expenses for financial advisors	2,000
Process license fee	7,000
Miscellaneous expenses	2,600
Total	32,000

Key operational personnel will be employed 24 months before the start-up of the Steel Complex for training in overseas steel plants.
Other employees for the Steel Complex are assumed to be employed 6 months before start-up.

Labor costs during the above period are estimated as pre-production costs, which consists of costs and expenses required before start-up.

The above labor cost includes costs and expenses for the personnel to be dispatched from advanced, overseas steel companies.

The process license fee for the DRP is also assumed in the pre-production cost.

Pre-production cost is amortized equally for 15 years after start-up in the account of deferred assets.

The yearly payment schedule of pre-production cost is estimated.

Table 15-2-2 Payment Schedule of Pre-production Cost

(Unit: US$ 1,000)

Year	-3	-2	-1	Total
Labor cost	1,000	4,000	13,000	18,000
Office expenses	800	800	800	2,400
Financial advisor	2,000			2,000
Process license fee			7,000	7,000
Miscellaneous expenses	200	400	2,000	2,600
Total	4,000	5,200	22,800	32,000

3) Interest during construction period

The interests on long-term debts during construction period are amortized equally during 15 years after start-up in the account of deferred assets.

The yearly payment schedule of the above-mentioned interests is estimated.

Table 15-2-3 Payment Schedule of Interest during the Construction Period (IDC)

(Unit: US$ 1,000)

Year	-3	-2	-1	Total
IDC	5,253	18,232	37,666	61,151

4) Initial working capital fund

Fund requirements for raw materials and supplies at the start-up of operation is estimated as follows:

- Raw materials (pellets) : inventory of 1.5 months' consumption of the first operation year
- Manufacturing supplies : inventory of 3 months' consumption of the first operation year

Table 15-2-4 Initial Working Capital

(Unit: US$ 1,000)

Year	-3	-2	-1	Total
Raw materials			7,614	7,614
Manufacturing supplies			10,287	10,287
Total			17,901	17,901

Minimum cash at hand 7,619

5) Total investment cost

As a result of estimation based on the mentioned assumptions, the total investment is detailed in the following table.

Table 15-2-5 Total Investment Cost

(Unit: US$ 1,000)

Year	-3	-2	-1	Total
Capital investment	166,250	266,000	232,750	665,000
Pre-production cost	4,000	5,000	23,000	32,000
IDC	5,253	18,232	37,666	61,151
Initial working capital			25,520	25,520
Total	175,503	289,232	318,936	783,671

(2) Fund raising

The total investment is assumed to be covered by equity capital and long-term loans with the terms and conditions shown in the following.

(a) Debt-equity ratio is assumed to be 70:30.

(b) Terms and Conditions of Long-term Loans

Interest rate	9.0 % p.a.
Loan period	10 years
Grace period	2 years
Repayment	8 years

Repayment methods: annual equal repayment

(3) Fund raising and fund demand schedule

The fund demand and raising schedule for the Steel Complex Project is planned as shown in the following table.

Table 15-2-6 Schedule of Fund Raising and Demand

(Unit: US$ 1,000)

Year	-3	-2	-1	Total
Fund Demand				
Capital investment	166,250	266,000	232,750	665,000
Pre-production cost	4,000	5,000	23,000	32,000
IDC	5,232	18,232	37,666	61,151
Initial working capital			25,520	25,520
Total	175,503	289,232	318,936	783,671
Fund Raising				
Long-term loans	116,734	171,539	260,167	548,594
Equity capital	58,769	117,539	58,769	235,078
Total	175,503	289,232	318,936	783,671

(4) Short-term loans

The annual interest rate of short-term loans for working capital fund, when necessary, is assumed to be 10 % in consideration of trends in the international money market and to be paid in full.

15.2.3 Sales schedule

(1) Sales plan

On the basis of the production plan, the sales plan is planned by country or area in the following table.

