PRE- FEASIBILITY REPORT  
(In terms of provision of EIA Notification 2006)

For

The Proposed Expansion of Dariba Smelter Complex  
Zinc Smelter (2,50,000 TPA to 5,00,000 TPA + Fumer Plant)  
Lead Smelter (1,25,000 TPA to 1,50,000 TPA) and  
Captive Power Plant (2 x 85 MW to 3 X 85 MW)

By:

HINDUSTAN ZINC LIMITED,  
Dariba Smelter Complex,  
Dariba – 313 211, Rajsamand,  
Rajasthan

To:

Ministry of Environment Forest & Climate Change  
(MoEF & CC)  
New Delhi

December, 2017
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CHAPTER - 1

INTRODUCTION
1.1 PREAMBLE

1.1 About HZL

Hindustan Zinc Limited (HZL) is an India-based company, which is engaged in the mining and smelting of Zinc, Lead and Silver metal in India. The Company's segments are mining and smelting of Zinc, Lead and Silver and Wind energy. The Company's operations include five Zinc-Lead mines, over four Zinc Smelters, a Lead Smelter, a Zinc-Lead Smelter, seven sulphuric acid plants, a silver refinery plant and over six captive power plants in the state of Rajasthan. In addition, the Company also has a rock-phosphate mine in Maton near Udaipur in Rajasthan and Zinc, Lead, Silver processing and refining facilities in the State of Uttarakhnad. The Company also has wind power plants in the States of Rajasthan, Gujarat, Karnataka, Tamil Nadu and Maharashtra. It has a metal production capacity of over one million tons per annum with its key Lead-Zinc mines in Rampura Agucha and Sindesar Khurd, and smelting complexes in Debari Chanderiya and Dariba, all in the state of Rajasthan.

1.2 Identification of Project & Project Proponent

Hindustan Zinc Ltd. is one of the largest Lead-Zinc integrated producer & a Leading producer of silver with more than 60 years of experience in Mining & Smelting. Reserves & Resources of about 404.4 MT as on 31st March 2017 sufficient for more than 25 years of mine life. Environment Clearance Capacities- Ore Production- 16.55 MTPA, Zinc metal- 11.25 lakh TPA, Lead metal-2.20 lakh TPA, Silver- 772 TPA. Captive Thermal Power generation 474 MW, Waste heat power 35 MW & Wind power 274 MW and 16.2 MW solar power plant. Clean Development Mechanism (CDM) projects on waste heat recovery & wind power have an annual Certified Emission Reduction potential of over 5,83,685 TPA of CO2. Total Exchequer to Government during 2016-17 was Rs.17,760 Crores, including Royalty, taxes and dividend. HZL has established Sewage Treatment Plant at Udaipur under PPP model to treat 20 MLD sewage and utilize treated water in its operations. With the success of Phase-I, MOU has been signed with Udaipur Smart City Ltd for another 40 MLD on 25th June 2017. Vision to enhance the quality of life and economic wellbeing of the communities around its operations, mainly SAKHI, MARYADA, KHUSHI campaigns, reaching over 5 lakh people spread over 184 villages across Rajasthan.

Dariba Smelter Complex was established in the year 2010-11 in Rajpura Dariba Complex of Hindustan Zinc with Zinc Smelter (0.25 MTPA), Lead Smelter (0.125 MTPA) and Captive Power Plant (170 MW). Environment Clearance was granted by MoEF&CC for Integrated Project at Dariba, Hindustan Zinc Ltd. (Zinc Smelter (5,00,000 TPA), Lead Smelter (1,25,000 TPA), Captive Power Plant (255 MW) and expansion of Rajpura Dariba Mine (6,31,000 to 9,00,000 TPA) along with Beneficiation Plant (9,00,000 to 12,00,000 TPA) vide Letter No. J-11011/380/2008-IA II (I) dated 4.11.2009.

Dariba Smelter Complex (DSC) is located at a distance of 76 km NNE of Udaipur. The nearest railway station is Fatehnagar, about 15.5 km, on Chittorgarh-Udaipur broad gauge railway line. Plant is well connected by a metallled road from Udaipur, Chittorgarh, Bhilwara and District head quarter Rajsamand. The plant falls in Survey of India Topo sheet No. 45/L1.

The proposed expansion of Dariba Smelter Complex is from 2,50,000 to 5,00,000 TPA of Zinc Smelter, 1,25,000 to 1,50,000 TPA of Lead Smelter and from 170 MW
(2 X 85 MW) to 255 MW (3 X 85 MW) of Captive Power Plant. It is also proposed to install Fumer plant (pyro metallurgical process) within leaching circuit of Zinc Smelter to eliminate the generation of Jarosite, which is presently stabilized with lime and cement to convert into stabilized Jarofix and stored in Jarofix disposal yard.

1.3 Need for Project And It’s Importance

Global Zinc & Lead consumption is expected to grow steadily by 4-5% per annum in coming years which needs to be met by higher mine & Smelter output. As India is one of the fastest growing economies in the World, adequate support from metal sector is essential to support & sustain infrastructure development & growth. Galvanized iron products play key role in infrastructure development and therefore the requirement of Zinc metal is essential. Lead requirement in batteries is increasing with Automobile Industry expansion & power back up. Proposed expansion project shall augment the supply of Zinc to the domestic market for Industrial growth. The proposed expansion will generate additional direct employment of approximately 700 man power. In addition to this, there is ample opportunity for increase in indirect employment due to transport, workshop, garages and other services. Skill development & training programs to make local youth employable shall continue for development of community.

Zinc is a very versatile non-ferrous metal. Zinc’s different applications rank it as the 4th most common metal in use after iron, aluminum and copper. Global Zinc consumption is forecast to grow at a compound average annual rate of 2.4 % p.a. over the period 2016-2021. Global Zinc consumption is projected to grow to 20 Mt in 2035 representing average annual increase of 0.28 Mt.

1.3.1 Demand-Supply Gap

In the aftermath of the financial crisis of 2008-2009, the Indian economy lost momentum. Growth in industrial production slowed from an average of 7.9% during 2000-2008 to 3.9% over the period 2010-2015.

<table>
<thead>
<tr>
<th>Year</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand (kt)</td>
<td>699</td>
<td>844</td>
<td>833</td>
<td>828</td>
<td>824</td>
<td>827</td>
</tr>
<tr>
<td>Supply (kt)</td>
<td>643</td>
<td>838</td>
<td>811</td>
<td>849</td>
<td>837</td>
<td>837</td>
</tr>
</tbody>
</table>

Source: Wood Mackenzie Long Term Outlook

1.3.2 Import Vs Indigenous Production

The present production capacities of Zinc in India are sufficient to meet the domestic requirements. However, the demand for Zinc in India is expected to grow at a 7.1% which makes it viable for the expansion of the Zinc production capacities. Further the deficit in international market during the upcoming years provides opportunity for export.

1.3.3 Export Possibility

Indian exports majorly catered to South East Asian and African nations. In India, since Hindustan Zinc is the largest producer of primary Zinc, export of Zinc is highly feasible and shall bring value addition.
1.3.4 Domestic/Export Market

Zinc having found primary application in galvanization, a range of galvanized products are produced to meet various Industrial and consumer demands. Galvanized sheets (corrugated and plain), galvanized pipes, galvanized structure, galvanized sheet, galvanized wires are used for various applications. Galvanizing Segment accounts for 68% share of the overall Zinc demand in India while Non-Galvanizing accounts for 32% share. Among the major customer segments, Galvanized Sheets accounts for major share of the Zinc consumption followed by structure and Alloys. The following chart explains the demand for Zinc in India and its segment wise break-up India has the potential for exporting Zinc profitably as global Zinc demand continues to be high & driven mainly by galvanizing sector in the emerging of Asia and Africa. The reported increase in Chinese manufacturing activities and US automotive sales along with emerging signs of stability in Europe’s manufacturing and services sector are expected to support Zinc demand.
1.4 Legal Aspects

The relevant NOC’s and licenses will be obtained from the statutory agencies under the following Acts, Rules and amendments and HZL will adhere to the guidelines specified in:

- The Factories Act, 1948;
- Environment (Protection) Act – 1986 and its amendments to date;
- Manufacture, Storage and Import of Hazardous Chemical Rules 1989 amended in 2010;

HZL will comply with the prescribed limits laid down for air, effluent and noise emissions for protection of the environment under the following Acts, Rules and amendments:

- The Water (Prevention and Control of Pollution) Act, 1974;
- The Air (Prevention and Control of Pollution) Act, 1981;
- The Environment (Protection) Act, 1986;
- The Environment Impact Assessment, Notification, 2006 Rules issued there under;
- Environment (Protection) Act 1986 and Environment (Protection) Rules 1986 and amendments thereafter to date.

Compliance to State Rules and Notifications will also be ensured.
CHAPTER-2
PROJECT DESCRIPTION
2.1 Project Description

I. Type of Project including interlinked and independent projects

This chapter describes the process, and sources of pollution for proposed expansion i.e. production of Zinc from 2,50,000 TPA to 5,00,000 TPA, Lead from 1,25,000 TPA to 1,50,000 TPA and power generation from 170 (2 X 85) MW to 255 (3 X 85) MW to meet the needs of Dariba Smelter Complex, in the existing premises.

The following were the principle objectives, kept in mind while working on the feasibility of this proposal.

- Adopting environment friendly technology & equipment and working on reduction of pollution load of hazardous solid waste i.e. Jarosite by setting fumer plant.
- Conserving natural resources like water, thermal & electrical energy.
- Waste reduction and recycling options
- Aiming at waste heat recovery to best possible extent by state of art proven technology
- Value added By- Products

The proposed expansion project is classified as "CATEGORY-3(a) & 1(d)" by Ministry of Environment & Forest, New Delhi as per the EIA Notification dated 14th September 2006.

II. Location (map showing general location, specific location, and project boundary & project site layout) with coordinates:

Dariba Smelter Complex is located at a distance of 76 km NNE of Udaipur. The nearest railway station is Fatehnagar, about 15.5 km on Chittorgarh-Udaipur broad gauge railway line. The Plant is well connected by a metalled road from Udaipur, Chittorgarh, Bhilwara and District headquarter Rajsamand. The plant falls in Survey of India Toposheet No. 45/L1. Geographical location of the project site, study area map and study area satellite map have been provided in the Figure-2.1, Figure-2.2 and Figure-2.3. Environmental Setting of the Site is provided in the Table 2.1.
Proposed Expansion of Dariba Smelter Complex - Zinc Smelter (0.25 to 0.50 Million TPA + Fume Plant), Lead Smelter (0.125 Million TPA to 0.150 Million TPA) and Captive Power Plant (2 x 85 MW to 3 x 85 MW) at Village Dariba, Tehsil - Relmagra, District - Rajsamand, Rajasthan

FIGURE-2.1
GEOGRAPHICAL LOCATION OF THE PROJECT
FIGURE-2.2
STUDY AREA MAP
Proposed Expansion of Dariba Smelter Complex - Zinc Smelter (0.25 to 0.50 Million TPA + Fume Plant), Lead Smelter (0.125 Million TPA to 0.150 Million TPA) and Captive Power Plant (2 x 85 MW to 3 x 85 MW) at Village Dariba, Tehsil - Relmagra, District - Rajsamand, Rajasthan

FIGURE-2.3
STUDY AREA GOOGLE MAP
Proposed Expansion of Dariba Smelter Complex - Zinc Smelter (0.25 to 0.50 Million TPA + Fumer Plant), Lead Smelter (0.125 Million TPA to 0.150 Million TPA) and Captive Power Plant (2 x 85 MW to 3 X 85 MW) at Village Dariba, Tehsil - Relmagra, District - Rajsamand, Rajasthan

### TABLE 2.1
ENVIRONMENTAL SETTING OF THE SITE

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Project Location</td>
<td>Dariba Smelter Complex Village &amp; Post – Dariba, Tehsil – Relmagra, Dist. – Rajsamand, Rajasthan</td>
</tr>
<tr>
<td>2.</td>
<td>Latitude</td>
<td>N 24°57'22.16&quot; to 24°58'10.24&quot;</td>
</tr>
<tr>
<td>3.</td>
<td>Longitude</td>
<td>E 74°06'45.89&quot; to 74°08'02.44&quot;</td>
</tr>
<tr>
<td>4.</td>
<td>Elevation above MSL</td>
<td>480 m -490 m</td>
</tr>
<tr>
<td>5.</td>
<td>Toposheet No.</td>
<td>45L/1</td>
</tr>
<tr>
<td>6.</td>
<td>Climatic conditions</td>
<td>Annual maximum temp: 47.0°C, Annual minimum temp: 2.0°C, Annual total rainfall: 550 mm, Annual predominant wind direction: NW, W</td>
</tr>
<tr>
<td></td>
<td>IMD Dabok (Udaipur)</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Nearest Highway</td>
<td>NH-162A - 500 m, W Udaipur –Chittorgarh 4 Lane : (13.2 km, S)</td>
</tr>
<tr>
<td>8.</td>
<td>Nearest Railway Station</td>
<td>Fatehnagar (15.5-km, SW)</td>
</tr>
<tr>
<td>9.</td>
<td>Nearest Airport</td>
<td>Dabok, Udaipur (43.0 km, SW)</td>
</tr>
<tr>
<td>10.</td>
<td>Nearest River</td>
<td>Banas (7.9 km, NNE)</td>
</tr>
<tr>
<td>11.</td>
<td>Nearest Port</td>
<td>Kandla (450 km, SW)</td>
</tr>
<tr>
<td>12.</td>
<td>Nearest Village</td>
<td>Mahenduriya (0.5 km, W), Anjana (1.8 km SSW), Rajpura(1 km,N), Dariba (0.5 km,SW)</td>
</tr>
<tr>
<td>13.</td>
<td>Nearest Town/City</td>
<td>Rajsamand, (25.0 km,NW)</td>
</tr>
<tr>
<td>14.</td>
<td>Hills/Valleys</td>
<td>Nil in 10-km radius</td>
</tr>
<tr>
<td>15.</td>
<td>Monuments</td>
<td>Nil in 10-km radius</td>
</tr>
<tr>
<td>16.</td>
<td>Archaeologically important places</td>
<td>Nil in 10-km radius</td>
</tr>
<tr>
<td>17.</td>
<td>Reserved/Protected forest</td>
<td>Nil in 10-km radius</td>
</tr>
<tr>
<td>18.</td>
<td>Protected areas as per Wildlife</td>
<td>Nil in 10-km radius</td>
</tr>
<tr>
<td></td>
<td>Protection Act, 1972 (Biospheres,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tiger Reserves, Elephant Reserves,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>National Parks, Wildlife Sanctuaries,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Conservation Reserves, and Community</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reserves)</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>List of Industries</td>
<td>RajpuraDariba Mines (0.5 km, SE), SindesarKhurd mines (3.0-km, NNE) owned by HZL.</td>
</tr>
<tr>
<td>20.</td>
<td>Seismicity</td>
<td>Seismic Zone II</td>
</tr>
</tbody>
</table>
Zinc Smelter

Considering various process options available such as Pyro-metallurgical ISF route & Hydrometallurgical route, HZL has installed a hydrometallurgical Smelter at Dariba using conventional hydro-metallurgical route of roast-leach-electro-winning operations for the following reasons:

1. Higher recovery of Zinc and other by-products
2. Production of Special high grade quality Zinc (SHG)

Also, there is no plant operating in the world following pyro-metallurgical route for more than 0.12 MTPA.

