

3. PROJECT DESCRIPTION

3.1 INTRODUCTION

3.1.1 The purpose of this section is to describe the Qatalum Project in terms of: the site location; plant, equipment and utilities; the process, the proposed technology; future development scenarios and the overall Project schedule. In addition, this section presents materials and resource use and identifies the source and nature of emissions and wastes arising from Phase 1 of the Project. The identification of the potential environmental impacts associated with the Qatalum Project is presented in Chapter 4; the assessment of the significance of these impacts is discussed in Chapter 6.

3.1.2 The remainder of this chapter is split into the following main Sections:

- Project Overview;
- Site Selection;
- Site Alternatives;
- Site Location and Description;
- Project Schedule;
- Construction and Commissioning;
- Decommissioning;
- Operation – Main Site Layout
- Operation - Proposed Plant and Capacities Overview;
- Operation - Process Description;
- Technology Selection and BAT;
- Ancillary Processes, Services and Utilities;
- Operational Material and Resource Use; and
- Emissions and Waste Generation.

3.2 PROJECT OVERVIEW

3.2.1 Qatar Petroleum (QP) and Hydro are planning to develop one of the world's largest Aluminium Plants in Qatar. The plant will be built in the north of the Mesaieed Industrial Area, south of Doha, as indicated in Figure 1.1.

3.2.2 The Qatalum Project concept will be developed in phases. The planned capacity for the first phase is an annual production rate of 585,000 tonnes of primary aluminium. The plant site is sufficient for more than a doubling of the primary aluminium production capacity, up to 1.2 million tonnes per year. To serve the aluminium production process with the required, stable, supply of power (approximately 1,000 MW for the first phase), a dedicated Power Plant will be constructed.

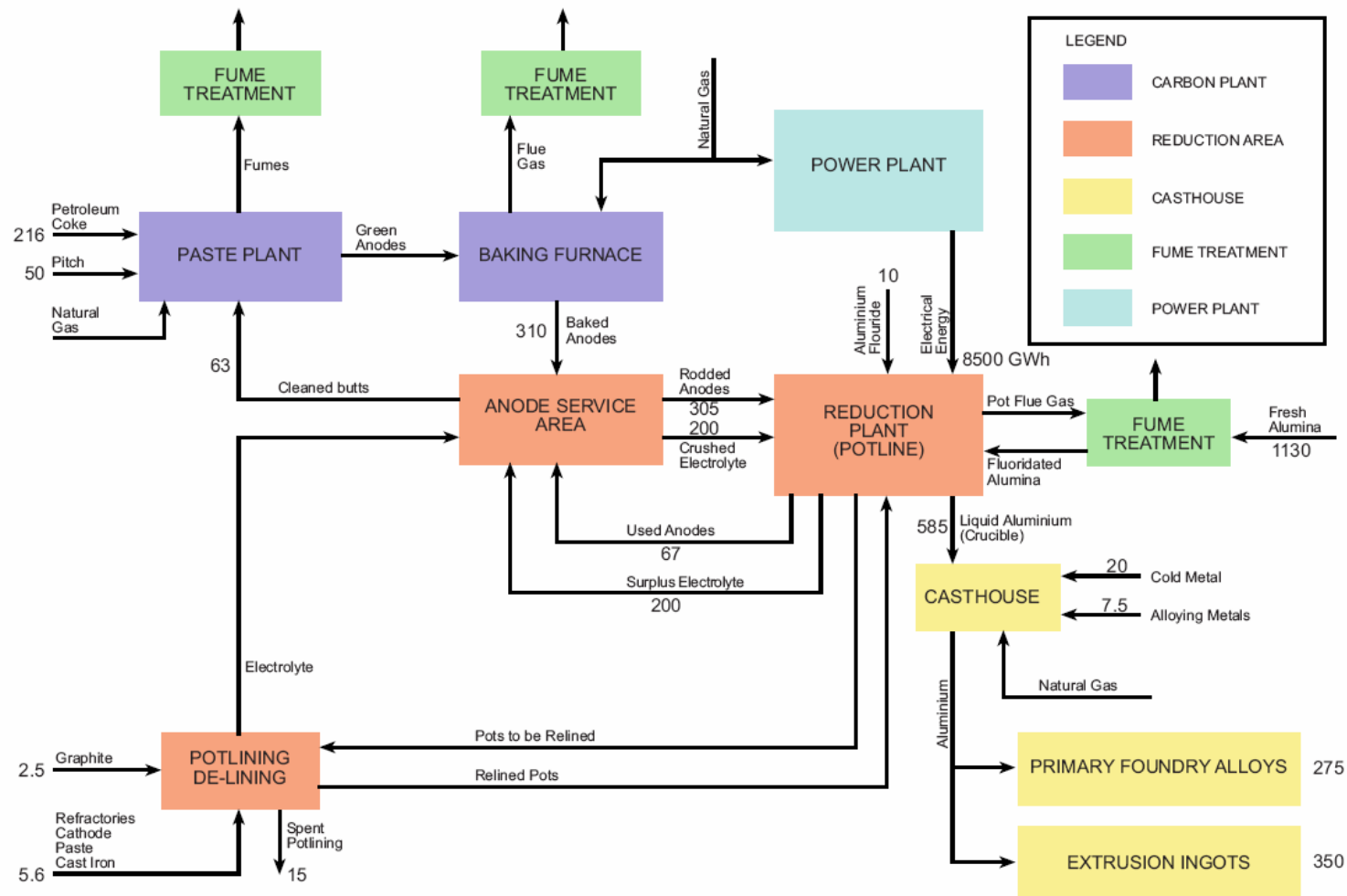
3.2.3 The Project involves the construction and installation of the following:

- Carbon Plant (including a Paste Plant and Anode Bake Plant);
- Reduction Plant (also referred to as Potrooms/Potlines);
- Casthouse;
- Anode Service Area (Rodding Plant and Electrolyte Treatment Plant);
- utilities and infrastructure;
- dedicated Power Plant; and
- Port area with import / export facilities.

3.2.4 The three main items of plant directly associated with the metals part of the process are the aluminium Reduction Plant (Potrooms), the Carbon Plant (for anode production) and the Casthouse. Each of the main plant areas has its own control centre and operates independently.

3.2.5 In very simplistic terms, liquid aluminium is produced in the Reduction Plant by electrolysing alumina (aluminium oxide) in a molten cryolite electrolyte. The liquid aluminium is transported from the potroom to the Casthouse where it is cast to form the aluminium products, such as extrusion ingots and primary foundry alloys ingots. The electrolysis process requires a continual supply of carbon anodes; these are produced in the Carbon Plant from petroleum coke and liquid pitch. The electricity required for the electrolysis process is supplied by the Power Plant. Raw materials and products are transported to and from the site via the Port. A simple schematic of the process, including approximate material usage and production rates is presented in Figure 3.1, overleaf.

Figure 3.1 – Overview Process Schematic (units in kilo tonnes per year)



3.3 SITE SELECTION

3.3.1 The key factors that need to be considered for the siting of an aluminium plant are:

- the dimensions of the site – the site needs to have a length that is sufficient to house the long potroom buildings;
- the availability of port / harbour facilities, or an area to develop these, and their proximity to the Main Site;
- proximity to the transport links;
- site access;
- availability of a cheap, reliable gas and /or power supply; and
- existing infrastructure / common utilities.

3.4 SITE ALTERNATIVES

Main Site Alternative Areas within Qatar

3.4.1 Before selecting the site at Mesaieed, Ras Laffan Industrial City was also considered; however, this was later discarded due to major investments that would have been required for harbour developments and/or the logistics associated with the long distances for transport of raw materials/products between the possible site and the existing harbour.

Main Site Alternative Areas within MIC

3.4.2 Within the Mesaieed Industrial Area, different possibilities for site location were discussed with the MIC Authority. A possible site, south of the Q-Chem plant, was identified, however, this was also discarded for the following reasons:

- a major sand dune would have needed to be removed and the site area would have still been subject to further influx of sand;
- the shape of the site was not suitable to accommodate the length and preferred orientation of the potroom buildings; and
- the proximity of recreational areas (i.e. the Sealine resort) may not provide the an appropriate neighbourhood for locating a smelter.

