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Environmental Impact Assessment – Executive Summary

## EMIRATES ALUMINIUM PROJECT





<b>1</b>	<b>INTRODUCTION .....</b>	<b>1</b>
1.1	PROJECT OVERVIEW .....	1
1.2	IMPACT ASSESSMENT .....	1
1.3	THE PROPONENT.....	1
1.4	EIA CONSULTANT.....	2
1.5	PROJECT RATIONALE.....	2
1.6	PROJECT SCHEDULE .....	2
<b>2</b>	<b>PROJECT DESCRIPTION .....</b>	<b>3</b>
2.1	MAIN PROJECT COMPONENTS .....	3
2.2	ALUMINIUM PRODUCTION PROCESS .....	3
2.3	ENVIRONMENTAL PROTECTION -ATMOSPHERIC EMISSIONS	4
<b>3</b>	<b>PROJECT ALTERNATIVES .....</b>	<b>5</b>
3.1	“NO-GO” ALTERNATIVE.....	5
3.2	SITING.....	5
3.3	ALTERNATIVE TECHNOLOGIES.....	5
3.4	POWER PLANT COOLING OPTIONS .....	6
<b>4</b>	<b>CONSULTATION .....</b>	<b>7</b>
<b>5</b>	<b>ENVIRONMENTAL IMPACTS .....</b>	<b>8</b>
5.1	EVALUATION METHODOLOGY .....	8
5.2	IMPACTS OF CONSTRUCTION.....	8
5.3	IMPACTS OF OPERATION .....	10
<b>6</b>	<b>HAZARDS AND RISKS .....</b>	<b>14</b>
<b>7</b>	<b>ENVIRONMENTAL MANAGEMENT AND MONITORING</b>	<b>15</b>
7.1	ENVIRONMENTAL POLICY .....	15
7.2	ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS.....	15
7.3	MONITORING PROGRAMS.....	15



# 1 INTRODUCTION

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## 1.1 PROJECT OVERVIEW

Emirates Aluminium (EMAL) has proposed the construction of a greenfield aluminium smelter, dedicated combined-cycle power plant, port facilities and dedicated materials handling and storage facilities. The Project will be executed in two phases: Phase I reaching a capacity of 700,000 tonnes per year (tpy) with a projected expansion to 1.4 million tpy in Phase II (associated installed power capacities of 1,950 MW in Phase I and 3,650 MW in Phase II). The Project will entail a capital investment of approximately 30 billion Dirhams.

The Project will be located within the proposed Khalifa Port and Industrial Zone (KPIZ), which lies on the southern shores of the Arabian Gulf, halfway between the cities of Abu Dhabi and Dubai. The smelter site will cover an area of approximately 600 ha, northeast of the area occupied by the Al Taweelah Power Company, in an area zoned for heavy industrial activity.

Even though the EMAL EIA was completed for the total planned production capacity of the smelter (Phases I and II), the EAD will only approve the first phase of the project. When the time comes to build Phase II, the EIA will be updated, to take the actual emissions and discharges of the smelter into account and will require resubmission to the EAD for Phase II approval. However, future KPIZ tenants will have to assess the cumulative impacts of their facilities by assuming the smelter will reach the full capacity of 1.4 Mt Al/y.

## 1.2 IMPACT ASSESSMENT

An impact assessment study has been carried out for the construction of the EMAL aluminium project (hereafter referred to as "the Project"). The impact assessment was prepared in accordance with the requirements of the Environment Agency - Abu Dhabi (EAD) and those of the Project's potential financing institutions, who have adopted the Equator Principles to ensure that the projects they finance are socially and environmentally responsible and sound. The Equator Principles refer to the directives and criteria of the International Finance Corporation (IFC).

The study area selected for the assessment of direct impacts of the project has been defined by an area of 15 km x 15 km. The study area is bound to the northwest by the Arabian Gulf, to the northeast by the mangrove of Ras Ghanada, to the southeast by the city of Al Samha and the Abu Dhabi – Dubai highway, and to the southwest by the mangrove of Ras Hanjurah. However, a larger area has been considered for the assessment of potential indirect impacts.

The EIA report integrates the findings of the baseline studies conducted by Halcrow International Partnership (HIP) in 2006-2007 for the KPIZ area, including:

- Marine and terrestrial ecological surveys;
- Archeological survey;
- Noise baseline and traffic count;
- Ambient air quality monitoring;
- Topographical and bathymetric surveys;
- Soil and groundwater site investigation.

## 1.3 THE PROPONENT

The proponent of the Project, Emirates Aluminium, is a joint partnership between Dubai Aluminium Company (DUBAL) and Mubadala Development Company. The ownership of the project is to be shared equally (50/50), while DUBAL will provide resource management and technology for the project.

DUBAL is a multi-billion dollar operation. Their Dubai smelter is one of the largest single-site aluminium smelter in the western world, and is the single largest non-oil contributor to Dubai's economy. During the past 25 years, DUBAL has increased production more than five-fold. DUBAL has expanded to eight potlines, now producing over 861,000 tonnes of quality metal aluminium for clients in over 44 countries, and will reach an annual production capacity of nearly 1 million tonnes in the coming year.

Mubadala Development Company is a wholly owned investment vehicle, established as a Public Joint Stock Company, of the Government of Abu Dhabi. Their mandate is to establish new companies and acquire

strategic holdings in existing companies in the UAE and abroad. Mubadala focuses on generating sustainable economic benefits through partnership with local, regional, and international investors by investing in a wide range of sectors, including energy, utilities, real estate, public-private partnerships, basic industries and services, so as to diversify the growing economy of Abu Dhabi.

#### 1.4 EIA CONSULTANT

SNC♦Lavalin Environment Inc. (SLEI) was mandated by EMAL to prepare an Environmental Impact Assessment (EIA) for the Emirates Aluminium Project. SLEI has in-depth experience in the aluminium industry, having prepared EIAs for 11 greenfield projects as well as several expansion projects.

#### 1.5 PROJECT RATIONALE

World aluminium consumption (estimated at 33 million tonnes in 2006) is forecast to grow on average by 4.2% to reach 40.7 million tonnes per year in 2011. In this context, the construction of new aluminium smelters is necessary to satisfy the forecasted world demand.