Conventional hydro-metallurgical route for Zinc extraction is through “Roast-Leach- Electro-winning” operations. The raw material for the Zinc Smelter is Zinc concentrate, which contains about 50% Zinc in the form of Zinc Sulphide. The Zinc concentrate containing Zinc& other impurities is roasted to convert it into Zinc oxide, which is leached in dilute sulphuric acid to produce a raw Zinc sulphate solution. The impurities like copper, cadmium, nickel, cobalt etc also get dissolved in the solution as sulphates. The insoluble impurities are separated in thickeners & clear over flows purified by addition of Zinc dust / powder and activators. The purified Zinc sulphate solution is then electrolysed to obtain Zinc cathodes, which are then melted and cast into Zinc metal ingots. The filter cakes obtained during purification are sent to cadmium section. Iron residue generated from leaching is Jarosite, a waste which is being stabilized by addition of lime and cement. The product is called Jarofix which is stockpiled at Jarofix yard and needs recurring land.

To eliminate Jarosite generation, it is proposed to set up fuming process within existing leaching circuit of Zinc Smelter.

Salient Features

- Recovery of minor metals like Lead-Silver, Copper and Cadmium thereby reduction in waste generation;
- Efficient gas cooling and cleaning process to get optically clear gas;
- Double Conversion Double Absorption (DCDA) process with Cesium catalyst results in high SO₂ recovery (>99.8 %) and low SO₂ emission in acid plant;
- Thermally auto genous process with power generation from waste heat;
- High end automation and interlocking with pollution control equipments;
- Pneumatic conveying system for calcine tanker unloading;
- Online stack monitoring for SOₓ.

Fumer Plant

After modification, the current jarosite process will be converted to the conventional leaching process, from which 3,80,000 tons of residue (dry base) will be treated with fuming furnaces.

In the fuming process, the leaching residue is treated in stages in a fuming furnace. The stages are: residue melting and heating, fuming, and slag tapping.

To reduce energy consumption and to facilitate leaching residue transfer after filtration, the residue will be dried by drying kiln. The leaching residue treatment system consists of leaching residue drying, proportioning, fuming, off gas waste heat recovery and dust collection. Off gas from the drying kiln and the fuming
furnaces will be sent to the off gas desulfurization plant (TGP). Zinc oxide desulfurization technology will be used, and the Zinc oxide needed will be produced from the fuming off gas and dust.

**Salient Features**

- The fuming slag is the clean slag;
- Valuable metals such as Zn, Pb, Ag will be extracted from the leaching residue at high recovery rates;
- The fuming off gas will be de sulfurized to meet environmental requirements;
- The off gas waste heat will be recovered in steam for power generation, which will serve the plant and save energy;
- In the material handling system, the discharge points, slag tap holes, and the granulation area will be equipped with ventilation and dust removal facilities, which improve the working environment;
- The two fuming furnaces will run in series, a pattern which provides high flexibility; However if required one can also be operated in case of exigencies
- The furnace tuyeres have a long service life;
- The furnace is easy to operate and highly automatic.

**Lead Smelter**

Based on HZL’s prior experience and recent assessment of technology the following process technology options were evaluated.

- Ausmelt Technology (Single Furnace Philosophy) - Australia
- Ausmelt Technology (Twin furnace philosophy) - Australia
- SKS Technology – China

Based on the evaluations done, SKS Technology route has been selected for the following reasons:

- ENFI / NFC technology offer is including minor metal & precious metal recovery facilities like Cu, Sb, Bi, Ag etc
- ENFI / NFC china offering a total turnkey solution from Technology to EPC to process Guarantees

**Salient Features**

- Pyro-route for smelting & hydro-route for Lead refining
- High Lead, Zinc and Silver Recovery
- Recovery of minor metals- Silver, Copper, Antimony and Bismuth
- Process capability to accept Lead Silver compound (a by-product of Zinc Smelter) and other Lead Secondary
- Effective dust collection and Hygiene systems
- Online stack monitoring for SOx

**Captive Power Plant**

Based on our proven and satisfactory experience, pulverised coal fired Boiler with steam turbine generator has been selected.
2.2 Project Details

The Operational hydro-metallurgical Smelter is designed to produce 0.25 million TPA of Special High Grade Zinc annually from Zinc concentrate/Calcine. The hydro-metallurgical route based on Roast – Leach – Electro-winning process is widely accepted process for manufacturing Zinc metal and it is proposed to increase the Zinc production from 0.25 million TPA to 0.5 million TPA with same technology. But this increase in production will take place in two phases, first from 0.25 to 0.375 million TPA then after successful commissioning 0.375 million TPA then the second phase will start from 0.375 to 0.5 million TPA.

To eliminate the issue of Jarosite, the Fumer plant is proposed in this project which will stop producing Jarosite i.e. Hazardous waste and start producing Slag which is non-hazardous waste. This important step is taken after inconsideration of environmental concerns in whole world to reduce Hazardous waste for safer environment for future generation i.e Sustainability.

In this proposed expansion the Lead Smelter production is increasing from 0.125 million TPA to 0.150 million TPA with same technology. There are 2 Plants of 85MW which is operational to meet the requirement of existing Zinc Smelter Complex but due to rise in production of Zinc there will be need of 1 more plant of 85 MW to meet the new requirements Change in Plant Capacity is depicted in Table-2.2.

Salient Features

- High efficiency ESPs with 8 nos. of fields;
- Covered coal conveyors with water sprinkling system using waste water;
- Bag filters at each coal transfer point, coal bunkers and fly ash silos to restrict emission;
- SOx and D Nox systems such as FGD and SCR for meeting the latest environmental norms;
- Online stack monitoring for SOx, NOx and PM.

Salient Features of the Smelters and CPP

- Integrated Utility plant;
- Integrated Effluent treatment plant followed with two stage RO Plant and Multiple Effect Evaporator (MEE) Plant;
- RO based DM plant thereby reducing effluent generation;
- Transportation of raw material and finished products in 40 MT bulkers;
- Cement concrete internal roads;
- Industrial sweeper;
- Truck / Tyre wash stations.
Proposed Expansion of Dariba Smelter Complex - Zinc Smelter (0.25 to 0.50 Million TPA + Fumer Plant), Lead Smelter (0.125 Million TPA to 0.150 Million TPA) and Captive Power Plant (2 x 85 MW to 3 X 85 MW) at Village Dariba, Tehsil - Relmagra, District - Rajsamand, Rajasthan

### TABLE 2.2
**PLANT CAPACITY**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Existing Granted Capacity (As per EC granted in Nov.'2009)</th>
<th>Existing Status</th>
<th>Additional Proposed Capacity</th>
<th>Total Capacities After Proposed Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc Smelter</td>
<td>0.5 MTPA</td>
<td>0.25 MTPA</td>
<td>0.25 MTPA</td>
<td>0.5 MTPA</td>
</tr>
<tr>
<td>Lead Smelter</td>
<td>0.125 MTPA</td>
<td>0.125 MTPA</td>
<td>0.025 MTPA</td>
<td>0.15 MTPA</td>
</tr>
<tr>
<td>Captive Power Plant</td>
<td>255 MW</td>
<td>170 MW</td>
<td>85 MW</td>
<td>255 MW</td>
</tr>
<tr>
<td>Fumer Plant</td>
<td>-</td>
<td>-</td>
<td>Associated with Zinc Smelter</td>
<td>Associated with Zinc Smelter</td>
</tr>
</tbody>
</table>

### TABLE 2.3
**PRODUCTS AND BYPRODUCTS**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Existing Granted Quantity (As per EC granted in Nov.'2009)</th>
<th>Existing Status</th>
<th>Additional Proposed Quantity</th>
<th>Total Quantity After Proposed Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Products</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc Smelter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHG Zinc Cathode/Ingot (Special High Grade)</td>
<td>0.50 MTPA</td>
<td>0.25 MTPA</td>
<td>0.25 MTPA</td>
<td>0.50 MTPA</td>
</tr>
<tr>
<td>Zinc (Continuous Galvanizing Grade) (out of 500,000 TPA SHG Zinc)</td>
<td>0.08 MTPA</td>
<td>0.04 MTPA</td>
<td>0.04 MTPA</td>
<td>0.08 MTPA</td>
</tr>
<tr>
<td>Lead Smelter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Cathode/Ingot</td>
<td>0.125 MTPA</td>
<td>0.125 MTPA</td>
<td>0.025 MTPA</td>
<td>0.150 MTPA</td>
</tr>
<tr>
<td>Lead Alloy (Pb-Sb&amp;Pb-Ca, Pb-Bi) (out of 150,000 TPA Lead)</td>
<td>0.05 MTPA</td>
<td>0.05 MTPA</td>
<td>0.01 MTPA</td>
<td>0.06 MTPA</td>
</tr>
<tr>
<td>Captive Power Plant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td>255 MW</td>
<td>170 MW</td>
<td>85 MW</td>
<td>255 MW</td>
</tr>
<tr>
<td><strong>By-products (TPA)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td>744000</td>
<td>744000</td>
<td>90,000</td>
<td>8,34,000</td>
</tr>
<tr>
<td>Lead – Silver Compound</td>
<td>80000</td>
<td>40000</td>
<td>40000</td>
<td>80000</td>
</tr>
<tr>
<td>Cadmium metal / Sponge (equivalent metal)</td>
<td>1600</td>
<td>800</td>
<td>1200</td>
<td>2000</td>
</tr>
<tr>
<td>Calomel</td>
<td>44</td>
<td>44</td>
<td>-</td>
<td>No Change</td>
</tr>
<tr>
<td>Silver</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>800</td>
</tr>
<tr>
<td>Copper as Copper cement/sulphate/matte/concentrate/Compound(equivalent metal)</td>
<td>1900</td>
<td>1400</td>
<td>1400</td>
<td>2800</td>
</tr>
<tr>
<td>Antimony as Antimony concentrate (equivalent metal)</td>
<td>850</td>
<td>850</td>
<td>170</td>
<td>1020</td>
</tr>
<tr>
<td>Waste Heat power</td>
<td>15 MW</td>
<td>15 MW</td>
<td>20 MW</td>
<td>35 MW</td>
</tr>
<tr>
<td>Bismuth as Bismuth concentrate (equivalent metal)</td>
<td>16</td>
<td>16</td>
<td>30</td>
<td>46</td>
</tr>
<tr>
<td>Zinc Oxide compound</td>
<td>20000</td>
<td>20000</td>
<td>16000</td>
<td>36000</td>
</tr>
<tr>
<td>Lead concentrate (Oxide)</td>
<td>5000</td>
<td>5000</td>
<td>1000</td>
<td>6000</td>
</tr>
<tr>
<td>Anode Slime</td>
<td>4000</td>
<td>4000</td>
<td>800</td>
<td>4800</td>
</tr>
<tr>
<td>Lead Bullion</td>
<td>-</td>
<td>-</td>
<td>20000</td>
<td>20000</td>
</tr>
</tbody>
</table>
Raw Material Storage

The concentrate is unloaded at unloading station and stored in concentrate storage yard, of 12,000 T capacity. From the stockyard, a pay loader feed the material into different hoppers. By means of discharge and transport belt conveyors including an over-belt magnetic separator, the material is transported to a transfer tower, from where concentrate is routed to the roasting plant. Similarly, separate silos for storing calcine have been made in the Roaster and Leaching & Purification area.

The major raw materials for the project are Zinc concentrates, calcine and coal. The raw materials requirement is given in Table-2.3. The raw material source and mode of transportation is given in Table-2.4. Deficit, if any, shall be met through import. Other raw materials are aluminum metal for CGG Zinc and coal/coke for Lead Smelter and coal for power production. These materials will be sourced from the market, based on techno-economic feasibility.

The requirement of other consumables (fuels & process chemicals) required in the plant has been estimated and furnished in Table-2.5.