Port Location Alternatives

Note - after submission of revision 01 of the EIA report, the Alternative Port concept (as described below) was chosen. A separate application for environmental clearance of the Port development will be submitted once the details have been established. However the text, relating to both Port concepts, within this updated (revision 02) EIA report has been retained, unchanged.

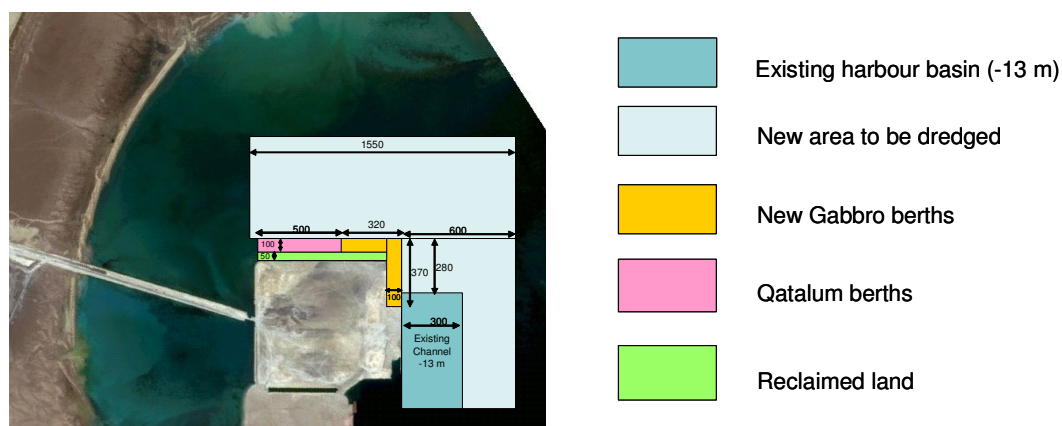
3.4.3 As noted in Chapter 1, the location of the Qatalum Port Area has not been finalised and two areas are still under evaluation. Originally it was planned to locate the Port facilities close to the Gabbro Berth; herein referred to as “Original” Port concept. More recently, an alternative location has been identified to the south of the QASCO steel works; herein referred to as “Alternative” Port concept. The locations of both port concepts are indicated in Figure 3.5 and the rational behind both concepts is discussed further below. Both Port concepts would include:

- import / export berth(s) for raw materials and products;
- silo / tank storage area for raw materials and container storage for products;
- a service corridor to the Qatalum Main Site for conveyors and pipelines;
- dredging to –15 m CD, in order to construct the necessary access and turning basins for incoming ships; and
- a seawater intake system.

Original Port Concept

3.4.4 A common solution for the Gabbro Berth expansion and the Qatalum Port was established in October 2005. The common solution involved the Gabbro Berth expansion extending from the existing Berth and then turning through 90 degrees to follow the line of the filled area. The Original Qatalum Berth would come as an extension of this. In Phase 1 of the Qatalum Project the Berth length would be 500 m, allowing berthing of a bulk ship simultaneously with a container cargo ship. The common solution for the Original Qatalum Port concept and Gabbro expansion is presented in Figure 3.2 below.

Figure 3.2 – Original Port Common Solution



- 3.4.5 This common solution to the Qatalum Original Port concept / Gabbro Expansion would involve dredging a relatively large seabed area for the two projects in combination as a result of construction of the Berths and the required ship turning circle. It was agreed that the dredging material from both projects would be available to Qatalum for use as fill for raising the level of the Qatalum Main Site to its permanent construction level (+ 3.3 m QNHD). The sediments in the areas that would be dredged consist of a large portion of silty materials, and it was estimated that up to 40 - 50% of the dredged material would not be suitable for site preparation. Thus, in order to get the required 5.5 million m³ of fill material required for the Qatalum Project, approximately 9.5 million m³ of the dredged material from the combined Berth construction projects would be needed. However, no further dredging would be required, in addition to that associated with construction of the Berths, solely for the purpose of providing fill material. To manage such large volumes of silty dredged material, an area would need to be allocated for dewatering the dredgings. A large area to the northeast of the Gabbro Storage site was identified for dewatering and disposal of the fine fraction, as indicated in Figure 3.5.
- 3.4.6 In addition to the common solution, SCENR requested MIC to investigate alternative solutions for the Gabbro Berth expansion and a further two options were considered, neither of which were suitable for the Qatalum Project:
- a linear extension to the northeast (i.e. a direct continuation the existing Berth); and
 - construction of a new causeway from the northeast corner of the existing infilled area, leading to an "island" with new berths.
- 3.4.7 All of the options considered for the combined Qatalum Original Port concept / Gabbro Expansion would result in development within the currently undisturbed marine environment at the northern extent of the MIC Industrial Area. Similarly all options would result in a considerable area of the seabed being dredged. However, according to Qatalum's evaluations the common solution, described above, offered the least significant negative impacts to the marine environment overall. The details of these Original port options and their environmental impacts are described in the Gabbro Expansion EIA² and in a separate submission from Qatalum to SCENR in May 2006²⁵.
- 3.4.8 MIC submitted an EIA for the expansion of the Gabbro Berth in January 2006. It was anticipated that SCENR's ruling on this submission would define the terms for the Qatalum Port, since this would just be an extension of the Gabbro expansion project. However, by the end of August 2006, the Gabbro expansion project had not received approval from SCENR and the timescale within which a final decision would be made was not known. In addition, the Qatalum Marine Survey for the Original Port and dredging concept (see Appendix C) indicated that seagrass beds were present in the vicinity of the Original Port and dredge areas. SCENR expressed concerns regarding the potential environmental impact of the above Original concept options, which it is understood primarily relate to the permanent loss of seagrass beds that would arise as a result of the footprint of the new Berths. In view of all of the above factors, Qatalum has worked together with MIC to develop an alternative location for the Qatalum Port Area, which resulted in the Alternative Port concept, located to the south of QASCO.

Alternative Port Concept

- 3.4.9 The Alternative Port concept was proposed by the Ministers Office, with support from MIC, and is located in the existing MIC industrial port area, between Berth 6 (to the north) and Berths 9 & 10 and the Small Boat Harbour to the south (see Figure 3.4 and Figure 3.5). The QASCO steel works, and an electrical substation are located to the north east of the proposed Alternative Port Area; QAFAC, QALCO and the Small Boat Harbour are to the south east. The area to the north west has been set aside for future industrial development. As indicated on Figure 3.4, the Alternative concept would be comprised of the following elements:
- the new Jetty (Berth No 8), which would enable import of bulk raw materials (alumina, coke and pitch);
 - use of the planned MIC Berth No. 7 - SCENR has approved the construction of a section of Berth No. 7 by MIC, as a temporary berth for import of cement; following this Berth 7 could then be completed for use as a container export harbour for aluminium products, as well as petrochemical products from the newly proposed PCC petrochemical complex;
 - a storage area for silos / tanks (for coke, alumina and pitch), which could be located on a strip of land adjacent to the corridor and between the Port and the land allocated for PCC;
 - a service corridor for a conveyor and pipelines; and
 - a seawater intake system, in common with PPC, the exact location of this is subject to further study but is likely to be in the vicinity of the Jetty.
- 3.4.10 The alternative Jetty would be a piled construction with a length of approximately 250 m. The total length of the container berth (Berth No. 7) will be approximately 460 m. The area surrounding the Alternative Jetty has already been dredged to –13 m CD; in order to accommodate the ship sizes anticipated for alumina transport, the Jetty would be designed to –15 m in depth, with 70 m wide pockets alongside to the same depth. In addition, the area south west of the jetty, which has been previously dredged to –10 m, should be deepened to –13 m to provide a turning basin on the south side of the Jetty (Berth No. 8). On this basis, the dredging required to construct the Jetty would generate approximately 1 million m³ of dredged material. This could be partly used to fill the container area behind the planned MIC Berth No. 7 and partly for fill material at the Main Site or the silo area.
- 3.4.11 One of the main differences between the Original Port concept and the Alternative concept is that the dredging requirements will no longer provide the necessary volumes of material necessary for site preparation. Alternatives sources of fill material are being evaluated and these are discussed in a later Section of this report (3.7, Construction and Commissioning).