The competitive advantages of the Project include convenient access to power, gas and port facilities. It is the opportunity to develop the largest aluminium smelter worldwide. Equipped with the current innovations in environmental pollution control technology, it would achieve very high standards of environmental performance.

The UAE are motivated to diversify the economy and invest in the aluminium industry according to industry best practice, creating high-profile job opportunities for nationals.

The Emirates Aluminium Project will bring a large, capital intensive project to the emirate of Abu Dhabi, bringing benefits such as the creation of approximately 4,000 permanent jobs and significant local, regional and national economic spin-offs.

#### 1.6 PROJECT SCHEDULE

The timeline of the main activities from the onset of the Project's environmental impact assessment is as follows:

- May 2006: Start-up of the Feasibility Study and EIA Study
- May 2006: Environmental Permit Application submitted to EAD
- June 2006 - February 2007: Baseline studies conducted by Halcrow/KPIZ
- July 2006: Terms of Reference for the EIA submitted to EAD
- September 2006: Feasibility Study completed
- November 2006: Initial Consultation with Stakeholders
- November 2006 – June 2007: Front End Engineering Design (FEED)
- March 2007: Submission of EIA report to EAD
- April 2007: EAD approves the project
- April – June 2007: Site mobilization
- May 2007 – September 2009: Detailed Engineering
- June 2007: Submission of updated EIA report to EAD
- July - December 2007: Site preparation
- December 2007: Construction begins
- May 2009 – July 2010: Progressive power generation
- April 2010: First metal produced
- February 2011: Complete start-up of Phase I (full operation)

The EAD will issue a Construction Environmental Permit for Phase 1 after they approve EMAL's Construction Environmental Management Plan (CEMP). The construction works will be monitored to ensure compliance with CEMP and permit conditions. Upon completion of the construction phase, the EAD issues an Environmental Operational Permit based on its inspection and the Operation Environmental Management Plan (OEMP) proposed by EMAL.

The construction activities at the smelter, power plant and Khalifa Port will be carried out over a period of approximately 36 months from project approval to completion of Phase I.

Phase II construction is expected to begin within 5 years following the completion of Phase I construction.

# 2 PROJECT DESCRIPTION

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## 2.1 MAIN PROJECT COMPONENTS

DX technology will be used for the electrolysis of alumina to aluminium, a technology developed in-house by the DUBAL. DX technology is efficient, having a high production of aluminium per unit power, and is currently used at DUBAL's smelting complex in Dubai.

The following major components are included in the Project:

- At the Khalifa Port, one berth for alumina unloading, one berth for coke and pitch unloading and pitch storage (3 x 10,000 t), and one berth dedicated to bulk material unloading and metal shipment;
- On-site alumina (5 x 70,000 t) and coke (4 x 25,000 t) storage silos;
- Four potlines of DUBAL DX technology cells, to be built in two phases of two potlines each;
- Two Gas Treatment Centres (GTCs) per potline, including an alumina injection dry scrubber and a wet scrubber for SO<sub>2</sub> removal;
- A carbon plant, where anodes are formed, baked, rodded and stored;
- A Fume Treatment Centre (FTC) including an alumina injection dry scrubber and a wet scrubber for SO<sub>2</sub> removal;
- A hot bath processing workshop equipped with a crusher, autogenous mill screening process and a GTC;
- A casthouse, where liquid aluminium is cast into sows, ingots, sheets and billets;
- Ancillary services, warehouses and storage buildings distributed throughout the plant;
- A gas-fired combined cycle power plant, consisting of five 730 MW blocks, each composed of two low-NO<sub>x</sub> gas turbines, two Heat Recovery Steam Generators (HRSG) and one steam turbine;
- On-site fuel oil reservoirs (back-up fuel for the power plant sufficient for two days of operation);

- An electrical substation, including groups of transformers/rectifiers to be installed between the potlines and the power plant;
- A Multi-Effect Distillation (MED) plant to provide desalinated for water process and potable water for consumption;
- A seawater cooling tower system for each power block. ADPC will provide a common modular seawater intake and outfall for the KPIZ tenants.

## 2.2 ALUMINIUM PRODUCTION PROCESS

Facilities involved in primary aluminium production (such as EMAL), are known as aluminium smelters or primary aluminium plants. These smelters comprise usually three principal processes:

- (1) Anode production
- (2) Electrolysis
- (3) Casting

Aluminium is produced by the electrolysis of alumina. Alumina is dissolved in an electrolytic bath of molten cryolite (sodium aluminium fluoride) and aluminium fluoride within a large carbon- or graphite-lined steel pot (cell). An electric current is passed through the electrolyte at low voltage, but high current. The electric current flows between a carbon anode made of petroleum coke and pitch, and a cathode formed by the thick carbon or graphite lining of the pot.

Alumina is automatically added to the bath, where it melts and is reduced to aluminium. The process occurs at approximately 950°C, maintained by fine adjustment of the pot voltage.

Anodes are continuously consumed in the electrolysis process, thereby requiring regular replacement. Anodes will be supplied by the on-site anode fabrication facilities.

Electrolysis requires a constant, substantial supply of electricity. Any interruption or variation in current intensity is detrimental to the thermal equilibrium in the electrolysis cell, affecting proper cell operation and potentially leading to the impossibility of restarting

operations in the event of a prolonged, uncontrolled interruption.

Molten aluminium is deposited on the cathode, below the surface of the cryolite bath. The liquid aluminium that settles at the bottom of the cell is removed regularly by siphoning, and is transported to the furnaces of the casthouse and cast as aluminium alloys in sheets and ingots. The approximate product mix will be the following:

Product	Estimated Production (tpy)	Installed Capacity (tpy)
Standard Ingot 23 kg	250,000	300,000
Remelt Sows 680 kg	100,000	150,000
Extrusion billets	200,000	330,000
Sheet Ingots	150,000	165,000
<b>Total Output</b>	<b>700,000</b>	<b>945,000</b>

### 2.3 ENVIRONMENTAL PROTECTION - ATMOSPHERIC EMISSIONS

At full capacity, the EMAL smelter will be the largest smelter in the world. Aggressive pollution control means must be deployed to ensure the environmental discharges will be as low as possible and remain acceptable in terms of environmental impacts.