**TABLE-2.3**

**BASIC RAW MATERIAL– SMelters & CPP**

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Existing Granted Quantity (As per EC granted in Nov.’2009)</th>
<th>Existing Requirement</th>
<th>Additional Requirement</th>
<th>Total Requirement After Proposed Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc concentrate</td>
<td>6,48,000</td>
<td>6,48,000</td>
<td>25000</td>
<td>6,73,000</td>
</tr>
<tr>
<td>Calcine (ZnO)</td>
<td>2,80,000</td>
<td>-</td>
<td>2,80,000</td>
<td>2,80,000</td>
</tr>
<tr>
<td>Aluminium metal</td>
<td>160</td>
<td>80</td>
<td>80</td>
<td>160</td>
</tr>
<tr>
<td>Lead concentrate</td>
<td>2,60,000</td>
<td>2,60,000</td>
<td>90,000</td>
<td>3,50,000</td>
</tr>
<tr>
<td>Coal for Lead Smelter</td>
<td>26000</td>
<td>26000</td>
<td>14000</td>
<td>40000</td>
</tr>
<tr>
<td>Coke for Lead Smelter</td>
<td>27000</td>
<td>27000</td>
<td>11000</td>
<td>38000</td>
</tr>
<tr>
<td>Coal for Fumer Plant</td>
<td>-</td>
<td>-</td>
<td>2,50,000</td>
<td>2,50,000</td>
</tr>
<tr>
<td>Cu2SO4 for Fumer plant</td>
<td>-</td>
<td>-</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Coal for power plant</td>
<td>11,62,000</td>
<td>7,74,667</td>
<td>3,87,333</td>
<td>11,62,000</td>
</tr>
<tr>
<td>Lead Silver Compound *</td>
<td>80,000</td>
<td>40,000</td>
<td>40,000</td>
<td>80,000</td>
</tr>
<tr>
<td>Zinc Dross/ Ash/ Zinc bearing waste*</td>
<td>-</td>
<td>30,000</td>
<td>-</td>
<td>30,000</td>
</tr>
<tr>
<td>Battery/Lead Scrap &amp; secondary *</td>
<td>80,000</td>
<td>80,000</td>
<td>-</td>
<td>80,000</td>
</tr>
</tbody>
</table>

**TABLE-2.4**

**BASIC RAW MATERIAL– SOURCE & TRANSPORTATION**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Item</th>
<th>Total Quantity/year (Tonnes)</th>
<th>Source of supply</th>
<th>Probable transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zinc concentrate</td>
<td>6,73,000</td>
<td>Imported% 100</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Calcine (ZnO)</td>
<td>280,000</td>
<td>Indigenous % 100</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Aluminium metal</td>
<td>160</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>Lead concentrate</td>
<td>3,50,000</td>
<td>45.3%</td>
<td>54.7%</td>
</tr>
</tbody>
</table>
Proposed Expansion of Dariba Smelter Complex - Zinc Smelter (0.25 to 0.50 Million TPA + Fumer Plant), Lead Smelter (0.125 Million TPA to 0.150 Million TPA) and Captive Power Plant (2 x 85 MW to 3 X 85 MW) at Village Dariba, Tehsil - Relmagra, District - Rajsamand, Rajasthan

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Item</th>
<th>Total Quantity/year (Tonnes)</th>
<th>Source of supply</th>
<th>Probable transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Imported%</td>
<td>Indigenous %</td>
</tr>
<tr>
<td>5</td>
<td>Lead silver compound for Lead</td>
<td>80,000</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>Lead secondary's</td>
<td>80,000</td>
<td>50.0</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>Coal for Fumer Plant</td>
<td>2,50,000</td>
<td>60.0</td>
<td>40</td>
</tr>
<tr>
<td>8</td>
<td>Coal for Lead Smelter</td>
<td>40,000</td>
<td>60.0</td>
<td>40</td>
</tr>
<tr>
<td>9</td>
<td>Coke for Lead Smelter</td>
<td>38,000</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>10</td>
<td>Coal for power plant</td>
<td>1,162,000</td>
<td>76.0</td>
<td>24</td>
</tr>
</tbody>
</table>

**TABLE-2.5**
Consumeable per annum

<table>
<thead>
<tr>
<th>Consumables</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flocculants</td>
<td>Tons</td>
<td>266</td>
</tr>
<tr>
<td>Lime</td>
<td>Tons</td>
<td>68,500</td>
</tr>
<tr>
<td>SiO₂</td>
<td>Tons</td>
<td>13,000</td>
</tr>
<tr>
<td>H₂F₂S₆ (Silico Floric Acid)</td>
<td>Tons</td>
<td>3,000</td>
</tr>
<tr>
<td>LDO/LSH/HS/LNG</td>
<td>KL</td>
<td>14,000</td>
</tr>
<tr>
<td>Sulphuric acid (internal)</td>
<td>Tons</td>
<td>27,500</td>
</tr>
<tr>
<td>MnO₂ (internal)</td>
<td>Tons</td>
<td>6,375</td>
</tr>
<tr>
<td>Caustic Soda Solution</td>
<td>M3</td>
<td>1,500</td>
</tr>
<tr>
<td>Ammonium Chloride</td>
<td>Tons</td>
<td>638</td>
</tr>
<tr>
<td>Limestone</td>
<td>Tons</td>
<td>74,000</td>
</tr>
<tr>
<td>Iron Ore</td>
<td>Tons</td>
<td>18,000</td>
</tr>
<tr>
<td>Cement</td>
<td>Tons</td>
<td>2,000</td>
</tr>
</tbody>
</table>

**Power Requirement**

The power requirement for the Smelter and CPP project is 240 MW. The total power requirement for the Smelter, CPP will be 252 MW. 255 MW coal based Captive Power Plant is envisaged for providing power to proposed expansion Smelter.

**Water Requirement**

Water requirement for industrial and township usage will be met from Matri kundia Dam, Mansi wakal Dam and Common Sewage Treatment Plant installed in Udaipur. Consumption pattern of water for the enhancement of Smelters and CPP is given in Table-2.6.
### 2.3 Process Description

#### 2.3.1 Zinc Smelter

- **Roasting Plant**

  The Zinc concentrate, which is in Zinc sulphide form along with other sulphides, is not leachable at normal temperature and acidity. It is therefore necessary to convert this sulphide material to acid leachable form. The purpose of Roasting is to convert the Zinc sulphide to Zinc oxide (Calcine) by burning with air in a fluo-solid Roaster thereby expelling the sulphur as SO\(_2\) gas and subsequently recovering as sulphuric acid in acid plant.

  The Zinc concentrate to be treated is stored in a surge bin, with a holding capacity for more than one shift.

  The concentrate is discharged from the bin by means of a slow running rubber belt. The capacity of Roaster furnace is 954 Tonnes of concentrate per day (Dry) with a hearth area of 123 m\(^2\).

---

**Table-2.6**

**WATER REQUIREMENT**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Existing Granted Quantity (As per EC granted in Nov.'2009) (m(^3)/day)</th>
<th>Existing Requirement (m(^3)/day)</th>
<th>Additional Requirement (m(^3)/day)</th>
<th>Total Requirement After Proposed Expansion (m(^3)/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc Smelter</td>
<td>11,000</td>
<td>8,010</td>
<td>2,990</td>
<td>11,000</td>
</tr>
<tr>
<td>Fumer Plant</td>
<td>-</td>
<td>-</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Lead Smelter</td>
<td>7,250</td>
<td>2,800</td>
<td>4,450</td>
<td>7,250</td>
</tr>
<tr>
<td>Captive Power Plant</td>
<td>17,000</td>
<td>11,000</td>
<td>5,760</td>
<td>16,760</td>
</tr>
<tr>
<td>Domestic</td>
<td>1,000</td>
<td>600</td>
<td>400</td>
<td>1,000</td>
</tr>
<tr>
<td>Total</td>
<td><strong>36,250</strong></td>
<td><strong>22,410</strong></td>
<td><strong>23,600</strong></td>
<td><strong>46,010</strong></td>
</tr>
</tbody>
</table>

Water is sourced from the dams/ STP through pipelines, the details are given in **Table-2.7**

**Table-2.7**

**SOURCES OF WATER**

<table>
<thead>
<tr>
<th>Source</th>
<th>Availability (m(^3)/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matri-kundia dam</td>
<td>9,000</td>
</tr>
<tr>
<td>Mansi Wakal dam</td>
<td>10,800</td>
</tr>
<tr>
<td>STP Udaipur</td>
<td>20,000</td>
</tr>
<tr>
<td>STP Udaipur – Expansion</td>
<td>20,000</td>
</tr>
<tr>
<td>Total</td>
<td><strong>59,800</strong></td>
</tr>
</tbody>
</table>

An agreement has been signed between the Govt. of Rajasthan and HZL for supply of 117 m\(^3\)/ft water from Matri kundia Dam. A Memorandum of Understanding (MoU) has been signed between Govt. of Rajasthan and HZL for implementation of Mansi Wakal Project Stage-I. Under this MoU, the water diverted from the Mansi Wakal Stage-I project, 30% of water available at off-take point of the common carrier system shall be made available to HZL.
The principal roasting reactions are as follows;

\[ 2\text{ZnS} + 3\text{O}_2 = \rightarrow 2\text{ZnO} + 2\text{SO}_2 + 223.6 \text{ Kcal} \]
\[ 4\text{FeS} + 7\text{O}_2 = \rightarrow 2\text{Fe}_2\text{O}_3 + 4\text{SO}_2 + \text{Heat} \]
\[ \text{ZnO} + \text{Fe}_2\text{O}_3 = \rightarrow \text{ZnFe}_2\text{O}_4 \] (Zinc ferrite)

In order to avoid any gas leakage, in particular through the charge openings, the furnace is maintained under a slight negative pressure. This draught is provided by the \( \text{SO}_2 \) gas blower and controlled by a louver type damper. The roasting gas at the furnace exit has a temperature of about \( 950 \) to \( 1000^\circ\text{C} \) and a \( \text{SO}_2 \) content of approximately \( 9\% \) (Vol.). In a waste heat boiler, the gas is cooled to about \( 350^\circ\text{C} \).

The waste heat boiler is of the forced circulation type. It is designed to produce superheated steam at \( \sim 40 \text{ bar} / 400^\circ\text{C} \). The boiler design provides for tube lined walls and the use of evaporator bundles. All the bundles are suspended at the boiler roof. To avoid any air ingress, the roof is tight welded. A part of the flue dust may adhere on the tube surface; all the bundles are equipped with an effective rapping device, controlled by a timer to make this adhering calcine to fall. The rapping periods may be set as required to optimize operation.

Only de-aerated and treated feed water will be used for the boiler. This water is prepared in the de-mineralized water treatment plant. It is fed into the boiler drum by means of a boiler feed pump. From the drum, the circulating pump delivers the water into the evaporator bundles and wall tubes and the cooling coils of the roaster.

The calcine, collected in the waste heat boiler, drops into a longitudinal hopper arranged underneath the boiler and is discharged by a continuous air-cooled chain conveyor and water-cooled rotary valve. The calcine, collected from the roaster and waste heat boiler, passes through a rotating drum cooler, to be cooled to a temperature below \( 150^\circ\text{C} \).

The cooler discharge then passes through a ball mill. The mill discharge and the fine dust coming from the cyclone and hot gas precipitator are combined and transported to an intermediate bin. From the intermediate bin the calcine is pneumatically transported to the leaching plant. A bag filter is provided to ensure de-dusting of the calcine handling system.

Before the first start-up, as well as for start-ups after long shutdowns, the fluid bed furnace and the waste heat boiler have to be preheated. For this purpose the roaster is equipped with a preheating unit for starting-up purposes, which consists of an oil tank with a pump, oil burners and oil lances. The necessary combustion air is taken from an air blower. Start-up gases are withdrawn by a start-up fan and vented via a start-up stack to the atmosphere provided after gas cleaning section.

- **Gas Cleaning**

The purpose of gas cleaning is to clean the gases of dust particles, saturated with water vapour, cooling and making it optically clear by removing the mist particles, thereby making it suitable for feed to the acid plant.
The gas cleaning section consists of the following units:

1. Hot gas cleaning
2. Wet gas cooling/condensing
3. Acid mist precipitator
4. Mercury removal system

1. Hot Gas Cleaning

The dust loaded SO₂ gases from the waste heat boiler are de-dusted in one single line three field hot ESP.

The hot gas electrostatic precipitator comprises of three separate electrostatic fields arranged in series. The dust particles are charged and separated on the collecting electrodes by the influence of the electrostatic fields. A gas distribution plate located at the electrostatic precipitator inlet ensures the even gas distribution over the sectional area of the electrostatic precipitator. The dust adhering to the collecting electrodes, discharge electrodes and gas distribution plate is removed at certain intervals by motorized rappers.

The removed dust drops into a longitudinal hopper arranged below the electrostatic precipitator casing and is discharged by a continuously operating dust conveyor and two rotary valves arranged in series. The collecting electrodes consist of cold-rolled strips of steel plate. They are arranged in passages. The discharge electrodes of large cross section are rigidly fixed into pipe frames, which are vertically suspended between the collecting electrodes. This rigid frame design is highly efficient.

Both electrode system – collecting electrodes and discharge electrodes – are equipped with highly efficient motorized rapping systems. Hot purge air will be injected to prevent any condensation of Sulphuric acid mists on the surface of the supporting insulators of the discharge electrode systems.

The casing of the electrostatic precipitator will be fabricated from steel sheet and welded gas tight. It has to be fitted with particularly carefully designed heat insulation to avoid condensation of Sulphuric acid and corrosion. Each transformer rectifier is controlled by an automatic high voltage control system.

2. Wet Gas Cleaning

Washing Tower

After pre-cleaning in the hot-gas cleaning system, the gas is routed to the wet gas section equipped with a washing tower, which cools the gas adiabatically to a temperature of about 60°C by means of circulating liquid. The washing tower also serves to wash out the bulk of the solids entering from the hot gas ESP’s, as well as condensed volatile impurities. Excess liquid will be discharged to a stripper for SO₂ removal.

Cooling Tower

The cooling of the SO₂ gas is done in a packed gas-cooling tower. In counter current flow, cooling liquid (weak acid) is sprayed into the tower and flows downward through packing. By direct contact between the warm gases and the cooling liquid, heat is transferred. Flue gas cools down, gaseous water condenses...
and the cooling liquid is heated. The condensate leaving the cooling tower is collected in its sump from where it is delivered to the nozzles by means of a gas cooler flushing pump. The surplus of condensate is withdrawn by gravity from the sump to the washing tower weak acid circuit.

3. Acid Mist Precipitator

From the washing and cooling section, the gases are forwarded into two wet gas ESP’s for mist elimination arranged in two stages. These ESP’s are of the proven tubular type and are constructed mainly of plastic with high mechanical strength and a high chemical resistance. All parts in contact with the gas are of plastic or homogeneously Lead-lined steel. The materials are selected according to the operating environment and stresses acting on the various components. The gases pass through the ESP tubes in a vertical direction, in the first stage flowing upwards and in the second stage flowing downwards. Spike design of discharge electrodes ensure that the mist particles are charged and separated on the tubes. The discharged condensate flows as a film along the tube surface to be collected in the bottom section of the ESP from where it is drained. The condensate stream is combined with the wash acid in the washing tower.

4. Mercury Removal System (Calomel Process)

The mercury contained in Zinc concentrate is transferred mainly into metallic mercury vapour during roasting. Some of the mercury may condense or re-combine with other components in the gas to form insoluble compounds. These particles or compounds may be separated in the conventional unit for gas cleaning and cooling before the gases enter the Sulphuric acid plant. But some amount of mercury vapour passes the conventional gas cooling and cleaning system as metallic vapour that must be removed from the gas before feeding to sulphuric acid plant.