3.5 SITE LOCATION AND DESCRIPTION

Site Location

- 3.5.1 The Main Qatalum Site will be situated in the north-eastern quadrant of the Mesaieed Industrial City (MIC), within the region of Umm Sa'id (Mesaieed). The MIC Industrial Area is located in a natural bay on the southern coast of the Qatar Eastern Peninsula, approximately 40 kilometres south of the State's capital, Doha (see Figure 1.1). MIC occupies an area of around 117 km²; and consists of an Industrial Area and a Community Area. The Industrial Area occupies an area of around 43 km², which accommodates a variety of industrial plants and well-established port facilities.
- 3.5.2 Figure 3.3 and Figure 3.4 show the general layout and location of the Qatalum Main Site and the two Port concepts, relative to the nearest industries. Aerial photographs, indicating the location of the Qatalum Project area and its immediate surrounding area are presented in Figure 3.5 and Figure 3.6.
- 3.5.3 An area of approximately 2.7 km² was originally allocated for the Qatalum Project. The current plans include the use of approximately 1.4 km² for the Aluminium Plantⁱⁱ and 0.25 km² for the Qatalum Power Plant within this area. The remaining parts of the original site will partly be allocated to an Independent Power Plant (Mesaieed A), to supply the national grid, and partly be left for undetermined future use. A further area of land in the region of ~0.27 km² or ~0.16 km² would be used for the Alternative and Original Port facilities respectively (including the Service Corridor between the Port Area and the Main Site). As per the requirements of the MIC Environmental Protection Criteria, 3.5% of the land-lease area shall be utilised for landscaping purposes.
- 3.5.4 In addition to the Main Site and Port Area, a construction workers' accommodation camp will be built and an area may temporarily be required for storage / dewatering of the dredged materials to be used for infill. The proposed locations of these are indicated in Figure 3.5 and shown in more detail in Figure 3.7. The location of the workers camp will enable workers to be readily and efficiently transported to the Qatalum Site. The south eastern portion of the proposed location for dewatering of dredge materials overlaps with an area that has been proposed for expansion of the Gabbro storage area².

ⁱⁱ In this report, the term "Aluminium Plant" includes the Carbon Plant, Reduction Plant, Casthouse, Anode Service Area, and related utilities.