The project integrates or improves the Best Available Techniques (BAT) described by the European Union's Integrated Pollution Prevention and Control (IPPC) Directive for aluminium smelters, which includes the following controls for atmospheric emissions:

- Alumina scrubbers and fabric filters to control fluoride emissions.
- Seawater scrubbers for SO<sub>2</sub> removal (a technology with higher efficiency than simply limiting the sulphur content of the anodes, as stated by IPPC).

- Process-control based on active cell databases in order to control emissions of polyfluorocarbons (PFCs).
- Fabric filters to control dust (type of filter depends on characteristics of dust).
- Premix dry low NO<sub>x</sub> (DLN) burners for gas turbines in single or combined cycle mode.

The EAD requests that the project complies not only with EAD regulations, but with the more stringent IPPC Directives for both the smelter and power plant.

Parameter	Project Abatement	IPPC mg/Nm <sup>3</sup>	Project mg/Nm <sup>3</sup>
HF	GTC/FTC + wet <sup>(1)</sup>	< 0.2	< 0.2
Total F	GTC/FTC + wet <sup>(1)</sup>	< 0.5	< 0.3
Particulate	GTC/FTC + wet <sup>(1)</sup>	1 - 5	< 2
Particulate	Dust collector	1 - 5	< 5
NO <sub>x</sub> <sup>(2)</sup>	Premix DLN	50	50

(1) GTC/FTC + wet = Alumina injection dry scrubber and seawater wet scrubber for SO<sub>2</sub> removal at potlines (GTC) and anode baking furnaces (FTC).

(2) Gas Turbines: at 15% O<sub>2</sub> – dry basis

In addition to IPPC requirements, the Project will implement a fume collection efficiency of the pot hoods maximized by a high draft rate which maintains the airtight integrity of the pot hoods (2.8 Nm<sup>3</sup>/s/pot). A double ventilation system will allow the pot ventilation to be increased to 4 Nm<sup>3</sup>/s/pot for the equivalent of 15 pots per potline. These measures will minimize potroom roof emissions to a very low level (less than 0.4 kg of total fluorides per tonne of aluminium). Less than 10% of the aluminium smelters in the world are equipped with a double ventilation system.

# 3 PROJECT ALTERNATIVES

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An analysis of reasonable alternatives for meeting the project objectives is a requirement of an EIA, and may lead to designs that are more environmentally, socio-culturally or economically sound.

## 3.1 “No-Go” ALTERNATIVE

If the proposed Emirates Aluminium Project does not proceed (the “no-go” alternative), the adverse impacts identified in the EIA would be avoided. The main adverse impacts are air pollution (mainly sulphur dioxide and nitrogen oxides), climate change (greenhouse gases); a liquid effluent likely to have an impact on the patch coral reef; increased traffic, and generation and disposal of industrial waste.

However, if the proposed project does not proceed, the project's benefits would be lost, including diversification of the economy; increased employment for the region and the UAE; economic benefits from significant capital investment and increased support of the local, regional and national economies, and potential UAE supply chain development.

## 3.2 SITING

Given that the complex requires port facilities to import raw materials and export metal and that power generation requires the extraction and disposal of large quantities of seawater, only sites located in close proximity to the sea were considered. Four sites were investigated for the project:

- Fujairah, on the Gulf of Oman;
- Mussafah, near the island of Abu Dhabi;
- Al Ruwais, an oil refinery site;
- A plot of land in the northeast of the proposed KPIZ.

Site comparison led to the conclusions that Fujairah has insufficient available flat land; Al Ruwais is too far from the existing DUBAL smelter and too close to dugong feeding grounds, and as Mussafah is developing a large residential area and light industrial area, it is unlikely to be compatible with a large smelter complex. Comparatively, the proposed KPIZ site (approximately 60 km from the DUBAL smelter), offers a potential synergy with DUBAL's operations and use of the Jebel

Ali Port, should the Khalifa Port not be ready in time for smelter start-up. The proximity of the Al Taweelah power plant also offers the possibility of using its grid, if necessary.

## 3.3 ALTERNATIVE TECHNOLOGIES

Technological alternatives for aluminium production, materials transport, pollution control, spent pot lining management and desalination have been investigated.

### Aluminium Production

The prebaked anode technology selected for the EMAL project is usually used in new smelters, as it has a higher electrical efficiency than Söderberg technology, releases fewer fluoride emissions to the atmosphere, and reduces the atmospheric emissions of polycyclic aromatic hydrocarbons (PAHs) and dusts to negligible quantities.

### Raw Materials Transport

Raw materials will be delivered to the Khalifa Port by large marine vessels and transported to the smelter site by conveyors or trucks.

The main decision-making factor in selection of a conveyor for coke and alumina transport was length. From an EHS perspective, the probability of accident by conveyor is less than that by truck. Also, conveyors generally result in less noise and air emissions.

Liquid pitch could be transported to the site by either pipeline or tanker truck, yet in consideration of the continuous heating requirements of a pipeline, tanker trucks will be more economical and efficient.

### Air Pollution Control

The most common method for SO<sub>2</sub> emission reductions at aluminium smelters is the use of low sulphur coke and pitch in anode fabrication. Both of which have recently become increasingly rare and expensive. An efficient, low-cost technology is seawater scrubbing, whereby seawater is sprayed on the electrolysis fumes, transforming SO<sub>2</sub> into sulphates (already found in seawater at high concentrations). Considering the high level of uncertainty of obtaining low sulphur coke at

economically feasible costs, the project will install seawater scrubbers for SO<sub>2</sub> removal.

Previously, the most commonly method of NO<sub>x</sub> abatement for combustion turbines was water injection, which also lowers efficiency and requires demineralized water. Water injection will only be used in emergency situations when oil firing is required. Dry low NO<sub>x</sub> technology was selected for operation of the power plant, which reduces NO<sub>x</sub> emissions using a very precise burner and combustion chamber configuration.

### **Management of Spent Pot Lining**

Spent pot lining (SPL) is the largest volume of process solid waste produced by primary smelting operations. SPL is classified as a hazardous waste because of its toxicity (contains cyanide, metals, fluorides), corrosivity (high pH level), and reactivity with water, releasing flammable, toxic and explosive gases (e.g. methane, hydrogen, and ammonia). SPL will be produced in significant quantities 4-5 years after Phase I reaches full operation.