Description of Mercury Removal System

The calomel process was originally developed for the purpose of removing mercury vapour from Zinc concentrates roaster gases, after these gases have been treated in the conventional cleaning, washing and cooling plant.

The reactor for removal of mercury treats gases at a temperature of 38°C. The reactor is a counter current absorption tower made of glass fiber reinforced plastic. The tower is packed with plastic rings made of polypropylene. The HgCl₂ solution is sprayed over the packing by nozzles. The mercury vapour comes in contact with mercuric chloride solution and transforms to mercurous chloride. When mercury content in circulating water increases, some of the mercurous chloride is taken to a chlorination tank to convert mercurous chloride to mercuric chloride, which is used as make-up in circulating water. The mercurous chloride (calomel) is withdrawn periodically and stored for sale to interested buyers. The main reactions are as follows:

\[
\text{HgCl}_2 (l) + \text{HgO (gas)} \rightarrow \text{Hg}_2\text{Cl}_2 (s) \\
\text{Hg}_2\text{Cl}_2 (s) + \text{Cl}_2 (gas) \rightarrow 2 \text{HgCl}_2 (l)
\]

The towers are furnished with demisters in order to prevent drops leaving the tower with the purified gases. The clean gas then goes to sulphuric acid plant for production of H₂SO₄.
• **Sulphuric Acid Plant**

The SO$_2$ gas from the gas cleaning section is converted to sulphuric acid by first converting the SO$_2$ to SO$_3$ in converter in presence of V$_2$O$_5$ as catalyst. The converter has four layers of V$_2$O$_5$ catalyst. After 3rd mass, the gas is withdrawn and passed on to intermediate absorption tower where the SO$_3$ gas is absorbed to produce sulphuric acid. The residual SO$_2$ is further converted to SO$_3$ gas in 4th mass in order to achieve maximum conversion efficiency. The withdrawal of SO$_3$ gas after 3rd mass and converting it to H$_2$SO$_4$ accelerates conversion of SO$_2$ to SO$_3$ in fourth mass. Conversion of SO$_2$ to SO$_3$ in two stages and absorbing SO$_3$ in two stages is known as double conversion and double absorption (DCDA). In this process, the conversion of SO$_2$ to SO$_3$ gas is very high (more than 99.7%) thus allowing very low SO$_2$ emission (less than 650 mg/Nm$^3$).

The Sulphuric acid plant mainly consists of 3 plant sections:

- The drying and absorption section
- The converter section with the gas-to-gas heat exchangers
- The product acid tank farm

**1. Drying and Absorption Section**

The drying and absorption section mainly consists of the drying tower, the intermediate absorber, the final absorber, the acid pumps, the acid pump tanks, the acid coolers and the acid piping.

The gas flow through the towers is counter-current to the acid flow, i.e. the gas flows from the bottom to the top of the tower. From the bottom of the tower(s) the acid flows to the pump tank and is pumped from there by the acid pumps (via the acid coolers) back to the spray system.

Acid transfer lines between the drying tower, the intermediate absorber and the final absorber and injection lines for dilution water at the intermediate absorber and final absorber allow control of the necessary acid concentration for each of the towers.

The Sulphuric acid is produced as +98% H$_2$SO$_4$ and the product acid is taken from the final absorber pump tank. The acid is then cooled in the product acid cooler and pumped to the existing acid storage tanks.

**a. Converter System**

In the converter, the SO$_2$ bearing gas is converted to SO$_3$ (sulphur trioxide) in the presence of Vanadium Pentoxide as catalyst, which is subsequently absorbed in acid towers to convert into sulphuric acid.

The converter system consists of a four-layer central tube converter. The intermediate absorption is following outlet of the 3rd layer. The converter itself is an insulated, vertical and cylindrical vessel divided in four sections called layers or trays with a central tube. The catalyst required for the conversion of SO$_2$ to SO$_3$ is arranged on these layers. The SO$_2$ gas flows up stream through layer 1 and down stream through layer 2, 3, 4.
Three gas-to-gas heat exchangers II, III and IV are designed as mixed cross flow/counter flow shell and tube heat exchangers. These heat exchangers mainly consist of inlet and outlet chambers, the tube sheets, the tubes and baffles. Heat exchanger III ensures the optimum gas temperature for the intermediate absorber as well as for the inlet of layer 4.

Another heat exchanger I, inside the converter, arranged in the bottom of the central tube between layer 1 and 2, is designed as counter flow for pre heating SO₂ gas to the inlet temperature of layer 1.

b. SO₂ Gas Blower

The SO₂ gas blower is arranged downstream of the drying tower and routes the gas from the Zinc roaster section via the gas cleaning plant through the Sulphuric acid plant. The blower will be provided with an electric motor.

c. Pre-heater

A pre-heater is needed to preheat the converter system from cold condition to operating temperature, whereas during normal operation of the plant the heat released within the process allows auto-thermal operation of the plant. In addition, lower or varying SO₂-concentrations can be compensated. The separate pre-heater preheats air or, in the start phases, SO₂-gas to the required temperature.

d. Process Criteria for the Acid Plant

For the production of the sulphuric acid, SO₂ containing gases from the Zinc concentrate roasting are used. There are four main process criteria in the production of these kinds of gases by the contact/converter process. They are

- Gas drying;
- Water balance;
- Heat balance;
- Conversion of SO₂ to SO₃ at the required O₂/SO₂ ratio.

Gas Drying

Gas drying is an important process in this type of contact plant. Gas drying protects cooler parts of the plant, such as heat exchangers, against corrosion by acid condensation. It safeguards against the formation of acid mist, which can be very difficult to absorb at a latter stage of the process. It also protects the catalyst from acid condensation during plant shutdowns. Therefore, the life of the plant and also the tail gas purity largely depend on appropriate gas drying.

The substantial amount of heat, not just the heat of dilution of the sulphuric acid but also the heat of condensation of the water, is liberated in the gas drying stage. For that reason the circulated acid is generally cooled by indirect heat exchanger before being recycled to the dryer.

Water Balance

The water balance of contact sulphuric acid plants in general may simply be defined by the specific amount of process water required for achieving the desired product acid strength from the amount of SO₂ converted to SO₃.
In the case of acid gas plants (like roaster plants) the process water requirements are usually balanced nearly completely by the water vapour content of the SO\textsubscript{2} feed gases entering in the drying tower except for a small margin necessary for the automatic acid strength control.

Thus at a given SO\textsubscript{2} gas concentration and SO\textsubscript{2} conversion rate and at a fixed product acid strength, the only variable that can and has to be controlled or limited is water vapour content of the feed gases entering the drying tower in order not to exceed the water balance of the whole system. This is done in the wet gas purification system by cooling the SO\textsubscript{2} gasses down to the dew point temperature corresponding to the maximum allowable water vapour content. For determination of the required dew point temperature, it is important not only to consider the negative pressure, for which the gas purification system is designed, but also the external barometric pressure, which depends largely on the elevation of the plant above sea level.

**Absorption of SO\textsubscript{3}**

Sulphur trioxide formed by catalytic oxidation of sulphur dioxide is absorbed in sulphuric acid of at least 98% concentration, in which it reacts with existing or added water to form more sulphuric acid. The process gas leaving the converter system is cooled, first in a gas-to-gas heat exchanger to a temperature of about 160\degree C before entering the absorber. The gas entering the absorber is therefore not completely cold and it transfers heat to absorber acid as it passes through absorber, by the time it reaches the outlet it is virtually at the same temperature as the incoming absorber acid.

A substantial amount of heat is also generated in the absorber acid from the absorption of sulphur trioxide and the formation of sulphuric acid, and the acid temperature rises as a result by a margin, which depends on the acid circulation rate. The acid concentration is maintained constant by adding process water to the acid leaving the absorber and the acid cross flow from the dryer (to the intermediate absorber only) at a rate controlled by a concentration measuring device. The circulated acid is cooled by indirect cooling.

**Heat Balance**

The SO\textsubscript{2} gases leaving the wet gas cleaning system enter the acid plant at a temperature of 35\degree-40\degree C (depending on the SO\textsubscript{2} concentration). After removing the residual water content in the dryer, the process gases must be heated up to the required converter inlet temperature of 440\degree C. This is achieved by indirect heat exchange with the available sensible gas heat released by SO\textsubscript{2} oxidation in the converter. The main objective of designing such a cold gas plant is to attain auto thermal operating conditions, which becomes primarily a question of the required gas heat exchanger surface, depending on the feed gas SO\textsubscript{2} concentration.

The reaction heat in a double catalysis plant based on roaster gases is released from;

- Catalytic oxidation
  \[ \text{SO}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{SO}_3 + 23.45 \text{ Kcal} \]  
(1)
- Sulphur trioxide absorption and sulphuric acid formation
SO₃ + H₂O = => H₂SO₄  \hspace{1cm} (2)

- Dilution to the acid production strength of 98.5% H₂SO₄

Condensation heat for water content of the gases entering the drying tower system.

**Conversion of SO₂ to SO₃**

The catalytic oxidation of sulphur dioxide with atmospheric oxygen in the presence of a solid catalyst to form sulphur trioxide can be described as the classical example of an exothermal, reversible reaction

\[ \text{SO}_2 (g) + \frac{1}{2} \text{O}_2 (g) ==> \text{SO}_3 (g) + 23.45 \text{Kcal} \]

The decisive factor for conversion is in each case also the O₂ concentration of the feed gas. Although, from stoichiometric aspects, a SO₂/O₂ ratio of 1:0.5 would be sufficient, it results already from the consideration of the chemical equilibrium that oxygen in excess will have a favorable influence on SO₃ formation.

In practice, the O₂ content of the gas entering the converter corresponds to 1.0 up to 1.8 times the SO₂ content, this being especially due to the influence of SO₂/O₂ ratio on the activity of the catalyst.

The heat of reaction liberated by SO₂ oxidation (1) Leads to a temperature rise of the gas on its adiabatic passage through the catalyst layer so that the conversion is limited in accordance with the temperature equilibrium curve. With respect to obtaining a maximum SO₂ conversion efficiency to perform the catalytic SO₂ oxidation in several steps and to cool the gas to the most favorable temperature before it enters the next catalyst layer.

The theoretical basis of the double catalysis process is relatively simple and can be derived from the law of mass action. After a defined preliminary SO₂ conversion, after 3rd catalyst layer, the SO₃ formed at this stage is removed from the chemical equilibrium by intermediate absorption so that the equilibrium is shifted in favour of SO₃ formation.

On the basis of the corresponding temperature/conversion equilibrium it is possible to note already qualitatively that with the same number of contact layers as compared to the normal catalyst process, an essentially higher final SO₂ conversion is achievable which is more than 99.7% in practice.

A decisive advantage of the double catalysis process is the possibility of feeding gases of higher SO₂ concentration than with the normal catalysis process and this means smaller gas volumes and consequently smaller equipment dimensions at comparable production capacities.

**O₂/SO₂ Ratio**

For the conversion of SO₂ to SO₃ the proportion of O₂ volume in the feed gas to the converter called SO₂/O₂ ratio, is an important factor for the conversion rate.

**Product Acid Storage Tank**

The total acid production received in the intermediate and the final absorber is pumped from the final absorber pump tank via the product acid cooler to the acid storage tanks.
Leaching Plant

As the concentrate will have high silver viable for its recovery, thus the plant is being upgraded with fumer technology for recovery of Lead-silver using concentrate/ Calcine having high silver.

The Calcine produced in the roaster and the calcine procured from the other Smelters is stored in the silos. This calcine is conveyed to two hoppers situated where the leaching plant tanks are located. From there it is distributed throughout the different stages of the process by variable speed screw feeders and conveyors, which are regulated by pH meters that control the process variables.

Neutral Leaching (NL)

The slurry that comes from the cells cleaning and the spent from the Electrolysis area, are pumped into the Head Tank, where Iron content is adjusted in order to improve impurities removal. During the Neutral Leaching stage, the solution contained in the Head tank is pumped to the first tank. The control room predetermines the flow rates. Calcine from the hopper is fed into this tank. The stream from the first tank passes through the tanks successively.

The stream from the last tank flows by gravity to neutral thickeners after adding flocculant. The neutral overflow, free of solids, is pumped into the Purification Plant. The Underflow is pumped into the Weak Acid Leaching tanks.

Weak Acid Leaching (WAL)

The Underflow from the Neutral Leaching and Pre-Neutralization thickener is fed into the first of a series of tanks, together with spent electrolyte, as required. In these tanks, remaining Zinc oxide and some Zinc ferrite are leached. After leaving the last tank flocculent is added to the stream before it enters the Weak Acid Leaching thickeners. The Underflow from the thickener is pumped to the Strong Acid Leaching stage while the Overflow is pumped to Zinc fuming section.

Zinc Fuming Process:

In the fuming process the weak acid leaching underflow is filtered, dried and fed to fuming furnaces (2 No's) in series where at elevated temperatures Zinc is fumed and Iron is converted into slag. Coal is added for raising the temperature and also creating reducing atmosphere. Air/Oxygen is added for combustion. The slag so produced is removed from the bottom of the furnace. The Zinc oxide from furnaces in form of off gas is captured in boiler and gas cleaning section & used for SO2 scrubbing and the same slurry will be sent to the fume oxide treatment section. In the process of the Zinc fuming, saturated steam is generated at the waste heat boiler and the saturated steam is used to produce electricity (~ 20 MW) from the waste heat.

The main equipment’s in this section are as follows:

1. Fuming Furnaces with Hygiene Stack
2. Waste heat recovery boilers
3. Turbine- Generator set with auxiliaries
4. ESP & Bag Filter
5. Filter Presses
6. Quench Tower
7. Raw material section with Stack
8. Coal Handling & Pulverizing Plant
9. Oxygen & Nitrogen Plant
10. Slag Granulation system

The steps which are involved in this Fuming process are:

**Acid Leaching Residue Filtration and Drying**

Weak acid leaching thickener underflow from Zinc calcine leaching plant goes into bottom flow agitated tank sand the slurry produced after agitation is pumped into eight membrane filter presses. The filter residue is discharged through hopper to eight both-way belt conveyers (B=1000, L=8400) and then transferred to the feeding bin on the top of drying kilns by two transfer belt conveyers. Then the leaching residue is dried in the drying kiln and the filtrate is returned to neutral leaching tank in Zinc calcine leaching plant.