Figure 3.3 – General Layout and Site Location for Original Port Concept

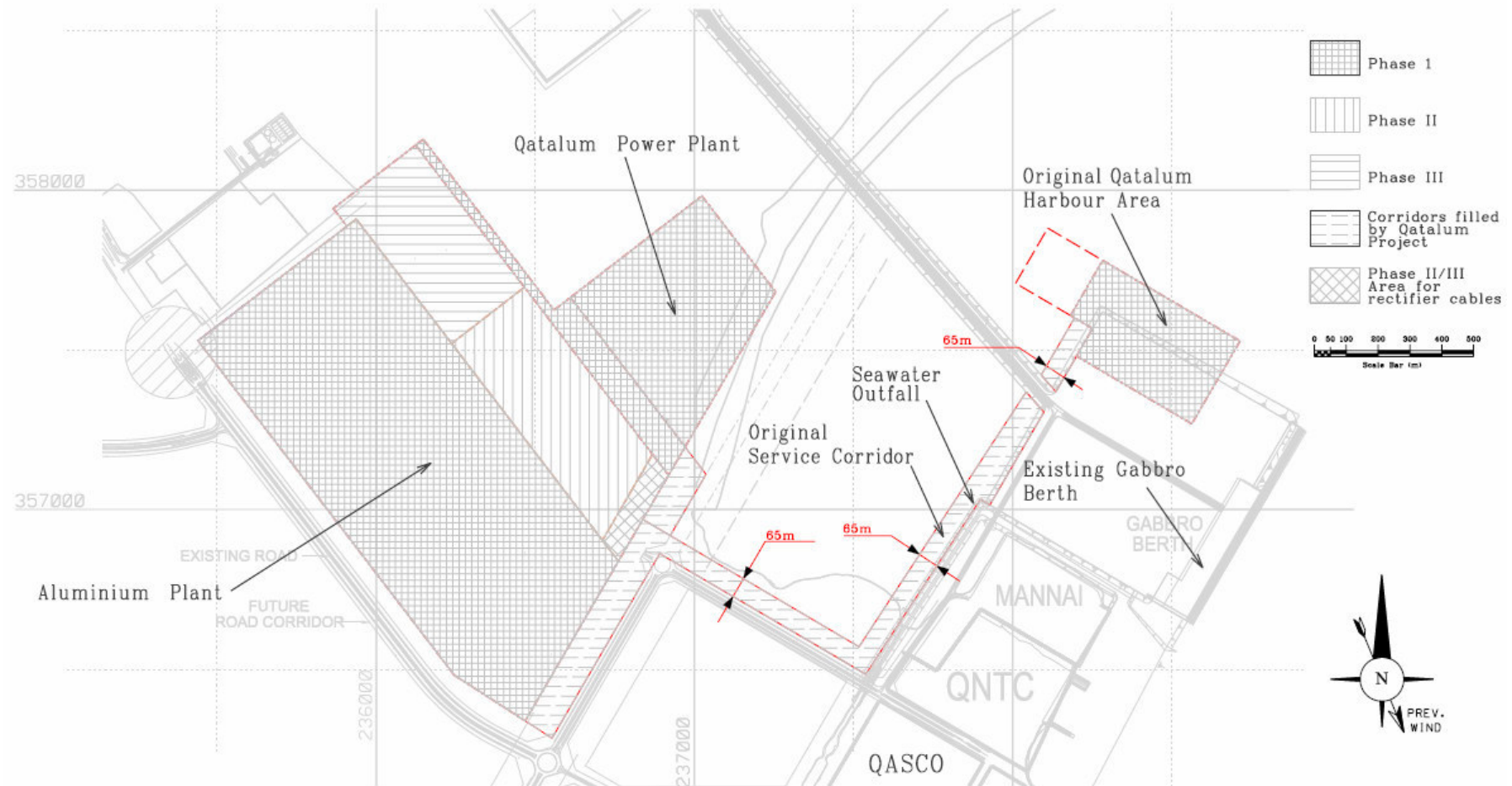


Figure 3.4 – General Layout and Site Location for Alternative Port Concept

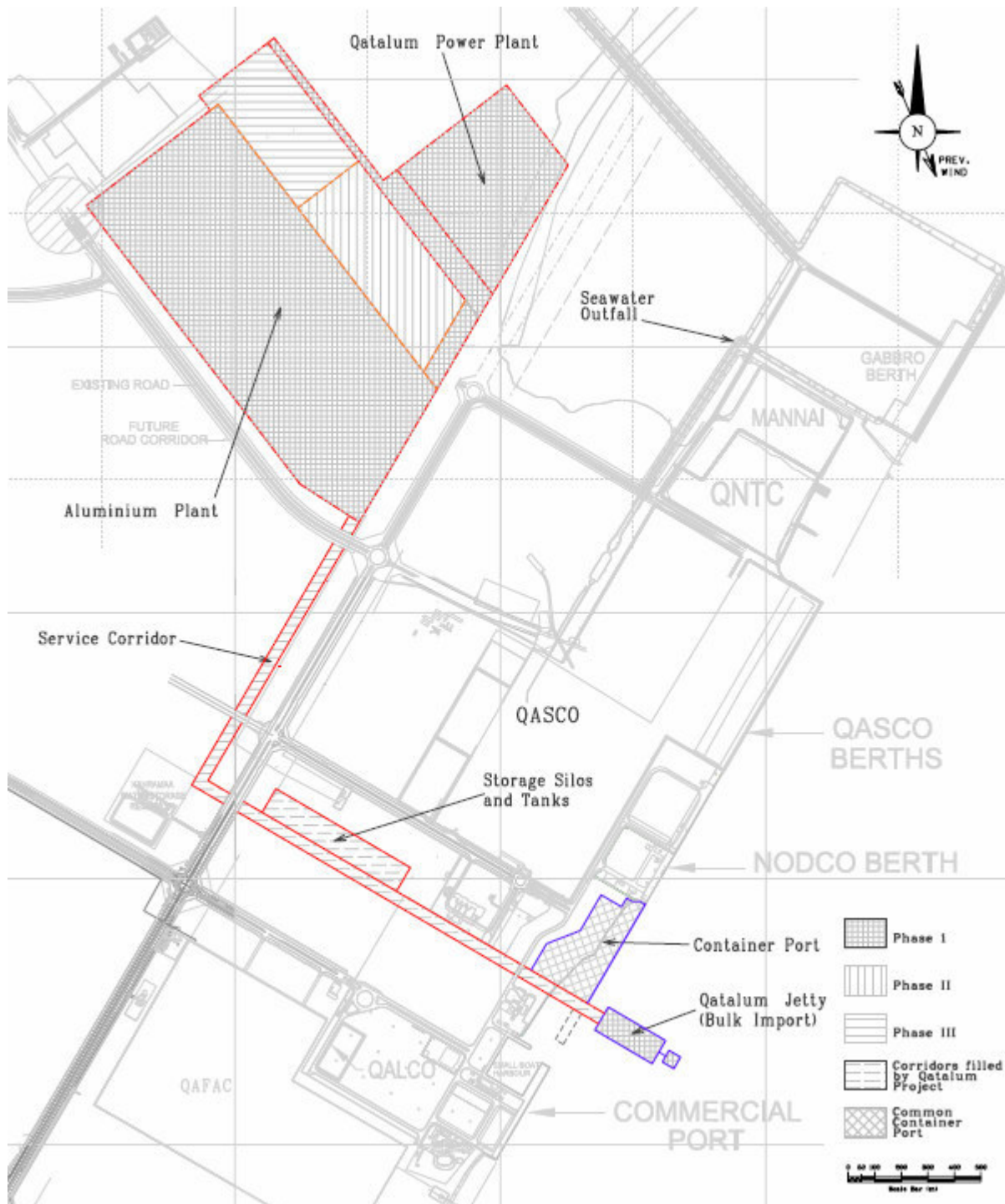


Figure 3.5 – Aerial Photograph of MIC Showing the Qatalum Project Site

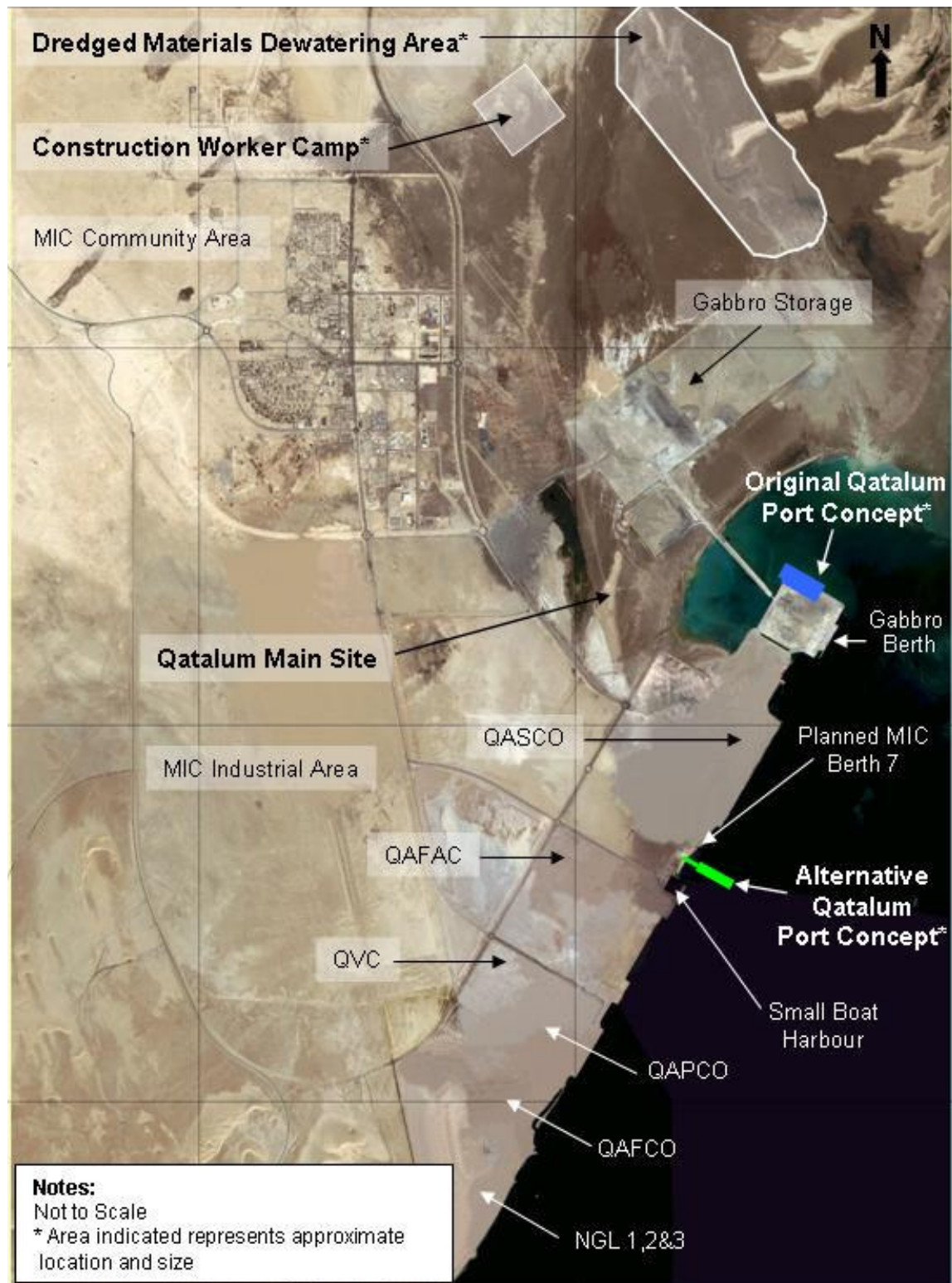
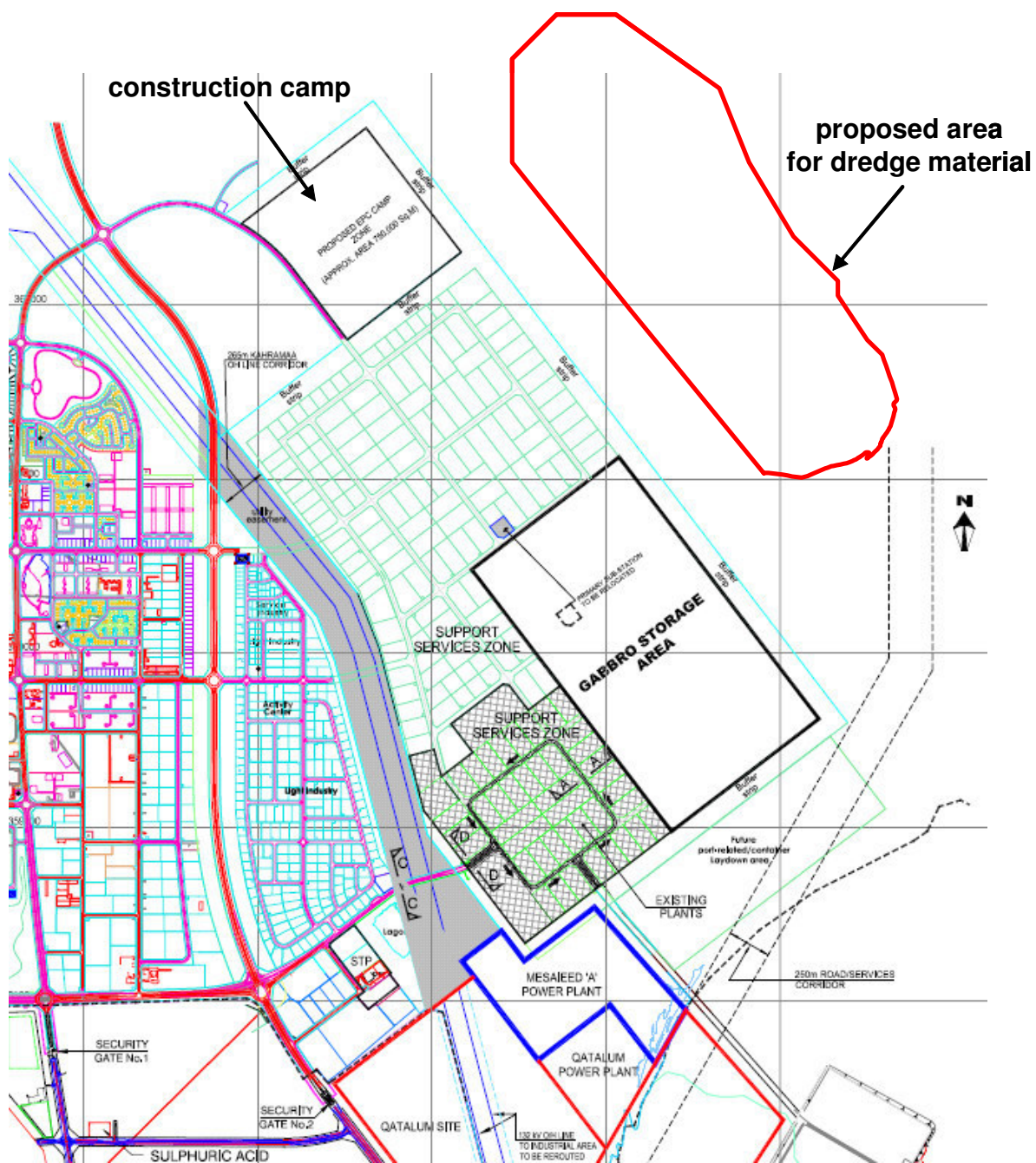