Jesse Brough Metals International Limited (JBMI) has initiated an SPL and dross recycling facility project in Oman. JBMI could potentially establish a processing plant in the KPIZ or elsewhere in the Gulf. The technology consists of processing SPL into aluminium oxide for use in specialized products or as a substitute for oxides in cement fabrication.

The CalSiFrit process is another option, and completely recycles SPL into an amorphous siliceous material without generating any solid or liquid waste. The product can be used as an additive to cement or surrogate to sand in concrete fabrication. The first CalSiFrit facility dedicated to SPL treatment is currently at planning stage for a project in the USA.

The possibility of using SPL in the cement industry or any other local industry as a fuel substitute will also be explored as an option for waste management.

EMAL will closely benchmark the effort of the aluminium industry and the progress of the above-mentioned emerging technologies. The best feasible option will be implemented by the time SPL generation will be significant.

## **Desalination**

Multi-Stage Flash distillation is historically the technology choice for desalination in the UAE, yet for the requirements of simultaneous power and desalinated water generation at the specific volume of water for the proposed project, multi-effect distillation was selected as the most cost-effective distillation technology.

### **3.4 POWER PLANT COOLING OPTIONS**

#### **Technology**

Combined-cycle power plants require a cooling process to condense steam for water reuse within the HRSG. Three options are available for the EMAL project.

Evaporative cooling towers involve steam condensation through closed-circuit water circulation. Seawater cooling towers reduce substantially the volume of seawater and amount of heat ( $\Delta T$ ) in the discharge, but with a higher salinity.

In an air-cooling condenser system, large fans dissipate heat to the atmosphere through coils. This system is more costly than water-based systems and is less energy-efficient, especially when the ambient air temperature is high. It is mostly used when there is no water source available at the chosen site.

In direct seawater cooling, the seawater intake is usually designed as a near-shore channel, and the heated seawater is returned to the sea through an outfall. Thermal plume analysis by HIP determined that once-through cooling would require a 9.6 km offshore diffuser.

For environmental reasons, seawater cooling towers have been selected for the Project.

#### **Outfall Location**

Three outfall options are possible: first, a channel similar to that of Al Taweelah (raising the Al Taweelah seawater intake water temperature to an unacceptable level); second, discharging the seawater to a location far enough to avoid impacts on the Al Taweelah intake and on the patch coral reefs (9.6 km is required for once-through cooling). The 3rd option (most likely to be selected), is building an outfall structure of multi-stage pipes that can be expanded to accommodate the needs of the future tenants.

## 4 CONSULTATION

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Groups and individuals identified as stakeholders in the Project and met in November 2006 during the initial consultation activities included:

- Environment Agency – Abu Dhabi (EAD);
- General Health Authority;
- Ministry of Education;
- Abu Dhabi Municipality (particularly, the Town Planning department);
- Abu Dhabi Water Electricity Authority (ADWEA) and private companies involved in the Al Taweelah Power plant;
- Residents from Al Samha, whose land is in closest proximity to the smelter (12 km);
- Al Taweelah Girls' school and Al Falahiya Boys' School;
- Coast Guard and association of fishermen active at the Al Sadr Port;
- Non-Government Organizations active in the Emirates, such as the World Wildlife Fund (WWF) and the Emirates Environmental Group.

Regular coordination meetings take place with Abu Dhabi Ports Company (ADPC) about the Khalifa Port and Industrial Zone (KPIZ) development and interface.

Consultation with stakeholders was carried out in partnership with Synergy Global Ltd., the company mandated by Halcrow International partnership (HIP) to carry out the Social Impact Assessment of the KPIZ (HIP having been mandated by ADPC to undertake the KPIZ EIA). Consultation activities were carried out primarily in November 2006, during which time, stakeholders were introduced to the KPIZ and EMAL projects in the Al Taweelah area.

The following key concerns were addressed during the meetings:

- ADWEA and private producers questioned the effects of the port construction on sediment loadings, as well as the effects of the smelter complex on their operations and development plans (in terms of impacts of the thermal plume on marine habitats, cumulative effects on air quality, and traffic on access routes).
- Local populations raised concerns about nuisances to their tightly-knit community in terms of traffic and air pollution, and questioned the location and management of the labour camps that will accommodate the influx of foreign workers. They requested that temporary construction camps and operation townships be established at a minimum distance from their city.
- WWF (who is currently managing a 3-year investigation on the coral reefs in the UAE, and has qualified the patch coral reef offshore of the Ras Ghanada mangrove as the largest and most unique in the UAE) is concerned about impacts of the development on the coral reef.

It has been suggested that ADPC and EMAL identify an individual or establish a team within the company responsible for ensuring ongoing communication with stakeholders, especially on issues of mutual concern.

EMAL will develop a Community Engagement Plan (CEP) that sets out how EMAL plans to continue engaging with key stakeholders over the lifetime of the project. The CEP will include the following:

- Appointing of a Community Liaison Officer for the Project.
- A grievance mechanism being set-up by EMAL that will be proactive in dealing with complaints quickly and fairly.
- Maintaining and expanding relationships with groups at the national level. The relationships with government authorities established at the planning stage of the Project will be maintained.
- Maintaining contacts with stakeholders identified during the Social Review in order to receive and respond to community concerns on an ongoing basis.

# 5 ENVIRONMENTAL IMPACTS

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## 5.1 EVALUATION METHODOLOGY

Impact evaluation consists of making a value-based judgment on a project's effects, in terms of the bio-physical environment, ecosystems, social environment, population, and in understanding how the surroundings, its habitants, and the links between them will be affected by the project. The significance of an anticipated impact provides an overall assessment on a given environmental component (ranging from very high to very low significance) based on the impact's intensity, extent and duration.

The impact summary of the impacts of the Project during the construction and operation phases is presented in Table 5.11 of the EIA report. The table include the affected components, anticipated effects, mitigation measures, improvement or monitoring measures to be implemented, and an evaluation of impact significance.

## 5.2 IMPACTS OF CONSTRUCTION

During the construction phase, the main impacts will be related to air and water quality, noise levels, biological environment, economy, quality of life, resettlement, and living and working conditions of construction workers and their presence.