After filtering, acid leaching residue (moisture content 25%) is sent to wet disc feeder by belt conveyer and is then fed into the drying kiln(φ2.2m×18m). The drying method adopts counter flow drying, with two drying kilns in total.

The fuel for drying kiln comes from pulverized coal preparation plant, and air is provided by primary fan and secondary fan. The pulverized coal is sent to the burner by impeller feeder before injected into the kiln for combustion. Secondary air is adjusted to control the temperature of hot off-gas of the kiln to be about 800°C. Hot off-gases and the residue flows in the opposite direction for full heat exchange to dry the residue.

Off-gas from drying kiln is about 150°C. The volume of off-gas is about~22000Nm³/h. The off-gas goes directly into dust collection system. The residue after being dried (moisture content 15%) is discharged from the tap-hole at the bottom of the hood in the front of the kiln, and sent to the leaching slag blending storage by belt conveyor.

**Leaching Residue Blending Storage Blending Storage**

The leaching residue blending storage is used to store and mix the leaching residue and flux. The leaching residue after being dried is delivered into the storage bin conveyor by belt conveyor and is then sent to fuming plant by weighing belt. The flux is transported by trucks to the stacking area of blending storage and is fed into the blending storage by carry-scrapers. The leaching residue is fed by belt weight feeder while the flux is fed through constant weight feeder and the mixed material is sent into the fuming furnace plant through feeding belt.

**Melting and Fuming Plant**

There is one melting furnace (24m²) and one fuming furnace (20m²) in the plant. The leaching residue will be charged into melting furnace for process and melting residue will be charged into fuming furnace through chute for converting.

The fuming furnace plant is also equipped with an electric heating fore well (20m²) for start-up of furnaces.
The leaching residue after mixing with flux is sent from the leaching residue blending storage through belt conveyor to furnace front bin in melting and fuming plant. Weighing by belt weigh feeder, the mixed material is then fed into melting furnace through two feeding ports by moveable belt feeder.

The furnace structure of melting furnace is the same with fuming furnace, but in production process, melting furnace adopts oxygen-enriching process, requiring oxygen concentration of 25%.

Off-gas outlets are on the upper of melting furnace and fuming furnace and are directly connected with the membrane wall of waste heat boiler.

On one side of diaphragm wall of melting furnace, two feeding ports are provided for evenly feeding of leaching residue into the furnace, so as to accelerate melting speed and reduce coal consumption. Melting furnace has slag discharging holes and melting residue can be fed into fuming furnace through chutes.

Fuming furnace has one hot slag feeding hole and two slag discharging holes at both ends. Two tap holes (upper one and lower one) are arranged at one end, with the upper one for slag tapping during normal operation. Accidental emergency slag tap-hole is arranged at the other end.

Melting furnace and fuming furnace are equipped with lances on both sides. Air and pulverized coal will be evenly distributed into the furnace through multi-layer distribution pipes. Moreover, the pulverized coal can be used as fuel and reductant. Melting furnace and fuming furnace adopt quantitative pulverized coal injection system (including pulverized coal injection device and storage bin).

In drying plant, oil tank and oil pump are equipped to provide diesel for start-up of furnaces.

The fuming furnace slag is transported to the intermediate storage bin by bucket crane after granulation and is then transported by trucks to the temporary slag yard for storage. The slag washing water will return for slag washing after cooling down.

**Waste Heat Boiler of Fuming Furnace**

A waste heat boiler will be set behind each fuming furnace for recovering waste heat from high-temperature off-gas and for cooling and dust collection as well.

The drum of fuming furnace is placed in the main melting building, and it mainly consists of fuming furnace hood, uptake flue, decline flue, radiation cooling chamber and convection zone. The fuming furnace waste heat boiler has its cover connected to the off-gas outlet of fuming furnace through flexible expansion joint, and the off-gas passes through fuming furnace hood, uptake flue, decline flue, radiation cooling chamber and convection zone successively and will be discharged from waste heat boiler to dust collection system after being cooled to 360°C. The waste heat boilers equipped with dust removal devices to effectively remove dust on heating surface in time to ensure normal operation of the boiler. At the bottom of the dust hopper of the boiler, a chain conveyor is placed to transport settling dust of boiler and ashes cleaned by dust removal devices to dust collection system. The boiler body is supported on a steel frame made from structural steel.
In order to guarantee normal operation of the boiler, a supporting waste heat boiler room is designed and its thermodynamic system includes water circulation, steam production, waste discharging, and sampling test for safe operation of waste heat boiler.

**Dust Collection System**

The dust collecting system is mainly composed of dry kiln dust collecting system, melting furnace dust collecting system and fuming furnace dust collecting system.

The dry kiln dust collecting system is used for collecting dust of flue gas from the dry kiln, and each of the two dry kilns is equipped with a dust collecting system. The flue gas comes out form the outlet of the kiln at temperature of about 150°C and directly enters the bag-type dust collector. The purified flue gas will be sent to the flue gas desulphurization system and the collected dust by the bag-type dust collector will be delivered to the dedicated melting belt conveyor through a buried scraper and will be transferred to the fuming workshop along with the leached residue.

The melting furnace dust collecting system is used for collecting dust of flue gas from the melting furnace and there is a melting furnace equipped with a dust collecting system. The flue gas comes out form the outlet of the waste heat boiler at temperature of about 360°C and directly enters an electrostatic precipitator for purification. The purified flue gas will be sent to the flue gas desulphurization system and the Zinc oxide smoke dust collected by the waste heat boiler and the dust collecting system will be used as absorbant for the flue gas desulphurization system.

The fuming furnace dust collecting system is used for collecting dust of flue gas from the fuming furnace and there is a fuming furnace equipped with a dust collecting system. The flue gas comes out form the outlet of the fuming furnace at temperature of about 360°C and enters the bag filter after being cooling down through a surface cooler. Afterwards, the purified flue gas will be sent to the flue gas desulphurization system and the Zinc oxide smoke dust collected by the waste heat boiler and the dust collecting system will be used as absorbant for the flue gas desulphurization system.

**Off-gas Desulfurization and Zinc Oxide Dust Treatment**

Zinc oxide dust from melting and fuming furnace is used as absorbent for off-gas desulfurization and Zinc oxide dust treatment. The de-dusted and dried off-gas from drying kiln and fuming furnace is sent for desulfurization. Slurry containing Zinc sulfite will be produced during off-gas desulfurization.

Off-gas desulfurization and Zinc oxide dust treatment system is mainly composed of seven parts: slurry preparation and supply, off-gas cleaning, sulfur dioxide absorption, process water, Zinc sulfite leaching, Cl & Fe removal and residue filtration.

The melting off-gas, after dust collection, is pressurized by booster fan, washed in the scrubber, enters into two ZnO absorption towers, a swirl board scrubber in sequence and then is vented to air through an 80-metre-high chimney after series absorption & purification.
After pressurization by booster fan, the off-gas from drying kiln and fuming furnace flows into the scrubber for washing to remove As, F, Cl and dust. After preliminary cleaning, the off-gas flows into absorption tower for scrubbing. The Zinc oxide dust is delivered mechanically from the dust collecting system to the Zinc oxide blending storage bin in this system. After weighing and proportioned mixed in slurry proportion tank, the Zinc oxide is quantitatively fed into the absorption tower by pumping. Two identical spray absorption towers are designed in series operation to treat the SO\textsubscript{2} in the off-gas, and the slurry solution sprayed in the absorption tower is Zinc oxide slurry made from Zinc oxide dust in a suitable concentration, and the slurry solution from the absorption tower is then sent to the existing leaching residue filtration and drying plant. Sodium absorption tower uses sodium hydroxide (or sodium carbonate) as absorbent to make sodium hydroxide solution for desulfurization. The by-product sodium sulfate will be sent to waste water treatment station.

After liquid-solid separation of slurry in filter press, the filtrate returns to the desulfurization device for reutilization. The slurry filter residue is transported to one-stage leaching tank for Zinc sulphite one-stage leaching by adding two-stage leaching filtrate and waste electrolyte. High-concentrated SO\textsubscript{2}off-gas will be produced during one-stage leaching, which is sent to the drying tower of existing sulphuric acid system. After liquid-solid separation of slurry in thickener, the clear overflow returns to the pre neutral leaching tank or chlorine removal tank in existing calcine leaching plant. The dense underflow is pumped to the Zinc sulfite two-stage leaching tank for Zinc sulphite two-stage leaching by adding waste electrolyte and concentrated sulfuric acid. After second-stage leaching, the slurry is pumped to the two-stage leaching filter press in the new filtration plant for filter pressing. The filtrate returns to chlorine removal tank. The filter residue is Lead and silver residue, which is sent to Lead plant to recover Lead and silver.

When F and Cl content in the Zinc sulfate solution is higher, the one-stage leaching solution is pumped into the chlorine removal tank (utilize the conversion tank in existing calcine leaching plant) for Cl removal. The CuCl sediment is produced by adding copper sulphate and Zinc powder. The slurry after reaction is sent to the Cl removal filter press in the new residue filtration plant. The filter residue is CuCl residue, which is temporarily stock piled for sale. The filtrate is sent to the goethite tank (the conversion tanks in the existing calcine leaching plant are reutilized) for Fe removal. Limestone slurry, air is added to the Fe removal tank to produce goethite residue from Fe, F and other impurities in the solution and make goethite settled. After reaction, the slurry flows by gravity to goethite thickener for liquid and solid separation. The thickener overflow returns to the existing neutral leaching tank in existing calcine leaching; and the under flowis sent to belt filter press (utilize the used one) for filtrating. The filter residue is stockpiled and the filtrate returns to the goethite thickener overflow tank.

**Process General Description**

Zinc concentrate will first be roasted and calcine will be produced. The calcine will be conventionally leached, and the Zinc-bearing residue will be transferred by slurry pumps to the new residue filtering plant (RFP), where the residue will be pressure filtered and then send to the kiln to dry. The residue after drying will be sent by belt conveyor, together with flux, into the fuming furnaces after proportioning. The process block diagram given below.
Proposed Expansion of Dariba Smelter Complex - Zinc Smelter (0.25 to 0.50 Million TPA + Fumer Plant), Lead Smelter (0.125 Million TPA to 0.150 Million TPA) and Captive Power Plant (2 x 85 MW to 3 X 85 MW) at Village Dariba, Tehsil - Relmagra, District - Rajsamand, Rajasthan

**Purification Plant**

The neutral overflow is pumped to the Purification Section where impurities are removed until levels drop to the point which facilitates the best possible results in the Electrolysis Section. Special considerations in the design of this plant are:

- The plant has to produce the best quality purified solution
- Minimum Zinc dust consumption
- To obtain the best by-products quality
- The plant has to be fully automated
- The control philosophy for the plant design is to be integrated in a Distributed Control System, managing at the same time Leaching and Purification Plants. Main instrumentation in the file is:
  - Frequency speed drives
  - pH meters
  - Flow meters, regulation and control
In the Pre-filtration section, neutral over flow solution (containing app. 150 gpl of Zinc as Zinc sulphate) produced in the leaching plant at >65°C temperature is sent to pre filtration to remove any cake or mica etc.

Copper Removal

The Neutral Leaching overflow is processed in a series of reactors along with Zinc dust in order to remove the copper and cadmium in the solution. The amount of Zinc dust added is adjusted according to the results obtained from the control analysis every hour. The solution flows by gravity in reactors, from there it flows by gravity by means of a launder into a new thickener where solids are settled.

The thickener overflow is collected in a tank where a small portion of Neutral Leaching overflow is added in order to increase the copper content up to the required level for the cobalt removal in the Hot Purification stage and finally pumped to the Hot Purification stage for further treatment.

The Copper Removal thickener underflow is treated with spent electrolyte (at controlled pH) in separate reactors to allow for the selective leaching of cadmium and excess Zinc dust. The solution flows by gravity into the second tank and then it is pumped to filter presses, where the solid matter containing the copper is retained as cake. The filtrate is collected in a tank which it is pumped to be mixed.
with the Copper Removal thickener overflow and finally sent to the Hot Purification stage

**Hot Purification/Cobalt Removal**

The Cu removal Overflow is pumped through heat exchangers to the first of a series of tanks. The temperature at the entrance of this tank is a constant 75°C, and is regulated by controlling the supply of steam to the heat exchangers. In the first tank both a solution containing K, Sb, tartrate (premixed in the preparation tanks) and Zinc dust are added. After leaving the last tank of the series, the mixture is pumped to the automatic Filter Presses, where the solid matter containing the removed impurities, is retained.

This filtrate is further purified in polishing section by pumping to series of tanks, where Zinc dust is added for removing any residual impurities, if any. After leaving the last tank of the series, the mixture is pumped to the Filter Presses, where the solid matter containing the removed impurities, is retained.

The working cycle of the Filter Presses is between eight to twelve hours. Once the cycle has been completed the filter press is isolated from the circuit and the cake is discharged onto re-pulping tank, and then to the first tank of the Cadmium stage for further removal of Cadmium and Cobalt. The filter cloths are also washed online to remove the solid particles adhering to them.

The pH of the solution, previously filtered through the Hot Purification stages, is adjusted by the controlled addition of spent, before the solution enters in the tank from where it is pumped up to the cooling towers.

**Cadmium Recovery**

Cu-Cd cake generated from purification is treated in cadmium plant. The impurities are separated during cementation process and sponge generated is leached, purified and filtered. The Cd neutral solution obtained is fed to Cd cells. Sheets are stripped every 24 hours dried, melted, and casted into pencils.

Typical analysis of Cadmium:

<table>
<thead>
<tr>
<th>Element</th>
<th>Purity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd</td>
<td>99.95%</td>
</tr>
<tr>
<td>Pb</td>
<td>250 ppm</td>
</tr>
<tr>
<td>Ni</td>
<td>150 ppm</td>
</tr>
<tr>
<td>Zn</td>
<td>10 ppm</td>
</tr>
<tr>
<td>Cu</td>
<td>100 ppm</td>
</tr>
</tbody>
</table>

**Electro-Winning**

The purified and cooled Zinc sulphate solution is electrolyzed in cell house (electrolytic cells) using aluminum cathodes and Lead anodes. The Zinc metal gets deposited on the cathodes and the spent electrolyte containing sulphuric acid with depleted level of Zinc is returned to leaching section. The Zinc deposited on cathodes will be pulled out and stripped off with automatic stripping machines once in 48 hours cycle.