Figure 3.6 – Aerial Photograph of the Qatalum Main Site and Surroundings



Figure 3.7 – Location of Construction Camp and Dredging Storage



Site Description

- 3.5.5 The proposed Main Site for the Aluminium and Power Plant is reported to be an undeveloped site in that historically, no industrial activities have been undertaken at the site; however, part of the site has previously been reclaimed and the surface over much of the site has been disturbed.
- 3.5.6 With the exception of two overhead power transmission lines (132 kV), there is no existing infrastructure present. The overhead power lines will be rerouted prior to construction of the Qatalum facilities. SCENR granted an Environmental Authorisation to Kahramaa to undertake this work; a copy of the approval is presented in Appendix A.
- 3.5.7 There is an area of artificially created reedbed within the western corner of the Main Site, which is associated with the discharge of treated effluent from the neighbouring sewage works; this will be cleared prior to construction. With the exception of the reedbed, no other notable vegetation is present on the site. The Main Site is relatively flat, varying from 0 m to +1.5 m relative to Qatar National Height Datum (QNHD)ⁱⁱⁱ. The final level of the site will be raised to +3.3 m above QNHD.
- 3.5.8 The land in the vicinity of the Original Port concept has been previously disturbed through construction of the existing berth and the causeway. The seabed levels in this area are shallow; seawater depths vary from 0 to 1.5 m in the lagoon area and from 1 m to 5 m within the proposed dredge areas.
- 3.5.9 The onshore area set aside for the Alternative Port facilities, including the service corridor, is currently an unused site, situated between existing MIC industries and infrastructure. The site is a flat, sandy, area comprised of heavily disturbed made ground. The land cover in terms of vegetation is therefore limited; however scattered plants do grow on this made / disturbed ground; the species found are typically hardy and salt-tolerant coastal species. The seabed in area surrounding the proposed Alternative Jetty was dredged to -13 m CD in 1978. Much of the seabed in the wider area has also been disturbed through previous dredging activities (as indicated in Figure 3.8).
- 3.5.10 The construction worker accommodation camp will be built within MIC on an area of land that is currently unused (as indicated in Figure 3.5). The site is a sandy, low lying area with sparse vegetation and no existing infrastructure. It is understood that the MIC Authority will be undertaking improvements to the road surfaces, and access to this area, as part of its future development plans.

ⁱⁱⁱ QNHD is 1.3 m above Chart Datum

- 3.5.11 The site proposed for the storage / dewatering of the silty dredge materials is a currently unused area. The surface of the overall area is frequently encrusted with salt and is virtually devoid of vegetation. In the north westerly extent of the area the substrate is barren tidal flat or "sabkha", very similar to that observed in the construction camp area. Heading in a south easterly direction, fine materials are encountered. Closer to the Gabbro Storage area there are engineered drainage channels, which are understood to arise as a result of historical dredging / dewatering activities. The engineered channels open into a low lying coastal area and an asphalt track has been constructed from the end of the channels to the sea, presumably to enable access and to enable monitoring of the water run-off to be undertaken.
- 3.5.12 Photographs of the Main Site, Port Area, Construction Camp, dredge materials Dewatering Area and the general surrounding areas are included Chapter 5 and in Appendix B (Baseline Soil and Groundwater Investigation), Appendix E (Baseline Terrestrial Ecology and Birds) and Appendix F (Noise Survey and Assessment).

3.6 PROJECT SCHEDULE

- 3.6.1 The key projected Project milestones are presented below:
- approval of expenditure proposal (CEP): October 2006;
 - contract for potroom building infrastructure and utilities, including front end engineering and design (FEED): September 2006;
 - start of site preparation and dredging: January 2007;
 - major contracts awards: August – December 2007;
 - first power from Power Plant: August 2009;
 - first metal: November 2009; and
 - full production: June 2010.

3.7 CONSTRUCTION AND COMMISSIONING

General

- 3.7.1 Part of the Contractor(s) obligations will be to provide full construction method statements and HSE management plans; however, an overview of the construction and commissioning stages of the Project are presented below.
- 3.7.2 It is anticipated that the first construction contract for the dredging, construction of the Qatalum Port Area / Jetty and site preparation will be awarded in late 2006. General construction work will commence in September 2007. The construction and commissioning period is planned to last for approximately 30-36 months.
- 3.7.3 The major elements of the construction programme will be the dredging activities, and (for the Alternative Port concept) import of dry fill material, required to construct the Qatalum Berth / Jetty and the filling and levelling of the Main Site. During construction, the final level of the Main Site will be raised to +3.3 m above QNHD.

Site Preparation and Dredging

3.7.4 The fill requirements for the Project are in the region of 5-6 million cubic meters. As noted previously, for the Original Port concept, the fill requirements could be met through the combined dredging for the Qatalum / Gabbro Berth Expansion projects. For the Alternative Port concept, fill material is expected to be obtained through a combination of sources, these are discussed further below and include:

- quarried materials;
- dune sand from within MIC (which has already been approved for removal);
- silty fines from previous dredging activities that have been stockpiled
- the material from dredging required to construct the Jetty; and
- material from further dredging in areas near the Alternative Port which are likely to be dredged in the future, this could involve deeper dredging in areas that have already been dredged and / or dredging in new areas.

3.7.5 Qatalum plans to prioritise the use of materials from non-dredge sources to minimise the amount of dredging required solely to provide fill material, so far as this is possible. Due to the physical / geotechnical properties required for fill material for the Qatalum Site, careful consideration will be given to how much material from each source can be used. The final ratio of each of these sources has not yet been determined; based on preliminary consultations and evaluations a mix of these sources is likely. The factors that need to be taken into account in deciding on the optimum mix of sources are discussed further below.

Quarry Materials

3.7.6 For environmental reasons, Qatar has set an objective to close down quarry activities; however, the expansion of the Gabbro Berth is necessary to allow this objective to be achieved. In the meantime, quarries are still licensed to operate and Qatalum has been in contact with quarries that could supply the necessary quantities of fill materials.

Dune Sand

3.7.7 A sand dune, near the Q-Chem site, within the MIC Industrial Area, has been approved for removal; preliminary enquiries indicate that some of the sand could be made available to the Qatalum Project. However, to ensure that the overall fill has the appropriate geotechnical properties, only a certain percentage of sand, probably 10 – 20%, can be used in a mix with other materials.