Table 15-2-7 Sales Plan (Country-wise Sales Quantity)

(Unit: 1,000 tons/year)

Country/Area	Year 2005 Sales Tonnage	Year 2010 Sales Tonnage
Domestic (Oman)	400	570
UAE	470	395
Kuwait	34	40
Bahrain	10	5
Saudi Arabia	30	10
Yemen	130	105
Jordan	5	4
Syria	10	6
Kenya	1	1
Tanzania	1	1
Pakistan	3	2
Asia	70	25
Total	1,164	1,164

The sales plan by area in the domestic market is estimated as follows:

Table 15-2-8 Domestic Sales Plan (Area-wise Sales Quantity)

Area	Sales Tonnage ('000 tons/year)	(%)
Muscat	74	(18%)
Al Batinah (Sohar)	67	(17%)
Mustadam	10	(3%)
A'Dahirah	54	(13%)
Ad Dakhlyah (Nizwa)	85	(21%)
Ashharqiyah (Sur)	55	(14%)
Al-Wusta	16	(4%)
Dhofar (Salalah)	39	(10%)
Total	400	(100%)

(2) Sales price

The C&F price of imported steel bars is very conservatively assumed at US$ 300 per ton in consideration of the recently very depressed worldwide market situation.

Sales prices of steel bars are estimated on the basis of actual prices in the targeted market area and the trend of the international market.
The net FOB price of steel bars for the Steel Complex is calculated to be the sales price to the customers minus transportation costs and related charges from the Steel Complex.

Sales prices assumption

Domestic	(US$/ton)	
CIF price of imported steel bars	300	
Import duty (5%)	15	
Location advantage	10	
Transportation cost to Dhofar area	(-) 3	(US$ 30/ton x 10%)
Ex-factory domestic price	322	

The location advantage represents the costs that importers would have to cover for (1) opening a letter of credit, (2) maintaining large storage yards and inventories, (3) buying reasonably large quantities to minimize unit import-related costs, and (4) handling charges before deliveries.

Export	(US$/ton)	
CIF price of imported steel bars	300	
Import duty		
(4% is accounted for GCC countries)	14	
Location advantage	10	
(applied for only UAE)		
(-) Transportation cost	- (T)	
Ex-factory export prices		
for UAE	314	
for Saudi, Kuwait, Bahrain	292	
for Yemen, Jordan, Syria, Kenya, Tanzania, Pakistan	270	
for Asia	260	
Weighted average export price	298	301
	(in 2005)	(in 2010)

In the market in Oman and GCC countries, the preferential buying policy of domestic products and common tariff are taken into consideration. The present import duties in GCC countries are as follows:

Oman	:	5% (general except special luxury items)
UAE	:	4% (general except special luxury items)
Saudi Arabia	:	12% (general except special luxury items), 20% for steel bars and wire rods
Qatar	:	5% (general except special luxury items), 20% for steel bars
Bahrain	:	4% (general except special luxury items)

The sales plan of the Steel Complex is summarized as follows:

Table 15-2-9 Sales Plan

Year	1st year			2nd year			3 - 7 year		
	Tonnage ('000 tons)	@ (US$/T)	Amount (mill. US$)	Tonnage ('000 tons)	@ (US$/T)	Amount (mill. US$)	Tonnage ('000 tons)	@ (US$/T)	Amount (mill. US$)
Domestic	400	322	128.8	400	322	128.8	400	322	128.8
Export	356.6	298	106.3	662.7	298	197.5	764	298	227.7
Total	756.6	310.7	235.1	1,062.7	307.0	326.3	1,164	306.2	356.5

Year	8th year and after		
	Tonnage ('000 tons)	@ (US$/T)	Amount (mill. US$)
Domestic	570	322	183.5
Export	594	301	178.8
Total	1,164	311.3	362.3

15.2.4 Sales expenses and general & administrative expenses

General & administrative expenses and selling & distribution expenses are already mentioned in Section 14.2.8 " Sales and General Expenses" .

15.2.5 Corporate income tax

It is assumed that the Steel Complex is exempted from corporate income tax for 5 years after the start-up under the provision of Law. The tax exemption may be extended for another 5 years. In this study 10-year tax holiday is adopted.

After the completion of tax-exemption period, corporate income tax is estimated at 7.5 % of taxable income in compliance with the Corporate Income Tax Law.
(The above tax rate is applicable to companies : foreign capital is equal to or less than 90%, Omani capital is equal or more than 51%, public share holding company and public share is 40%.)