For the proposed plant, large size cells have been selected for reducing floor area requirement. The current density, temperature etc. have been selected to
optimize the area required, deposit quality and power consumption while rendering high operational efficiency.

This plant consists of the following sections:

1. Cooling, gypsum and basic salt separation
2. Cell house
3. Automatic handling and stripping of cathodes
4. Anode cleaning and flattening

1. **Cooling and Basic Salt Separation (Gypsum Removal)**

The purified solution from the hot purification section must be cooled down from 75°C to approx. 35°C prior to being fed to the electrolyte cycle. During this cooling operation, basic Zinc salts as well as gypsum crystals together with some impurities are partly precipitated in line with the temperature-dependent solubility limits in aqueous Zinc sulphate solutions.

Cooling is achieved in atmospheric cooling towers, where the solution is contacted with air in counter current flow. The cooled solution is collected in a launder system and flows to a settler where the solids, mainly basic Zinc salts and gypsum crystals, will settle. The settler overflow is fed to the spent electrolyte. The cooler cake obtained while periodical cleaning of cooling tower is discarded.

2. **Cell House**

The purified solution, after having been treated for basic salt, is stored in the purified solution tank. The tank house will be designed according to the latest commercial technology using 3.5 m² cathodes as well as an automatic cathode transport system and full automatic stripping of the Zinc deposits.

Spent electrolyte discharged from the tank house via the main collecting launder is collected in spent electrolyte storage tanks. From there a certain amount of spent electrolyte is pumped directly to the neutral leaching plant.

The major portion of the spent electrolyte is pumped to atmospheric cooling towers, where the spent electrolyte is cooled down to approximately 35°C. The cooling towers are of the same design as those for the neutral solution. The mixing of neutral leach solution and spent electrolyte takes place in the collecting launder under the influence of turbulence.

The electrolytic recovery of Zinc is brought about by passing continuously electric current through the aqueous Zinc sulphate electrolyte acidified with H₂SO₄ and the insoluble electrodes, causing the decomposition of the Zinc sulphate and the water. The metallic Zinc settles on the cathode and the oxygen on the anode, thereby recovering Sulphuric acid from the hydrogen of the water.

This process takes place in lined and insulated cells equipped with 115 anodes and 114 cathodes each. The tank house contains 136 cells. The electrodes of each cell are coupled in parallel by bus bar.

The electrolyte is supplied to the individual cells via distributing launder and pipes. Reagents, such as strontium carbonate, Arabic gum, are added to improve deposit quality, increase current efficiency and suppress acid mist formation.
The direct current is fed from the rectifiers to the individual cells via bus bars mounted on isolators, which rest on special supports. The basic reaction in electrolysis is as follows;

\[
\text{ZnSO}_4 + \text{electricity} \rightarrow \text{Zn}^{++} + \text{SO}_4^{2-}
\]

\[
\text{Zn}^{++} + 2\text{e}^- \rightarrow \text{Zn}
\]

3. **Stripping of Cathodes**

During the electrolysis process as already mentioned the Zinc is deposited on aluminum cathodes, which in a cycle of 48 hours have to be taken out from the cells in order to remove the Zinc deposit. The cathodes are automatically stripped in stripping machines.

The transport of the cathodes to the stripping machines is performed by a cathode and anode transport system provided with a special grab device, which is able to lift un stripped cathodes from the cell.

The cathodes are washed in a washing device prior to being distributed to the stripping unit of the stripping machine. The feeding of the inlet chain conveyors of each stripping machine with the cathodes is automatically regulated by the control system.

The stripped Zinc sheets are stacked below the stripping machine, weighed and transported by forklift to the storage platform inside the melting and casting plant. The cathode transport system is also used for the anode cleaning operation.

**Melting and Casting Plant**

The Zinc sheets coming from the stripping machines are first stored on the storage platform in order to ensure that they are completely dry prior to feeding them into the melting furnaces.

1. **Melting of Zinc Cathodes**

The Zinc sheets are fed into the induction furnaces by means of forklifts. The Zinc sheets are melted down under a layer of ammonium chloride which serves the purpose to destroy the oxide film that may be formed during the melting operation, thus ensuring that the amount of Zinc going into the dross is kept relatively low.

The molten Zinc is pumped from the furnace’s sump by graphite made vertical pumps through steel launders lined with heat resistant materials to the slab/jumbo casting machines

2. **Casting of Zinc Slabs**

The Zinc ingot production will be cast into standard 25 kg slabs / 1,000 kg Zinc blocks. The molten Zinc is pumped from the induction furnace through the launders to the casting machine. The casting machine is provided with automatic Zinc pouring and skimming devices that ensure the proper filling of each casting mould with the required amount of molten Zinc. The Zinc slabs/blocks are cooled down inside the casting machine by water sprays.
Afterwards, the slabs are automatically stacked in the stacking device and weighed on a scale. The bundles of Zinc slabs with a weight of 1000 kg are collected on magazine conveyors from where they are transported to the storage section by forklift and finally strapped.

3. **Dross Treatment Section**

The dross from the Zinc cathode melting furnaces, which contains approximately up to 90% of Zinc, is firstly stored and cooled down in the transport containers.

The dross mills are discontinuously charged with dross produced at the main induction furnaces. During the grinding operation a suction fan continuously withdraws the fine dross particles mainly consisting of Zinc oxides and ammonium chloride. The mixture of air and dust passes through a cyclone and afterwards the bag filter. The clean air is discharged to atmosphere; whilst the fine dust is collected and conveyed to the raw-material storage. The metallic Zinc is sent to the Zinc dust plant for melting/ charging in the induction furnace.

- **Zinc Dust Plant**

The Zinc dust plant consists mainly of three sections:

- atomizing furnace
- expansion chamber with a de-dusting bag house
- dust screening and storage

A portion of the molten Zinc from the induction furnace is charged into the ladle of the gas/electric heated atomizing furnace. This furnace has at its lowest point a special plug which permits to drain about 1 to 2 tph of liquid Zinc. A special designed compressed air jet nozzle atomizes these 5 to 8 liquid Zinc streams by blowing them into the expansion chamber/cyclone.

In the expansion chamber/cyclone, which is under slightly negative pressure the solid Zinc dust will precipitate and collect in a bin, which discharges onto vibration conveyors that extract the Zinc dust, from the expansion chamber.

The main quantity of Zinc dust, which is precipitated in the expansion chamber, is transported to the Zinc dust screening station. At this screen, oversize Zinc dust is separated which is recycled to the induction furnace. The clean air passes through bag filter before it leaves into the atmosphere through stack.
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FIGURE-2.1
EXISTING PROCESS FLOW DIAGRAM
Lead Smelter

In line with HZL’s long term strategy of meeting India’s Lead demand, it has been decided to up our Lead production capacity from 0.125 MTPA to 0.15 MTPA by adopting the proven pyro metallurgical processing route. With the installation of this new Lead capacity HZL’s overall primary Lead production capacity shall reach 0.245 MTPA.

Details of Selected Process Technology

The SKS process is discussed below in the following steps

Raw Material Storage

As like any other pyro smelting technology, a robust feed storage facility is considered for the storage of Concentrate, Coal fluxes, intermediates and secondary’s. This will primarily consist of storage bunkers, conveyors and storage bins for plant consumption with necessary weigh feeding arrangement. This system will also include feed preparation facility like pelletizing system.

SKS Smelting Furnace

The SKS smelting furnace is a horizontal cylindrical vessel with bottom blowing capability. The furnace will be fed with feed materials from the top through feed port and oxygen shall be blown from the bottom of the furnace. The furnace is operated on a continuous smelting philosophy. Bullion from the furnace is tapped at regular intervals and cast into ingots. The bullion ingots are then transported to the refinery for further purifications. The slag with approximately 45% Lead content will be cast on a cooled chain conveyor which will then be fed to the blast furnace to recover balance Lead in the slag. The off gas system shall consist of a WHRB, Hot ESP, Wet gas cleaning facility followed by a conventional Sulphuric acid plant.

SKS Furnace Inputs

- **Mixed Feed** (Fresh Lead Conc. + Lead Silver Complex+ SKS Dust + Blast Furnace Dust + Limestone + Iron Ore).
- **Oxygen** at 16 bar Pressure.
- **Nitrogen** (Only in case of Oxygen Failure) at 16 Bar Pressure (Nitrogen should be Started within 15 minutes of O₂ Failure).
- **DM water**.

SKS Furnace Outputs

1. Lead Bullion (97% Purity).
2. Lead Oxidation Slag (SKS Slag)
3. **SO₂ (~13% rich off gas)**.
4. SKS dust in off gas.

SKS Furnace Reactions

\[ \text{PbS} + \text{O}_2 \rightarrow \text{PbO} + \text{SO}_2 \]

\[ \text{PbO} + \text{PbS} \rightarrow \text{Pb} + \text{SO}_2 \]
At 1150°C, Lead Sulphide reacts with Oxygen to form Lead Oxide and Sulphur-di-oxide. The Lead Oxide in turn reacts with Lead Sulphide to form pure Lead metal and Sulphur-di-Oxide is liberated. The Heavier Lead bullion collects at the bottom of the furnace and the Slag floats at the top. The Furnace has an inbuilt Siphon to tap out the Lead bullion. Lead Oxidation Slag is tapped out through a slag tap-hole at the opposite side of the siphon. Sulphur forms Sulphur-di-oxide and escapes through Off Gas.

**Off-Gas Collection**

The SO₂ rich Off gas with Lead dust generated in the smelting process is continuously removed under the negative pressure created by an Induced Draft Fan in the Off-Gas System. Along, with the Smelting Off Gas, air sucked from throat and feed inlets also enters the Off gas stream. Around 15 % PbS to PbO Conversion takes place in the off gas. The off gas stream passes through the Waste Heat Recovery Boiler (WHRB) and Electro-Static Precipitator (ESP) before entering the Acid Plant Battery Limit(Gas Cleaning Plant).

Almost 97.67% of sulphur fed into the furnace enters the off gas and rest being carried in the SKS Slag.

**Waste Heat Recovery Boiler**

The excess heat in the Off-Gas (which is at ~1150°C) is recovered as steam in the Waste Heat Recovery Boiler System along with collection of off-gas dust. Some of the Dust in the stream gets collected at the bottom of the Boiler which is conveyed by a chain conveyor to the common dust chain conveyor of Dust Collection System. This dust which is rich in Lead (~60% Pb) in the form of PbO is then sent to the SKS feed Pelletiser through a weigh feeder and a Bucket Elevator.

**Electrostatic Precipitator**

The Off-gas leaving the WHRB enters the Hot ESP, which is having 60 m² collection area in five fields. The discharge electrodes in the fields are charged with high voltage and the collecting plates are neutral which collects the statically charged dust. The dust from the collecting plates is discharged by rapping system during each cycle of operation. Dust gets collected at the bottom of the ESP, which is conveyed by a chain conveyor to the intermediate chain conveyor. The Off-Gas with a dust load of ~400 mg/Nm³ and at temperature ~350°C then enters the Gas cleaning section for recovery of SO₂.

**Blast Furnace**

The slag from SKS furnace shall be fed to a conventional blast furnace along with coke for recovering the Lead. Bullion produced from the blast furnace is cast into ingots and transported to the refinery for further treatment. The slag from blast furnace containing approximately 3% Lead and 15% Zn is fed to the electric arc holding furnace. Off-gas from the blast furnace is treated through a Cooling Fin Bag filter to recover dust in the off-gas. The dust collected from the Cooling Fin and Bag Filter is re-cycled as they have high Lead content.

**Blast Furnace Inputs**

1. Lead Oxidation Slag (40% Lead content).
2. Limestone.
3. Coke
4. Air Blast from Blower House.
5. Lean Slag from Noble Lead Furnace.

**Blast Furnace Outputs**

1. Lead Bullion(97 % purity).
2. Blast Furnace Slag.

**Blast Furnace Reactions**

\[
PbO + C \rightarrow Pb + CO + CO_2 \text{ Reduction} \]

**Off-Gas Dust Collection Section**

The off-gas from blast furnace passes through the cooling flue (Surface Cooler) and bag filter and then will be sent to the Tail-gas Scrubbing section. The Induced Draft Fan located at the Outlet of the Bag filter keeps the negative pressure in operation for off gas flow from Blast furnace through Cooling flue and Bag Filter. The Dust load of the off gas is \(~10.69 \text{ g/m}^3\).

There are 3 sets of 900 m\(^2\) cooling flues for the Dust Collection. A cold air valve is installed on the inlet of cooling flue. When Off-gas temperature is above 170\(^\circ\)C, this valve will automatically open for diluting the off gas with cold air. When temperature becomes less than 100\(^\circ\)C, it will automatically close. The Duct between blast furnace and cooling flue is designed as up-side-down ‘V’ shaped to avoid dust accumulation.

A cooling water jacket is equipped on the outlet pipe of the Blast furnace. When the off-gas temperature is higher than the design value, the water feed system will turn on automatically for cold water charging.

After the cooling Flue, the gas enters a Bag filter of collection area 2400m\(^2\). The bag filter is waterproof and covered with temperature resistant materials. The bag filter is designed to meet the gas emission requirements. Explosion valves are equipped on the bag filter for safe operation as the off gas from blast furnace contains good amount of CO (refer equation).

The Dust collected in the cooling flue and Bag Filter are conveyed to the Lead Dust receiving bin located at SKS furnace workshop through a Pneumatic Conveying System. This Pneumatic conveying system uses compressed nitrogen from the oxygen plant for SKS furnace.

**Slag Fuming Furnace**

The blast furnace slag is first taken to the electric arc furnace to maintain the temperature of the slag and also to buffer a stock of slag for one batch of slag fuming furnace operation. The slag fuming is done on batch processing philosophy by using pulverized coal along with high pressure air. The final slag produced after fuming is discard able quality with huge potential for downstream applications. The off-gas system is designed to recover Waste heat through WHRB. Zinc Oxide compound (with \(~10\) to \(20\)% Lead and \(~55\)% Zinc) in the off
gas shall be recovered from WHRB and Bag Filter system. The Zinc Oxide shall be utilized in the Leaching section of Zinc Smelter or in the Pyro Smelter.