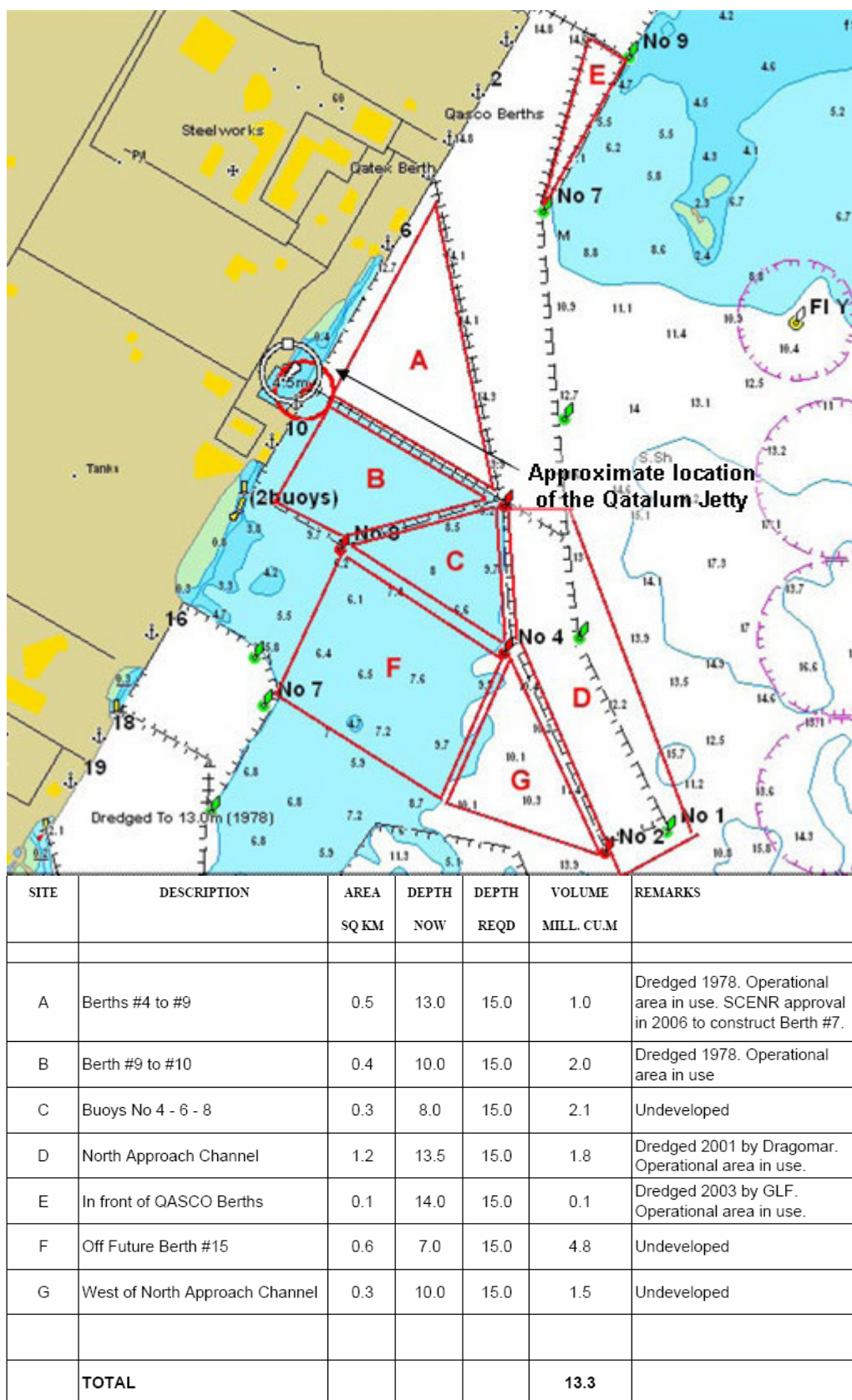
Previously Dredged Materials

3.7.8 Materials from historical dredging activities have been stockpiled near the Gabbro Storage Area. Most of this material is silty, and only a small fraction of this could be used as a mixture with sand, quarry materials and new dredging materials. At this stage, the availability of such materials has not been verified.

Further Dredging

- 3.7.9 MIC has identified seven potential areas that could be dredged to provide fill material, should this be required. Figure 3.8 indicates the location of these potential dredge areas and provides a brief description of each area and the potential dredging volumes. Four of these areas (A, B, D and E) have been previously disturbed through historical dredging activities. A dive survey and underwater video footage has been undertaken for the remaining possible dredge sites (C, F and G); these indicated that these areas are flat, featureless and consequently of very minimal ecological value.
- 3.7.10 The dredged materials from areas A-G would probably be of better quality, for fill purposes, than that from the Original Port location; thus, the potential dredging volumes required to supply sufficient fill are likely to be less than those required for the Original Port concept. Furthermore, dewatering and treatment of dredge water run-off will be easier to handle than that associated with the silty materials from the Original Port location. Nevertheless, the distance from areas A-G to the main site, as well as possible crossings of roads and/or the shipping lane, represent challenges that require further study before it can be decided whether dredging is a competitive and viable option compared with the other alternative sources of fill discussed above.
- 3.7.11 For the purpose of the EIA report, the following three dredging scenarios have been considered for the Alternative Port concept:
- scenario 1 - minimum dredging for the construction of the alternative Jetty; site fill material mainly sources from onshore materials;
 - scenario 2 - dredging to take place only within areas that have been dredged previously, fill material to be supplemented with onshore sourced materials (this would mainly involve dredging in areas A and B on Figure 3.8; Area D (within the existing navigation channel) is also a possibility, but this has not been considered further since dredging in the existing shipping channel whilst it is operational is challenging from a logistical and safety perspective); and
 - scenario 3 - dredging to provide the sole source of fill material; this would involve dredging areas A, B, C and F on Figure 3.8.
- 3.7.12 An area may temporarily be required for storage / dewatering of any dredged materials to be used for infill. The currently proposed location of this area is shown in Figure 3.7; this area is currently the same for both the Original and Alternative Port concepts. For practical reasons, discussions are on-going to determine whether an alternative site, closer to the Alternative Port / dredging area, can be made available. Furthermore, depending on the volume and nature of the materials to be dredged for the Alternative concept, dewatering on the dredging barge may be an option.

Figure 3.8 – Possible Dredging Areas for Alternative Port Concept



- 3.7.13 In addition to the fill and dredging works, construction is likely to involve the following activities:
- further ground investigation works;
 - site levelling and drainage;
 - piling;
 - concreting;
 - structural steelwork;
 - equipment installation;
 - piping and ducting;
 - refractory work;
 - cabling; and
 - road preparation.
- 3.7.14 The construction site will require a variety of facilities and services including: water, power, storage facilities, lay-down area, maintenance area, and temporary office accommodation. Construction infrastructure and facilities will be established in a progressive manner based on the site requirements.
- 3.7.15 A single Contractor will be responsible for the provision of the main utilities and services required for construction. The construction workforce will be housed in camps away from, though in ready travelling distance of, the site (see Figure 3.7). The construction camp facilities will include: toilets, washrooms, food preparation, sleeping accommodation etc.
- 3.7.16 As the different systems, buildings and process areas are completed, they will be commissioned by the operation organisation with assistance of the various Contractors.