### Air Quality

During the construction phase, there will be a number of potential sources of dust, including earthworks and construction traffic on unpaved roads. Dust emissions will be controlled by covering dust sources and using dust suppressors.

### Water Quality

During the construction phase, there will be infrequent rain that likely evaporate or rapidly seep into the ground without any accumulation. Heavier rain could cause storm water runoff to accumulate in site depressions, which (in such cases) would be collected and transferred to a settling pond. Water from the settling pond will serve the needs of the construction works (e.g., material compaction, water spraying on roads, etc.)

The temporary construction camp will be equipped with an adequate sewage treatment system. Isolated construction offices may be arranged with septic tanks that would be emptied regularly; their contents sent to the sewage treatment plant facility. No impact is expected on the capacity of the Mafraq sewage treatment plant.

### Noise

Site preparation and foundation laying should be the noisiest activities during construction, and could have an impact on the noise levels near to the site. Work will likely be organized on a 24-hour per day, six-day per week schedule. The load-bearing capacity of the existing soil may be insufficient and foundations may be supported on piles, steel caissons or stone columns. To the greatest possible extent, pile driving will be limited to during the day and into specific areas. Concrete for the foundations and backfill material (2.65 Mm<sup>3</sup>) will be supplied by an on-site batch plant or transported on local roads from local suppliers and existing quarries.

The residential areas are far enough from the site that the effects of the construction noise should not be significant. Transportation of backfill material and concrete from local suppliers will increase the noise along the roads and may have a significant effect, if the trucks pass through residential areas. However, the Al Taweelah road is at least 1 km from Al Samha. The impact would be of short duration (approximately 6 months) and of local extent. Also, where applicable, by-pass roads could be used to reduce the impacts of noise. The significance of the anticipated noise impact is low in the exposed areas.

### Marine Habitat

The main impacts on the marine environment and the intertidal area are linked to the construction of the port and the KPIZ common modular seawater intake and outfall structure of multi-stage intake cells and pipes. KPIZ will provide these facilities, and impacts will be assessed in their EIA.

### Endangered Avian Fauna

The main impact on the endangered avian fauna is related to a loss of habitat. The

Lesser Short-toed Lark, the Cream-coloured Courser and the Chestnut-bellied Sandgrouse are considered nationally threatened. Despite having a wide distribution in Africa, the Middle East and Asia, the project area is one of the few known nesting sites in the UAE, a particularly critical nesting site for the Lesser Short-toed Lark.

Without any mitigation measure, the significance of the impact is high. As a mitigation measure, ADPC plans to implement buffers and eco-corridors wherever possible. Construction in the fenced bird-breeding area will start between October and January to avoid the bird nesting season. If the mitigation measures were successful, the significance of the impact could be reduced to medium.

### **Terrestrial Habitat**

The selected smelter site includes coastal white sands, a terrestrial habitat important for UAE's biodiversity. The significance of the impact is very high. The following mitigation measures will be implemented:

- Conservation and fencing of white sand areas not required for Phase I;
- Translocation of smaller animals in appropriate areas;
- Creation of white sand habitats in areas unlikely to be developed, by preserving the top layer of sand at the site containing the majority of the seed bank;
- Avoiding spraying insecticides to maintain the food chains and the pollination of the vegetation;
- Elimination and destruction of *Prosopis juliflora*, a highly invasive plant species that is the main cause of mesquite allergies in the UAE.

### **Land Ownership, Zoning, Project Development**

The proposed site was selected in order to find a site for the Project that was compatible with the surrounding environment (with respect to noise and air quality). The proposed smelter site conforms to the land zoning proposed in the Khalifa Port Industrial Zone (heavy industrial). ADPC is in the process of acquiring ownership of the KPIZ land. The EMAL project was the first, and is currently the only confirmed project.

### **Economics & Employment**

Construction of the smelter represents an investment of over 30 billion Dirhams. At peak, construction activities for Phase I will require a workforce of nearly 9,000, with an average of 5,000 workers over the duration of the work. Construction of the Project will also have a direct positive effect on the local and regional economy, with the influx of workers creating a higher demand and purchasing of goods and services.

### **Workers' Accommodations**

Local population has expressed some concerns about the proximity of large construction camps to their communities. A temporary construction camp will be built on the smelter site to accommodate 5,000 people. The smelter site is at 12 km from the nearest community (Al Samha). Standards will be established to provide decent living conditions for foreign workers. It is likely that the local contractors already established in the Emirates that own living quarters for their construction workers (in areas such as the Jebel Ali Free Zone), will attempt to use these accommodations and will commute their workers to the construction site. In any case, EMAL will exert a control on their contractors to prevent unreasonable situations (e.g., commuting from Sharjah).

### **Infrastructure**

The Etisalat communication tower on the smelter site will be serviced with a new dedicated access road.

The entire site's potable water needs are to be fulfilled by a temporary connection to the Abu Dhabi Distribution Company's (ADDC) existing water distribution network (a water pipeline is at the southeast corner of the EMAL site) The amount of water required for the construction phase (2,500 m<sup>3</sup>/day) is negligible compared to the water generation capacity of Al Taweelah (1.35 Mm<sup>3</sup>/d).

A 33 kV temporary construction power line will be built between the Al Taweelah power plant and the proposed site, across barren saline flats.

The existing road network within KPIZ will be improved to grant access to heavy vehicles. A temporary 1.6 km link will be built for heavy vehicle traffic between the EMAL site and the

existing road network. The planned temporary road location is mainly in barren saline flats to avoid impacts on the white sand dunes habitat. New road access will also have to be provided for the 3 isolated weekend villas located along the Ras Ghanada mangrove, as the existing access road crosses the smelter site.

### **Traffic**

It is expected that heavy load trucks (50 t) will carry equipment or merchandise from the Jebel Ali Port or the Abu Dhabi Port, awaiting the establishment of a temporary jetty near the smelter site. A total of approximately 100 round trips per hour could be required for heavy load vehicles and approximately the same for light vehicles. Traffic from the Abu Dhabi Port will be scheduled outside of peak traffic hours.

The EMAL project would roughly double the traffic on the main access road between the highway and the Al Taweelah power plant, which currently has a relatively light traffic load estimated at approximately 2,500 vehicles per day. Overall, the impact of new traffic on this road and the Abu Dhabi-Dubai Highway and the existing road network is considered low. EMAL will support KPIZ in their implementation of a traffic management plan and the improvement of road infrastructure, both aiming to avoid congestion and maintain road safety.