**Fuming Furnace Inputs**

1. Blast Furnace Slag.
2. Pulverized Coal (fed to furnace by Air Blast Stream).
3. Blast Air (from Blower House).

**Fuming Furnace Outputs**

1. ZnO Fume.
2. Fuming Furnace Slag.

**Discard Slag**

The slag tapped from the fuming furnace will have ~0.5% of Pb and ~2.5% of Zn. This slag is not viable for further recovery of metals and hence shall be discarded. The slag is tapped and granulated by a jet of water in slag launder. After water Granulation and Settlement, the Slag will be grabbed by bridge crane and is stored in Slag Bin. From slag bin, the slag is transported to slag yard by trucks.

**Off-Gas Collection System**

The Off-Gas generated is sucked by an Induced Draft Fan located at the Outlet of the Bag filter and the fan keeps the negative pressure in operation. The off-gas passes through the WHRB and the temperature of off-gas drops to 360°C. Then it enters the cooling flue (Surface Cooler) and bag filter where the Zinc rich dust is collected. The off gas leaving the bag filter will be sent to Tail gas Scrubbing unit. The Dust load of the Off gas is ~79g/m³.

The dust collection in fuming furnace is similar to the dust collection system of Blast furnace section. The Zinc oxide compound (~55% Zn, 10~20% Pb) collected in the cooling flue and Bag Filter are conveyed to the Intermediate storage bin by chain conveyors. From the bin, the dust is collected and bagged in nylon bags by bagging machine of capacity 10-40 bags/hour. The Bags are then stored in Zinc Oxide Storage building and before being sent for recovery of Zinc & Lead.

**Coal Pulverization Plant**

The Off-gas from pulverized Coal Combustion in the firebox is sent to the coal mill through the spark catcher and after feeding with Cold Air. The Output of Coal mill is classified by the separator to separate the large-size granules (which are sent back to coal mill) and fine granules enter the cyclone separator and Blowback Bag filter which collect fine dust (sent to Intermediate Silo). The process block diagram of Lead Smelter is shown in Figure 2.3.

**Lead Refinery**

The Lead refining section consists of the following three main sub-sections

1. *Copper De-drossing and Anode Fabrication.*
2. *Cell House*
3. *Cathode Preparation / Melting & Ingot Casting Section*
The cast bullion produced from SKS & Blast furnace is transported to the electrolytic refinery for melting and drossing to remove copper from the bullion. After copper drossing, the Lead bullion is cast into anode forms suitable for electro refining. The initial thin cathode sheets are produced from refined Lead and the final thick cathodes produced from the electro-refining process are removed on periodical basis for melting and casting into saleable ingots. The slime from the electro-refining operation is further treated for recovery of valuable metals like silver, antimony, Bismuth etc.

**Silver Refinery**

The proposed plant shall have Rotary furnaces like Noble Lead furnace & Cupel furnace to produce silver bullion. The antimony and bismuth concentrate shall be recovered from the off-gas handling system of the furnaces which has Cooling Fins and Bag Filter. The bismuth concentrate is skimmed from the Cupel furnace. Lead rich slag (recyclable) and copper matte (saleable) is also recovered from the Cupel furnace. The silver bullion is further refined by electrolysis. The pure silver powder from the electrolytic process is melted and casted into silver ingot of 99.99% purity.

**Copper Recovery Plant**

The proposed plant will take the copper dross from the electro-refinery plant and will produce copper matte of around 40% purity. This plant uses the ball mill and rever beratory furnaces to produce the copper matte. Copper matte shall be sold.

**Off-Gas Collection**

The Off-Gas having little content of sulphur as SO\textsubscript{2} passes through a flue gas chamber and bag filter system under negative pressure created by induced draft fan and finally sent to Tail gas treatment plant. The hot off-gas is cooled in the flue chamber and in turn, the inlet air for the burner of Rever beratory furnace is preheated. The dust is collected in the bag filter and is sent back to SKS Furnace.
2.3.3 Captive Power Plant

**Raw Material**

Coal will be the only raw material required for the project apart from LDO which will be required during start up of the plant. The requirement of coal will be around 3,320 TPD depending on the quality of coal used.

**Process Description**

Each process is dealt with detail in the following chapters. The flow diagram of the proposed power plant is given in Figure-2.4.

- Fuel system
- Boiler and its auxiliaries
- Steam turbine & auxiliaries
- Generator and electrical system
- Water treatment plant
- Environment aspects, pollution control and safety measures

![Flow Diagram of Captive Power Plant](image-url)
Fuel System

As coal is the prime fuel for a thermal power plant, adequate emphasis needs to be given for its proper handling and storage. It is also important to have a sustained flow of the fuel to maintain uninterrupted power generation. The capacity of the coal storage for proposed CPP is 45,000 ton. The conveyor belts will be of capacity about 220 TPH for each unit. However, the conveying rate depends on the gross calorific value of the fuel used.

Coal Bunkers

These are in-process storage silos used for storing crushed coal conveyed from the coal handling system. These will be made up of welded steel plates with vibrating arrangement at the outlet to avoid choking of coal. For each mill there will be a bunker and all together there will be four bunkers for two crushing units, which will be fed through gravimetric feeders. These bunkers present on top of the mill to aid in gravity feeding of coal to the mills.

Coal Conveying System

This section deals with two primary aspects of preparation and firing of coal in detail. The coal preparation equipment viz. feeders and mills, firing systems and the firing equipment viz. the burners and their arrangement are described here under.

Feeders

In most of the power stations, the types of feeders used for transportation of coal from bunker to the mills are

- Drag chain feeders
- Belt feeders
- Table type rotary feeders
- Gravimetric type of feeders

Mills

Pulverized fuel firing is a method whereby the crushed coal, generally reduced to fineness such that 70-80% passes through a 200 mesh sieve, is carried forward pneumatically directly to burners or storage bins from where it is passed into burners. When discharged into combustion chamber, the mixture of air and coal ignites and burns in fluidized state.

The economic motives for the introduction and development of pulverized fuel firing are:

- Efficient utilization of low grade coals
- Flexibility in firing with ability to meet fluctuating loads
- Elimination of banking losses
- Better reaction to automatic control
- Ability to use high combustion air temperature increasing the overall efficiency of boiler
- Better availability
Even though the high capital cost is involved, the pulverized system is proposed due to the above mentioned advantages.

**Pulverizers**

Milling plant is divided into three main types- low, medium and high speed; each having its own advantages and drawbacks. In proposed CPP the mills will be of bowl mill type and will be operated at medium speed.

**Pulverized Coal Conveying System**

The system for direct firing of pulverized coal utilizes bowl mills to pulverize the coal and to admit the pulverized coal together with the air required for combustion (secondary air) to the furnace. As crushed coal is fed to each mill by its feeder, primary air is supplied from the primary air fans, which dries the coal as it is being pulverized and transports the pulverized coal through the coal piping system to the coal nozzles in the wind box assemblies. The pulverized coal and air discharged from the coal nozzles is directed towards the center of the furnace to form a fire ball. Fully preheated secondary air for combustion enters the furnace around the pulverized coal nozzles and through the auxiliary air compartments directly adjacent to the coal nozzle compartments. The pulverized coal and air streams entering the furnace are initially ignited by a suitable ignition source at nozzle exit. Above a predictable minimum loading condition the ignition becomes self sustaining. Combustion is completed as the gases spiral up in the furnace.

**Air and Draft System**

The air we need for combustion in the furnace and the flue gas that we must evacuate would not be possible without using fans. A fan is capable of imparting energy to the air/gas in the form of a boost in pressure. The losses through the system are overcome by means of this pressure boost. The boost is dependent on density for a given fan at a given speed. The higher the temperature, the lower is the boost. Fan performance (maximum capability) is represented as volume Vs pressure boost. The basic information needed to select a fan is:

1) Air or gas flow  
2) Density (as a function of temperature and pressure)  
3) System resistance (losses)

**Classification of fans**

In boiler practice, we come across the following fans

**Draft system**

The term ‘draft’ refers to the difference between the atmospheric pressure and the pressure in the furnace. Depending upon the draft used, we have

- Natural draft
- Induced draft
- Forced draft
- Balanced draft
Air Heaters

Air heater uses a heat transfer surface in which air temperature is raised by transferring heat from other fluids such as flue gas. Since air heater can be successfully employed to reclaim heat from the flue gas at low temperature levels than is possible with economizer, the heat rejected to chimney can be reduced to higher extent thus increasing the efficiency of the boiler. For every 20°C drop in flue gas exit temperature, the boiler efficiency increases by about 1%.

Boiler and its Auxiliaries

A boiler is a device for generating steam for power, processing or heating purposes. Boilers are designed to transmit heat from an external combustion source (usually fuel combustion to fluid) contained within the boiler itself. The heat generating unit includes a furnace in which the fuel is burned. With the advent of water cooled furnace walls, super heaters, air pre-heater and economizer, the term ‘steam generator’ was evolved as a better description of the apparatus.

Boilers may be classified on the basis of use, pressure, materials, size, tube content, tube shape and position, firing, heat source, fuel, fluid, circulations, furnace position, furnace type, general shape and other special features. As the unit is primarily for power generation it is known as control station steam generator or utility plants.

The boiler used in proposed expansion power plant will be a radiant, non reheat, natural circulated bi-drum, dry bottom type unit. Each corner of the boiler is fitted with tangential burner boxes comprising of two high energy arc ignitors, two light oil fired burners and four pulverized coal burners. The boiler is an external combustion device in that the combustion takes place outside the region of boiling water. A boiler furnace is that space under or adjacent to a boiler in which fuel is burnt and from which the combustion products pass into the boiler. It provides a chamber in which the combustion reaction can be isolated and confined so that the reaction remains a controlled force. In addition, it provides support or enclosure for the firing equipment.

Fuel Firing System

Fuel firing can be classified as direct firing system and indirect firing or intermediate bunker system. Both the systems can use any type of mill. But in proposed expansion power plant direct firing of coal will be employed and hot gas will be used for drying and transporting the coal in the form of primary air.

Tangential Firing

Tangential firing will be employed in the furnace here. In this system, burners are set at each corner of the furnace and are directed to strike the outside of an imaginary circle in the centre of the furnace. Because, the streams of the fuel so strike each other, extremely good mixing is obtained. Since the body of the flame produced is given a rotary motion it leads to a longer flame travel and the gases spread out and fill the combustion chamber.
**Burner and Arrangements**

Oil burner will be installed for burning LDO in proposed expansion power plant. The essential requirements for an oil burner design are:

- It must completely atomise the oil without drooling, fouling or clogging.
- The jet must be so shaped that it will completely mix with the air necessary for combustion.
- Maintenance of atomization over a comparatively wide capacity range.
- Combustion must be complete and excess air at a minimum over the entire operating range.
- A ready accessibility for effecting repairs, thereby minimizing burner outage as well as maintenance costs.

**Furnace**

The relative location of the furnace to the boiler is indicated by the description of the furnace as being internally or externally fired. The furnace is internally fired if the furnace region is completely surrounded by water cooled surfaces. It is externally fired if the furnace is auxiliary to the boiler. Here, in the proposed expansion power plant, the furnace will be internally fired as there is a water wall surface in the furnace. Boiler is classified according to the end use. The utility boilers will be large capacity steam generators used purely for the electrical power generation. The industrial boilers are mainly for use in the process industries. They have partial steam generation in the boiler bank tubes.

**Economizer**

The basic function of an economizer in a steam generating unit is to absorb heat from the flue gases and add this as sensible heat to the feed water before the water enters the evaporative circuit of the boiler. Earlier the economizers were introduced mainly to recover the heat available in flue gas that leaves the boiler and provision of this additional heating surface increased the efficiency of turbine unit and feed water temperature and hence the relative size of the economizer is less than earlier units. This is a good proposition as the heat available in boiler exit flue gas can be economically recovered using air heater which is essential for pulverized fuel fired boilers.

**Water Walls**

Almost all the modern power boilers are equipped with water walls. In large boilers, water walls completely cover the interior surfaces of the furnace providing complete elimination of exposed refractory surface. Water walls serve as the only means of heating and evaporating the feed water supplied to the boiler from the economizers. Water walls usually consist of substantially vertical tubes arranged almost tangentially and is connected at the top and bottom to headers. These tubes receive water form the boiler drum by means of down comers connected between drum and water walls lower header. In a boiler, approximately 50 percent of the heat released by the combustion of fuel in the furnace is absorbed by water walls. Heat so absorbed is used in evaporation of all or relatively large percentage of water supplied to the boiler.
Soot Blowers

Due to the combustion of coal, there is soot deposition along the walls of the boiler which is to be cleaned periodically by soot blowing for which soot blowers are used. There are three types of soot blowers. They are:

a) long retractable soot blowers
b) wall blowers
c) air heater blowers

Steam at a pressure of 103 kg/cm\(^2\) at 395°C is tapped from super heater for the purpose of soot blowing. Soot blowing is done when the furnace temperature goes beyond 900°C. The pressure is reduced to 31kg/cm\(^2\) at 330°C by means of pressure reducing valve. The soot blowers are used for efficient on-load cleaning of furnace, super heaters and regenerative air heaters.

Drum and Drum Internals

The boiler drum forms a part of the circulation system of the boiler. The steam and water drum serves two functions, the first and primary being that of separating steam from the mixture of water and steam discharged into it. Secondly, the drum house's all equipments used for purification of steam after being separated from water. This purification equipment is commonly referred to as the drum internals. The quantity of water contained in the boiler below the water level is relatively small compared to the total steam output.

Types of Super Heaters

Depending on the firing method, fuel fired etc., the super heaters are placed in the boiler flue passes, horizontally, vertically or combined.

*Pendant type*
*Radiant super heaters*
*Convection super heaters*
*Combined super heaters*

The combined type super heater will be used in proposed expansion power plant.