3.8 DECOMMISSIONING

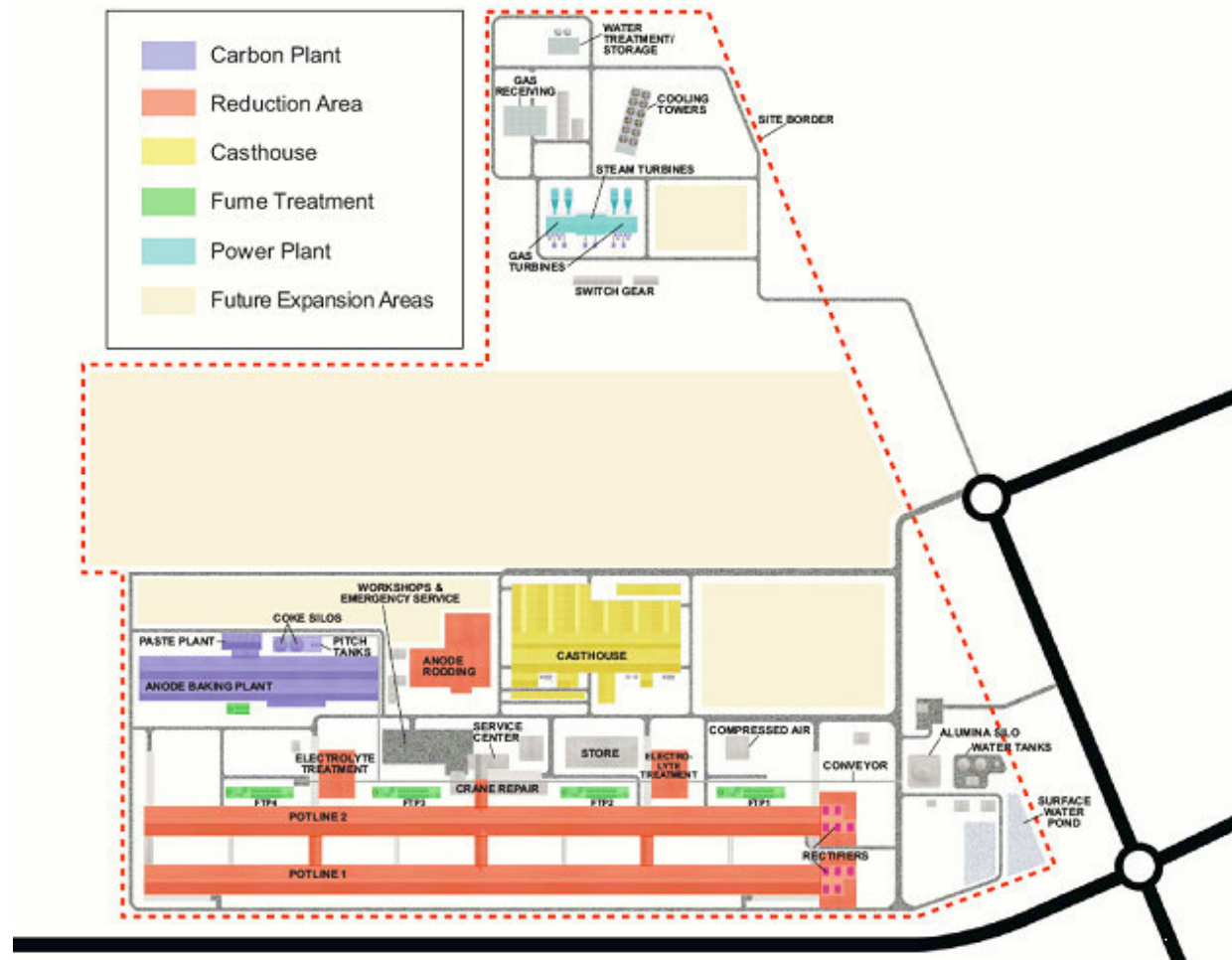
- 3.8.1 The plant is planned to operate for at least 40 years. If further production is not feasible, operation will cease and the plant will be decommissioned. The objective will be to return the site to its pre-project condition as far as practicable. At this early stage in the Project, no further information is available relating to the decommissioning phase of the Project. However, as a guideline, it is anticipated that decommissioning activities will be similar to those that could occur during the construction phases of the project. At the end of plant life, and prior to decommissioning, a detailed EIA will be undertaken to address environmental impacts associated with decommissioning, thus, decommissioning is not discussed in any further detail in this report.

3.9 OPERATION – MAIN SITE LAYOUT

- 3.9.1 An overview of the proposed Main Site layout is presented in Figure 3.9. At this stage in the Project, the layout may still be subject to minor refinements.

- 3.9.2 The proposed layout represents a change from the original plans. Initially, it was planned to utilise the flooded area and lagoon to the south east of the site and locate the Aluminium Plant as close to the Original Port concept (i.e. the Gabbro Berth area) as possible, in order to minimise the transport distances for raw materials and products. However, the geotechnical investigations revealed that eastern part of the site is very soft and that the dredged materials from the Original Port concept dredge areas would be soft with a high content of silty clay. These two factors would mean a more costly site preparation and, possibly, a longer period for settlement of the reclaimed materials before building construction could begin. Furthermore, questions were initially raised by SCENR regarding the possible ecological value of the lagoon area and the minimisation of land-take. As a result of all of these factors the plans for the site layout were re-evaluated. The current site layout takes into account the principles of sustainable development in that it aims to minimise land-take, the requirement for fill materials, dredging activities and the amount of coastal area taken, so far as this is possible.
- 3.9.3 Phase 1 of the Qatalum Project will therefore be located to the far west of the site as indicated in Figure 3.3 / Figure 3.4. The initial site preparation will however cover the whole area dedicated to the expanded Aluminium Plant. The lagoon will not be utilised for the currently planned development.
- 3.9.4 The dedicated Power Plant will be located to the east of the Aluminium Plant, as per the layout indicated in Figure 3.9. The initial capacity will be in the order of 1350 MW, with sufficient space for expansions to cover Phases 2 and 3 of the Qatalum Project expansions.
- 3.9.5 In addition to the Aluminium Plant and the dedicated Qatalum Power Plant, an area has also been allocated, adjacent to the Qatalum Power Plant and to the north east of the Aluminium Plant, for development of a separate power plant for exporting power to the Qatari National Grid System. This power plant (Mesaieed A) will be developed by an Independent Power Producer (IPP) and will be assessed in a separate EIA.

Figure 3.9 – Proposed Phase 1 Main Site Plant Layout



3.10 OPERATION - PROPOSED PLANT AND CAPACITIES OVERVIEW

- 3.10.1 The first phase of the Project is designed to produce 585,000 tonnes per year (t/yr) of liquid aluminium. This Section gives an overview of the main equipment, plant and facilities required for the Project and their capacities. A description of how the process works, and interactions within the plant is provided in the following Section - 3.11 Operation - Process Description
- 3.10.2 All equipment, facilities and components will be designed, assembled and tested according to the Project's General Technical Specifications. Equipment and component parts will also conform to the relevant standards/norms published by the Government of Qatar. In the event that suitable Qatari Standards are not available appropriate international standards will be used.
- 3.10.3 The Qatalum facilities can be divided into the following major plant and associated services which are described further below:
- a Carbon Plant, where anodes are formed (Paste Plant) and baked (bake furnace);
 - an Anode Service Area, where used anodes are removed from the anode hangers and new anodes are rodded and stored;
 - a Reduction Plant containing two full potlines, where alumina is reduced in an electrolytic process to liquid aluminium;
 - a Casthouse, where liquid aluminium is cast to form products such as extrusion ingot and primary foundry ingots;
 - a combined cycle gas fired Power Plant;
 - a Port Area with associated storage and transport facilities; and
 - utility/auxiliary services - gas distribution, cooling water systems; compressed air, warehouses/storage buildings etc;

Summary of Phase 1 Plant Capacities

- 3.10.4 A summary of the design capacity for the main plant is given in Table 3.1. The figures in Table 3.1 are nominal capacities. The EIA has been based on mass balances for a production rate of 585,000 tonnes per year of primary aluminium; however, it is anticipated that further optimisation of the operation may allow an increase in production of up to 600,000 tonnes per year, without major modifications and whilst still enabling the plant to operate within the estimated emissions rates presented in this report.

Table 3.1 – Approximate Phase 1 Main Plant Capacities

Plant	Product	Capacity	Units
Carbon Plant			
Paste Plant	green anodes	410,000	t/yr
Anode baking plant	finished anodes	370,000	t/yr
Reduction Plant			
Potlines	liquid aluminium	585,000	t/yr
Casthouse			
	aluminium products	625,000	t/yr

Future Development Scenarios

- 3.10.5 The layout of the initial development will be optimised to facilitate a later doubling of the initial capacity; with the final Aluminium Plant capacity being approximately 1.2 million t/yr. After the initial (Phase 1) development, future expansion may take place in two further stages: Phase 2 – installation of potline No.3 and Phase 3 – installation of potline No.4. A summary of the potential expansions, in the context of the initial development, is given in Table 3.2. The potline expansions would be accompanied by parallel expansions of the Anode Plant, Casthouse, Power Plant and other services.