### **5.3 IMPACTS OF OPERATION**

**T**he main impacts of the operation phase are expected to be on air and water quality, noise levels, marine environment, the economy, employment, and relationships with the community. Greenhouse gases may also be a cause for concern.

#### **Air Dispersion Modeling**

Air dispersion modeling was conducted for the proposed smelter to estimate hydrogen fluoride (HF), sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) and particulate matter (PM<sub>10</sub>) concentrations in the ambient air resulting from the emissions of the aluminium smelter and power plant. HF, SO<sub>2</sub> and NO<sub>x</sub> are the main gaseous emissions from the complex and also have the greatest potential for impact on air quality.

The air dispersion model Calpuff has been used, as this model can take into account long buoyant line sources such as potroom roof emissions. The modeling was done over a period of five years of meteorological representative of the Taweelah area.

#### **Air Pollution Control**

In order to minimize impacts of these emissions and comply with EAD standards, pollution abatement techniques must be implemented in addition to the pollution control equipment commonly found in a smelter (alumina dry scrubber). The smelter's GTCs (potlines) and FTCs (baking furnaces) will be equipped with seawater scrubbers for SO<sub>2</sub> removal, and a highly efficient pot ventilation system will be implemented, consisting of the usual ventilation system and double suction, locally increasing the ventilation when specific operations on a pot must be performed (e.g., hood opening, anode changing, etc.).

#### **Air Quality – HF**

In order to reduce emissions of fluorides to the greatest extent possible, the aforementioned double ventilation system will be used to capture fugitive emissions during pot maintenance. The predicted maximum concentrations of HF in ambient air will only be a fraction of the recommended World Health Organization (WHO) levels, and there will therefore be no impact of fluorides on human health, either acute (irritation) or chronic (fluorosis). For areas next to the smelter, odours of fluorides will be imperceptible.

No sensitive species of flora are found in the 0.3 to 1.0 µg HF/m<sup>3</sup> concentration isocontour of the area; therefore, there will be no impact on vegetation due to fluoride concentrations in ambient air. The low concentrations of HF in Ras Ghanada will result in low accumulations of fluorides in the grass. The risk of accumulating concentration potentially harmful to the gazelles (posing a risk of dental fluorosis) is low, if not negligible.

#### **Air Quality – SO<sub>2</sub>**

Sulphur dioxide (SO<sub>2</sub>) abatement for the potline gasses is achieved by a seawater scrubbing system installed sequentially after the FTP (95% SO<sub>2</sub> removal efficiency). The predicted maximum ambient air concentrations of SO<sub>2</sub> in residential areas (Al Samha) will be in the order of magnitude of the stringent

levels recommended by WHO (2006) as a precautionary approach to protect the health of the most vulnerable people (children, elderly, asthmatics, etc.) Health effects associated with very short-term exposure to SO<sub>2</sub> can then be considered negligible.

### **Air Quality - NO<sub>x</sub>**

The air dispersion modeling takes into account the increased nitrogen oxide (NO<sub>x</sub>) emissions from the Taweelah B power plant extension project. It was found that the addition of background levels to predicted ambient air concentrations will not result in concentrations surpassing the EAD's ambient air standards or World Health Organization's (WHO) annual Air Quality Guideline (AQG). In the residential area of Al Samha, the addition of 98th percentile value of the background level to the maximum predicted NO<sub>2</sub> concentration will still be within the WHO AQG and should not lead to any adverse health effects.

### **Agriculture and Plantations**

As expected levels of HF, SO<sub>2</sub> and NO<sub>2</sub> are below levels that could potentially affect natural vegetation (according to UNECE SO<sub>2</sub> and NO<sub>2</sub> critical levels), the level of perturbation will be very low (probably nil). Consequently, the impact of HF, SO<sub>2</sub> and NO<sub>x</sub> emissions on agriculture and plantations near Al-Samha will be negligible.

### **Greenhouse Gases (GHG)**

A 1.4 Mt Al/y smelter and power plant would contribute approximately 10 Mt CO<sub>2</sub>eq/y to GHG emissions. Anode effects, which can contribute significantly to the GHG emissions of a smelter, will be limited by the implementation of a process control that will limit their frequency and duration. The contribution of the smelter to the GHG emissions would be approximately 6% of the UAE's emissions, estimated to be 160 Mt CO<sub>2</sub>/y for 2006.

In terms of the future project's contribution to GDP, EMAL's emissions are estimated to be in the range of 1.8 to 2.5 kg CO<sub>2</sub>eq/US\$ GDP, depending on aluminium prices. This is higher than the current UAE's intensity estimated to be 0.95 kg CO<sub>2</sub>eq/US\$ GDP. The impact of the EMAL project's emissions on the national GHG budget is considered to be of high significance.

EMAL and DUBAL will implement a program aiming to reduce greenhouse gas emissions at their facilities. The objectives will be to define annual objectives and an accurate emissions inventory for GHG emissions from the facilities, and to identify opportunities for GHG reduction. DUBAL (through the involvement of Mubadala) has launched a program under Masdar, the Abu Dhabi's sustainable energy program, to review opportunities for saving energy at DUBAL's facilities. The outcome of this program will be reflected in the EMAL project.

### **Water Quality**

Aluminium smelting is essentially a dry process; the only significant wastewaters generated during operation of the complex will be cooling waters and sanitary wastewaters. Overall, less than 2 Mm<sup>3</sup>/day of seawater will be required for the entire plant, mainly in the seawater scrubbers to remove sulphur dioxide from the pot fumes and to condense the steam for reuse in the Heat Recovery Steam Generators (HRSG) at the power plant.

The final seawater effluent will be returned to the sea with a slightly higher temperature (<1°C), in addition to an increase in fluorides (<0.2 mg/l), sulphates (<300 mg/l), salinity (<3 gpl) and a slightly acidic pH (6 to 7). These changes in concentrations are negligible compared to natural seawater concentrations (1.4 mg/l of fluoride, 3,000 - 3,400 mg/l of sulphates, and 40-45 gpl in salinity). Seawater scrubbing is an excellent technique for reducing the negative effects of acid rain/acid deposition caused by increased levels of SO<sub>2</sub> in the ambient air, and will therefore have no negative impact on the marine environment.