Steam Turbine & Auxiliaries

A turbine, being a form of engine, requires, in-order to function a suitable working fluid, a source of high grade energy and a sink for low-grade energy. When fluid flows through the turbine, part of the energy content is continuously extracted and converted into useful mechanical work. Steam and gas turbines use heat energy, while water turbines use pressure energy. The steam turbines offer many advantages over other prime movers, both thermodynamically and mechanically. From a thermodynamic point of view, the main advantage of a steam turbine over reciprocating steam engine is that in the turbine, steam can be expanded down to a lower back pressure thereby, making available a greater heat drop. Whereas, it is highly impractical and uneconomical in the case of steam engines to construct large cylinders to deal with large volumes for steam expansion. In addition the internal efficiency of a turbine is high and so it is easier to convert a high proportion of this relatively large heat drop into mechanical work. From a mechanical point of view, the turbine is ideal, because the propelling force is applied directly to the rotating element of the machine and it is not as in the reciprocating engine where it is to be transmitted through a system of connecting
links which are necessary to transform a reciprocating motion into a rotary motion. Moreover, if the load on a turbine is kept constant, the torque developed at the coupling is also constant. A generator at a steady load offers a constant torque. Therefore, a turbine is suitable for driving a generator and particularly both the turbine and the generators are high speed machines.

Another advantage of turbine is that, it does not need any internal lubrication. This means that the exhaust steam is not contaminated with oil vapor and can be condensed and fed back to the boilers without passing through filters. The major advantage is that it can generate a much larger amount of power than a reciprocating engine.

**Factors affecting Thermal Cycle Efficiency**

Thermal cycle efficiency is affected by the following factors:

- Initial steam pressure
- Initial steam temperature
- Whether reheat is used or not, and if used reheat pressure and temperature
- Condenser pressure
- Regenerative feed water heating

**Water Treatment Plant**

The objective of water treatment is to produce a boiler feed water so that there is no scale formation causing resistance to passage of heat and burning of tube, no corrosion, no priming or foaming problems. This will ensure that the steam generated will be clean and the boiler plant will provide trouble free uninterrupted service. Water treatment plant is designed in such a way that it provides water which is very low in dissolved solids known as “demineralised water”. There are two stages in water treatment process viz. pretreatment section and demineralization section.

**Wastewater Generation**

Wastewater generation due to industrial process after expansion is given in Table2.8

**TABLE-2.8 WASTEWATER GENERATION**

<table>
<thead>
<tr>
<th>Units</th>
<th>Existing Wastewater Generation Quantity (As per EC granted in Nov.’2009)</th>
<th>Existing Generation</th>
<th>Additional Generation</th>
<th>Total Generation After Proposed Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc Smelter</td>
<td>6400</td>
<td>3600</td>
<td>2800</td>
<td>6400</td>
</tr>
<tr>
<td>Lead Smelter</td>
<td>2000</td>
<td>800</td>
<td>1200</td>
<td>2000</td>
</tr>
<tr>
<td>Captive Power Plant</td>
<td>3425</td>
<td>3200</td>
<td>1750</td>
<td>4950</td>
</tr>
<tr>
<td>Fumer</td>
<td>-</td>
<td>-</td>
<td>2000</td>
<td>2000</td>
</tr>
<tr>
<td>Domestic</td>
<td>500</td>
<td>380</td>
<td>300</td>
<td>680</td>
</tr>
<tr>
<td>Total</td>
<td>12325</td>
<td>7980</td>
<td>8050</td>
<td>16030</td>
</tr>
</tbody>
</table>
Solid Waste Generation

Solid waste generated due to Smelter complex in Table 2.9

<table>
<thead>
<tr>
<th>Unit</th>
<th>Existing Granted Quantity (As per EC granted in Nov.’2009)(Tonnes)</th>
<th>Existing Status (Tonnes)</th>
<th>Additional Proposed Quantity (Tonnes)</th>
<th>Total Quantity After Proposed Expansion (Tonnes/Annum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETP Cake</td>
<td>27500</td>
<td>15000</td>
<td>12500</td>
<td>27500</td>
</tr>
<tr>
<td>Purification Cake</td>
<td>19000</td>
<td>9500</td>
<td>9500</td>
<td>19000</td>
</tr>
<tr>
<td>Cooler Cake</td>
<td>6000</td>
<td>3000</td>
<td>3000</td>
<td>6000</td>
</tr>
<tr>
<td>Anode Mud</td>
<td>3200</td>
<td>1600</td>
<td>1600</td>
<td>3200</td>
</tr>
<tr>
<td>Cobalt cake</td>
<td>1400</td>
<td>700</td>
<td>700</td>
<td>1400</td>
</tr>
<tr>
<td>Used Oil</td>
<td>100KL/Year</td>
<td>75 KL/Year</td>
<td>25 KL/Year</td>
<td>100KL/Year</td>
</tr>
<tr>
<td>Waste Oil</td>
<td>75KL/Year</td>
<td>50 KL/Year</td>
<td>25 KL/Year</td>
<td>75 KL/Year</td>
</tr>
<tr>
<td>Spent Catalysts(V205)</td>
<td>55KL/Year</td>
<td>55KL/Year</td>
<td>-</td>
<td>55KL/Year</td>
</tr>
<tr>
<td>Chemical Sludge (MEE Salt)</td>
<td>-</td>
<td>15000</td>
<td>-</td>
<td>15000</td>
</tr>
<tr>
<td>Discarded Containers</td>
<td>-</td>
<td>1500 nos.</td>
<td>-</td>
<td>1500 nos.</td>
</tr>
<tr>
<td>Jerosite</td>
<td>310600</td>
<td>200000</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Geothite</td>
<td>-</td>
<td>-</td>
<td>36000</td>
<td>36000</td>
</tr>
<tr>
<td>Fly ash</td>
<td>3,14,000</td>
<td>-</td>
<td>1,00,000</td>
<td>4,14,000</td>
</tr>
<tr>
<td>Process Residue(Dross etc. from Lead plant)</td>
<td>-</td>
<td>12000</td>
<td>8000</td>
<td>20000</td>
</tr>
<tr>
<td>Slag from Fumer plant (Zinc &amp; Lead)</td>
<td>125000</td>
<td>125000</td>
<td>315000</td>
<td>440000</td>
</tr>
</tbody>
</table>
Chapter – 3
Site Analysis
3.1 Connectivity

The site is well connected to SH-12 (approx. 17.0 km in north direction from the plant site) and interconnecting NH 162 A (approx. 500 m. In west direction). Nearest city is Rajsamand (approx. 25 km in NW direction from the plant site). Nearest Railway station Fatehnagar Railway Station (approx. 15.5 km in S direction from the plant site). Nearest Airport is Dabok, Udaipur (43 km in SW direction from the plant site). The site is well connected with communication facilities like telephone and as such, no constraints are envisaged in this aspect.

3.2 Land from Land Use And Land Ownership

Dariba Smelter Complex was established in 2010-11, in 162 ha, which was already under the possession of M/s Hindustan Zinc Ltd., hence, no additional land was required. Land use of the existing land area is already industrial. For the proposed expansion of project, acquisition of 10 hectare of agricultural land is envisaged. Topography of the land is almost flat with minor undulation. The elevation of plant area is 480-490m above MSL.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Land Requirement (As per EC granted in Nov.'2009)</th>
<th>Additional Requirement</th>
<th>Total Requirement After Proposed Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Area (ha)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Zinc Plant</td>
<td>34.00</td>
<td>-</td>
<td>34.00</td>
</tr>
<tr>
<td>b) Lead Plant</td>
<td>28.58</td>
<td>-</td>
<td>28.58</td>
</tr>
<tr>
<td>c) Captive Power Plant</td>
<td>18.86</td>
<td>10.0</td>
<td>28.88</td>
</tr>
<tr>
<td>d) Utilities (ETP, RO etc)</td>
<td>6.46</td>
<td>-</td>
<td>6.46</td>
</tr>
<tr>
<td>e) Hazardous Waste Disposal Site</td>
<td>53.00</td>
<td>-</td>
<td>53.00</td>
</tr>
<tr>
<td>f) Fumer Plant</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Others (Open space &amp; internal roads)</td>
<td>21.10</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td><strong>162.00</strong></td>
<td><strong>10.0</strong></td>
<td><strong>172.00</strong></td>
</tr>
</tbody>
</table>

3.3 Topography

The topography of the area is undulating. The drainage pattern in the lease area is dendritic and parallel, radiating in all directions. The area within leasehold does not include any major streams or river across it. The drainage is mainly sheet flow. The surface water bodies in the area re characterized by the existence of tanks. The main source of drainage is River Banas, which is ephemeral and flows 7.9-km, NNE of the plant.

3.4 Existing Infrastructure

Dariba Smelter Complex consist of well-established township with all the amenities such as school, hospital, community centre, recreational club and guest house etc. A well-equipped occupational health monitoring facility with X-Ray, audiometry, lung function test, & blood Lead level monitoring is available in the hospital. The industrial facility consists of water storage tanks and distribution system; Water Treatment Plant, Effluent Treatment Plant, Central Store, Canteen, approach road & parking Plaza, Central Workshop, Electrical power and fuel distribution system, steam distribution and compressed air distribution for process and instrumentation and Fire hydrants & surveillance infrastructure and Environmental and Quality Assurance Labs. Surplus facilities are available at Dariba. However, wherever required, the same shall be augmented.
CHAPTER 4
PLANNING BRIEF
4.1 Planning Concept

Existing industry is metal industry. Facilities required for the proposed expansion project will be provided as per requirement. Transportation of raw material and final product is being / will be done via existing road and rail network and cement concrete road has been developed within the existing plant premises.

4.2 Population Projection

Direct and indirect employment will be created due to project. Temporary influx of people will be there as the managerial and supervisory staff will generally be outsider.

4.3 Land Use Planning

Dariba Smelter Complex was established in 2010-11, in 162 ha, which was already under the possession of M/s Hindustan Zinc Ltd., hence, no additional land was required. Land use of the existing land area is already industrial. For the proposed expansion of project, acquisition of 10 hectare of agricultural land is envisaged.

4.4 Assessment of Infrastructure Demand (Physical & Social)

Hindustan Zinc Ltd. has assessed the demand of infrastructure (Physical & Social) in nearby area of the plant site and development activities are being undertaken under corporate social responsibilities program for rural development initiatives for the up-liftment of the nearby communities from time to time. The existing infrastructure facilities available at the plant will be utilized for the proposed expansion project. Same will be expanded as per requirement.

4.5 Amenities/Facilities

Hindustan Zinc Ltd. has constructed hospital, school, canteen and club etc. for the permanent and contract employees. It is proposed to develop the amenities / facilities in nearby area of the plant site as per requirement of local people of the nearby area under corporate social responsibilities programme.
CHAPTER 5
REHABILITATION AND RESettlement (R & R) PLAN
I. Policy to be adopted (Central/State) in respect of the project affected persons including home oustees, land oustees and landless labourers

Proposed expansion will be done within the existing plant premises and only 10 hectare of the agricultural land shall be additionally acquired. There are no settlements in the additional area hence R & R is not applicable.
CHAPTER 6

PROJECT SCHEDULE AND
COST ESTIMATES
6.1 Time Schedule for the Project

The project will start only after obtaining Environmental Clearance and other clearances from statutory authorities. Project will be completed in two Phases from 2, 50,000 TPA to 3, 75,000 TPA then from 3, 75,000 to 5, 00,000 TPA after successful commissioning of previous phase after getting all the regulatory approvals. Completion of construction work will be about Dec 2022.

6.2 Project Cost

Estimated project cost along with analysis in term of economic viability of the project

The total investment for the proposed project works out to approximately INR 2825Crores. The estimated Investment Cost for the project is based on the requirement of fixed and non-fixed assets. The details of total investment are shown in the table below.

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount (Rs cr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc Smelter Expansion Phase I (0.25 MTPA to 0.375 MTPA)</td>
<td>450</td>
</tr>
<tr>
<td>Fumer Phase I (for 0.375 million TPA Zinc Smelter)</td>
<td>900</td>
</tr>
<tr>
<td>CPP – (1 x 85 MW)</td>
<td>425</td>
</tr>
<tr>
<td>Zinc Smelter Expansion Phase II (0.375 MTPA to 0.50 MTPA)</td>
<td>450</td>
</tr>
<tr>
<td>Fumer Phase II (for 0.125 million TPA Zinc Smelter)</td>
<td>300</td>
</tr>
<tr>
<td>Common Infrastructure/ Services</td>
<td>200</td>
</tr>
<tr>
<td>Water pipeline from Udaipur to Dariba</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2825</strong></td>
</tr>
</tbody>
</table>
CHAPTER 7
ANALYSIS OF PROPOSAL
7.1 Financial and Social Benefits

Proposed expansion project will result in growth of the surrounding areas by increasing direct and indirect employment opportunities in the region including ancillary development and supporting infrastructure. Special emphasis on financial and social benefits is being/ will be given to the local people.

Rajasthan state will get revenues in terms of taxes and local people will get direct & indirect employment. Business opportunities for local community will be available like transport of material to market, maintenance & house-keeping contract work, supplying goods, food to people etc. In addition, lots of CSR activities are being / will be carried out by the company.

7.2 Environment Friendly Project

Being concerned with the environmental conservation and ecological balance, the proposed projects is environmental improvements in nature in the existing Smelter within its premises and mainly aims at waste minimization.

Following are the environmental key features of the project:

- Currently process is generating Jarosite as waste which is neutralized and fixed by addition of lime & cement and converted into Jarofix which is stable material and then stored in jarofix yard. Fumer project will generate usable slag and remove the liability of land, for storage of Jarofix.
- Jarofix process consumes other resource like cement & lime. Fumer operation will mitigate the consumption of lime and cement.
- Fumer slag will be used in cement manufacturing and benefit to cement industry in terms of reduction in Clinker Factor and specific GHG emission.
- Waste heat recovery based power generation would be ~20 MWH of energy.
- Fumer process in addition to improving the environment also helps in recovering lead, silver & copper from zinc concentrate.
Chapter-8
CONCLUSION
8.1 Conclusion

Proposed expansion project will result in conservation of natural resources, growth of the surrounding areas by increased direct and indirect employment opportunities in the region including ancillary development and supporting infrastructure. Special emphasis on Financial and Social benefits will be given to the local people. Development of social amenities will be in the form of medical facilities, education to underprivileged and creation of self-help groups. No adverse effect on environment is envisaged as proper mitigation measure will be taken up for the proposed expansion units.