The complex will be equipped with a sewage treatment plant. The treated sewage water will be disinfected with a UV system permitting its use for irrigation purposes.

Run-off drainage water will be channelled to a settling pond where it will be evaporated, reused for landscape irrigation around the complex, trucked and reused in the process (e.g., anode cooling), or simply discharged to the sea during extreme rain events.

### **Coral Reef**

The marine environment is the most sensitive receptor in the vicinity of the proposed facility,

in particular, the patch coral reefs. Apart from being a biological wealth for the UAE environment, coral reefs may be vital to the UAE fisheries, supporting an abundance of marine life and providing spawning areas for various marine fauna and commercially important fish species. The coral communities off Ras Ghanada (e.g., the dense coral biotope) are considered to be amongst the most diverse in the region. This coral biotope is, at minimum, considered to be of national importance and a biodiversity resource.

The use of seawater cooling towers will reduce EMAL's flow and temperature differential to very low values compared to a once-through cooling system (which requires a much higher flow (1:25 on average) and a  $\Delta T < 7^\circ\text{C}$ , whereas  $\Delta T < 1^\circ\text{C}$  for cooling towers). As an input to the design, the preliminary outfall plume investigation will be reviewed by KPIZ to define an appropriate location and outfall length. Also the necessity for a diffuser will be verified, taking into account the new characteristics of the EMAL effluent, and to define a viable solution that prevents recirculation (short circuiting to the intake structure) and significant impacts on the marine habitat, in particular, the coral reef.

### **Other Marine Habitats**

Considering the characteristics of the final effluent, there should not be any impacts on the seagrass or the mangrove habitats.

### **Noise Impacts**

The power plant will be brought into production progressively, starting by commissioning the gas turbine blocks. Exhaust gas from the turbines will be diverted to the bypass stacks for a period of approximately 15 months, until the HRSG and the steam turbines are commissioned. The bypass stacks will be equipped with silencers to reduce the noise emissions during the commissioning period. Major sources of noise associated with start-up of the power plant include blowdown noise during valve testing, steam pipe purging, and steam venting during start-up and shutdown of an HRSG (high noise levels over short periods of time). Silencers should be used to reduce the noise emission and venting should be limited to the day period. The significance of the anticipated noise impact is low in the exposed areas.

Noise resulting from the operation of the smelter can be divided into three sources affecting three different areas: the loading and unloading of materials at the port facility, the transportation of material by road between the port and the smelter, and the operation of the smelter. The smelter is designed to be in continuous operations, 24 hours per day, 365 days per year.

Areas with noise levels surpassing the EAD's industrial area night limit of 60 dBA are located beside the power plant; a noise reduction of 10 dBA would be required to comply with the EAD's limits at the site perimeter. Noise mitigation will be implemented, such as silencers at gas turbine derivation stacks and HRSG stacks and a noise barrier along the power plant. With implementation of these noise mitigation measures, the complex will generally comply with noise standards.

The noise level at the three isolated weekend villas along the mangrove of Ras Ghanada is above the EAD's residential night limit of 40 dBA, but lower than EAD's commercial zone night limit of 55 dBA.

The noise level at the existing construction camp near the Al Taweelah power plant is above the EAD's residential area night limit, but the measured baseline noise level of 54.6 dBA at night already surpasses the limit. The additional noise caused by the proposed project would not raise the baseline noise levels.

The noise levels at the residential areas of Al Samha are below the EAD's residential area night limit of 40 dBA with light traffic. The measured baseline noise levels at night (42.4 to 54.7 dBA) also surpass the limit.

At other locations, the project noise is below the noise limit or the existing baseline noise and noise mitigation is not required. The noise impact will be low at the residential areas.

### **Economics and Employment**

During the operational phase, the complex will employ as many as 4,000 workers in permanent positions. DUBAL's hiring policy includes the objective of attracting and retaining the maximum number of UAE nationals in all areas of business. EMAL will offer job opportunities, aiming to hire an operational workforce of at least 20%

nationals. During hiring, in the case of equal competency, priority will be given to nationals. The positive impact is considered to be of very high significance.

The project is also anticipated to create approximately 5,000 to 10,000 indirect jobs in the UAE. It will have a direct positive effect on the local, regional and national economies, with the increased demand for goods and services, economic spin-offs, and potential UAE supply chain development, including secondary aluminium products.

### **Workers' Accommodations**

The workforce during the operational phase will be similar to that of the construction phase, in that the majority will be comprised of non-nationals. Permanent housing facilities will be planned for the KPIZ Area B (near light industrial zones); and some of the workers may also be transported by bus from Abu Dhabi or Dubai. ADPC will have to file a separate EIA for permanent 'cities' in KPIZ Area B (including the residential areas and permanent worker's villages) according to the EAD's requirements.

### **Traffic**

A potential impact of operation of the complex is increased traffic in the area from transport of materials and workers to the plant.

The location of the smelter access road from the Abu Dhabi-Dubai highway E11 through the industrial area has been defined in the KPIZ Master Plan. A vehicular flow of 10 heavy vehicles per hour and 160 light vehicles per hour is estimated on this road, including the buses shuttling the employees from the worker's village in Area B (the precise location will be defined in the KPIZ Master Plan). Also, a daily vehicular flow of 120 40-tonne trucks is expected on the dedicated 2-way road access connecting the EMAL port facilities to the smelter for transportation of metals and raw materials. These estimates are very low compared to the traffic expected for the entire KPIZ area and have also been submitted to the KPIZ authorities, for the development of a traffic management plan for the whole KPIZ area.

The KPIZ EIA has evaluated the changes in air quality at the proximity of Highway E11 and Al Taweelah road as minor.

### **Conclusion**

The fact that the aluminium smelter and power plant will be in an isolated area, 12 km from any significant urban residential area, contributes significantly to minimizing the environmental impacts. Implementation of pollution abatement and control technologies exceeding international standards and usual practice in the aluminium industry allows a higher production aluminium output with minimal impacts on the environment.

The construction and operation of an aluminium smelter, power plant and associated port facilities in a region devoted to industrial activity will (in general) not generate any major negative impact on the human and natural environment of the zone under study. Due to the mitigation measures that will be integrated into the project, most of the anticipated negative impacts are of medium, low or negligible significance.

However, the EMAL Project will be established on one of the last coastal white sand habitats, considered to be of importance for the biodiversity. Impact on the white sand habitat is considered to be very high. Depending on the success of the measures proposed to mitigate and/or compensate the loss of white sands, the impacts could be reduced to high or medium.

Finally, the impact of the EMAL Project's emissions on the national GHG budget is considered to be of high significance.

## 6 HAZARDS AND RISKS

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**H**azard and consequence analyses, taking into consideration the risks posed by plant operation, in addition to the sensitive elements in the surrounding environment and naturally occurring external risks, have found that construction and operation of the Project will not significantly increase risk to the surrounding communities.

The accident history indicates that the greatest risks to power plants are associated with the use of fuel and hydrogen, especially in the case of leaks in confined spaces.

Throughout the entire aluminium industry, accident statistics established by The Aluminium Association indicate that:

- The majority of accidents are explosions in the casthouse during furnace loading and casting;
- The presence of humidity or oxidative impurities seems to be the cause of the majority of events.

The results of these analyses have shown that there are no accidents at the project site that could result in equipment damage or seriously injured workers at the Al Taweelah power and desalination plants. Potential consequence evaluation has indicated that hazardous materials transport on the waterways, the highway located south of the site, or on the access road of the Al Taweelah power and desalination plants would not be affected by an accidental event on-site. However, in the case of a major uncontrolled spill of fuel oil or a chemical spill, the local aquatic fauna and flora, as well as the water intake of the Al Taweelah desalination plant, could be negatively affected.

A major release of chlorine from a 1-tonne cylinder could have lethal effects up to 1,240 m downwind with very low wind velocity and up to 250 m with average wind velocity. If a scrubber collects the chlorine release with 99% efficiency, there would be no lethal effects and permanent injury distance would be limited to a maximum distance of 200 m.

The equipment and facilities of the power plant and smelter will be designed, built, installed

and operated according to recognized industrial codes, as well as local regulations, guidelines and procedures.

Emirates Aluminium will implement policies for Quality, Environment, Health and Safety (similar to DUBAL's Core Policies for EHS), to eliminate the risk of accidents or minimize the potential consequences or the probability of these accidents. Finally, a Risk Management Plan will be implemented to manage the residual risks that cannot be eliminated, to ensure the safety of the workers, local population and environment.

Emergency Response Plans (ERP) will be developed for the smelter and power plant. Objectives will include:

- Reacting quickly and effectively during an emergency situation;
- Stopping an emergency situation as soon as possible, and controlling and minimizing its effects;
- Ensuring the safety of employees or any other persons (e.g., entrepreneurs, visitors, etc.);
- Ensuring public safety;
- Protecting the environment;
- Restricting damage to property;
- Creating an operational link with outside actors;
- Obtaining external assistance if necessary;
- Returning to normal operating conditions as quickly as possible.

The ERP will be kept up-to-date and revised when significant changes occur at the smelter or power plant. The employee training plan (including emergency exercises) and an emergency plan follow-up will also be included in the risk management plan.

The ERP will be developed at the beginning of the project and will include essential elements from the construction plans and specifications. It will be developed in coordination with local authorities, police, fire department, health services and neighbouring industries.

# 7 ENVIRONMENTAL MANAGEMENT AND MONITORING

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## 7.1 ENVIRONMENTAL POLICY

**E**MAL is dedicated to constructing and operating their aluminium smelter in an environmentally and socially responsible manner; complying with environmental laws, regulations, and guidelines.

EMAL will develop an environmental policy based on the philosophy of sustainable development, wherein economic development is achieved without undermining the incomes, resources or environment of future generations. The plant will actively work on a documented Environmental, Health and Safety Management System based on ISO 14001 and OSHAS 18 001 accreditation for both construction and operation phases.

## 7.2 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

**E**nvironmental Management Plans will be prepared for the construction and operation of the smelter and power plant. The plans identify actions to manage environmental impacts and specify monitoring requirements and performance criteria. They will be updated periodically to incorporate changes that may arise.

The Engineering, Procurement, Construction, Management contractor (SNC Lavalin / Worley Parsons) has submitted a CEMP (Construction Environmental Management Plan) to the EAD. The main objective of the CEMP is to mitigate impacts on the environment from construction activities by outlining environmental aspects of concern for the site, their levels of risk and the associated environmental protection measures for mitigating these risks.

EMAL will prepare the Environmental Management Plan for Operation (OEMP). Several plans (waste management, hazardous substances, greenhouse gases), programs and procedures will be developed to reach the objectives of the OEMP. In most cases, they will be based on existing protocols that have been developed for the DUBAL Aluminium Smelter. This strategy benefits from a transfer of knowledge and mentoring between DUBAL and EMAL workers.

A Community Engagement Plan (CEP) will be implemented to promote good relations with the community. The CEP aims to provide a timely response to any enquiries, concerns or complaints about construction or operation activities. One of its goals is to further EMAL's "good neighbour" strategy to be a good corporate citizen, protect the environment, and enhance the quality of life in its host communities. Involvement in the community is of prime importance to EMAL. As has been done with its shareholder, DUBAL, actions will be taken to promote community development in partnership with local organizations.

## 7.3 MONITORING PROGRAMS

**T**he environment of the project area and its surroundings will be monitored during construction and operation phases with the following goals:

- Ensuring compliance with UAE standards, regulations and commitments;
- Describing the contingency investigations and/or mitigation measures should unexpected impacts be detected;
- Facilitating continuous improvement and best management practices with respect to the environment.

The construction works will be monitored to ensure compliance with CEMP and permit conditions.

The monitoring program proposed for the operation phase will address atmospheric emissions, final liquid effluent, waste management, air quality, water quality, vegetation and noise. EMAL will submit an annual monitoring report to the EAD and confirm their compliance with the conditions of the permit. They will also present the main results to the local population; the mechanisms of the disclosure process (formation, creation of a follow-up committee, etc.) will be discussed with stakeholders (local population, authorities, local representatives of the EAD, etc.). After two years of operation, the environmental monitoring program will be reviewed in order to consider the development of the environmental impacts of the smelter.