Table 3.2 – Summary of Potential Project Development

Phase	Potline No	No of Cells	Liquid Al Production (t/yr)	Overall Al Production (t/yr)
1	1 & 2	704	600,000	600,000
2	3	352	300,000	900,000
3	4	352	300,000	1,200,000

- 3.10.6 The details and the timing of these future expansions have not been decided. However, the potential environmental impacts of the most critical parameters have been considered during the EIA process, to ensure that the local environment has a capacity for such a large development, and to identify mitigative measures that may need to be introduced from the offset in order to reduce impacts to an acceptable level. Prior to the commencement of any future expansion of the Qatalum Phase 1 Plant, a full EIA will be undertaken and submitted to SCENR in accordance with Qatari requirements.

3.11 OPERATION - PROCESS DESCRIPTION

Introduction

- 3.11.1 This Section aims to describe the overall processes involved in producing aluminium at the Qatalum plant. The focus is on processes that result in emissions under typical operating conditions; however, non-typical operational events (such as start-up of the reduction process) are also discussed.

- 3.11.2 This process description is based on the technologies that have already been selected during the development of the Project design. The following Section (3.12 – Technology Selection and BAT) discusses what is considered BAT for each element of the Project, and justifies how this has been incorporated into the design, in terms of both the main technology selection and the minimisation of emissions. Although some information is provided in this Section on emissions and wastes, further details are provided in Section 3.12 and Section 3.15 – Emissions and Wastes. As noted in Section 1.5, at this conceptual stage, some of the detailed design for the Project has yet to be completed, or will be confirmed by the Contractor, thus, some of the available information is relatively generic.

Carbon Plant (Anode Production)

Overview

- 3.11.3 Carbon anodes are required for electrolytic reduction of aluminium oxide to aluminium in the potlines. During this process the anodes are consumed; the net consumption of anodes is approximately 0.4 tonnes per tonne aluminium produced. The top portion of the anode is not consumed (this is recycled in the process), thus, gross production of anodes is in the order of 0.5 tonnes per tonne of aluminium.
- 3.11.4 The anode production facilities (the Carbon Plant) will comprise two main sections: the Paste Plant and the Bake Plant. A generic block diagram of a Carbon Plant is shown in Figure 3.11.
- 3.11.5 As well as the main production lines, the Carbon Plant area will house a number of ancillary buildings and storage facilities including: a control room; offices; maintenance shop; spare part store; cleaning station; green and baked anode storage; pitch storage tanks; storage silos for coke; and scrap silos.

Paste Plant

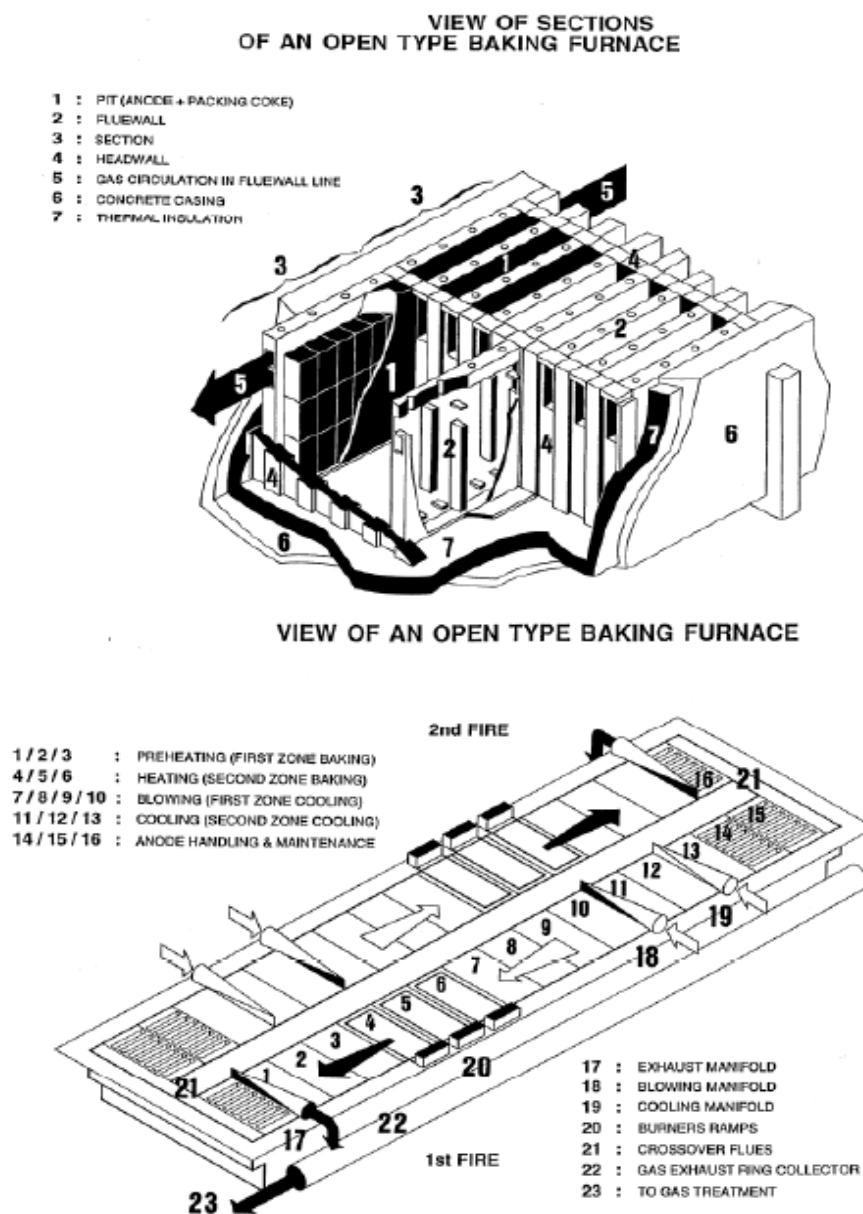
- 3.11.6 The main unit operations of the Paste Plant processes include;
- raw materials preparation - screening of coke for the Bake Plant (see below), pre-crushing of butts and coke, if required, for the Paste Plant and controlled blending of raw materials (coke, butts and recycled green anodes);
 - aggregate fractioning - screening / diminution of oversize and overflow aggregate by crushing and milling;
 - metering;
 - preheating;
 - paste mixing – this is the first homogenization step and crucial to product homogeneity; the mixing temperature at the aggregate/pitch inlet will be up to 190 °C, paste will be cooled to a maximum of 40 °C
 - green paste forming - vibro-compaction of the green paste to blocks and alphanumeric coding; and
 - cooling of green blocks and paste by water spray.

- 3.11.7 In simple terms, petroleum coke is mixed with pitch and crushed residues from used anodes and recycled off-spec anodes to form a paste. The mixed materials are heated, homogenized, cooled, formed into anode blocks in a vibrating compactor and cooled further.
- 3.11.8 The heat supply for the paste plant operations is provided by gas-fired hot oil heaters with ring main distribution to the actual consumer areas.
- 3.11.9 Cooling first occurs when cooling water gets into contact with the hot paste and evaporates. After compacting, the green anodes are further cooled to allow their handling and transportation by mechanical devices to the anode storage area or directly to the baking furnaces. This takes place by direct water spray in a ventilated cooling tunnel.
- 3.11.10 Off-gas from the Paste Plant, resulting from the use of hot pitch, is collected and treated using a regenerative thermal oxidation (RTO) process. Dust and pitch fume from material storage and handling is also collected and treated. The RTO and dust / fume treatment processes are described further in the following Section (3.12); the resultant emissions and wastes from the process are presented and summarised in Section 3.15.
- 3.11.11 For quality reasons, some product rejects (paste and/or blocks) will be generated; however, these will be recycled back into the process. The reject paste will be handled through a hooded conveyor/storage bin; blocks will be rejected after the cooling channel to eliminate pitch fumes from subsequent crushing and recycling. The fume from the paste handling system, will route to the RTO described above.

Bake Plant

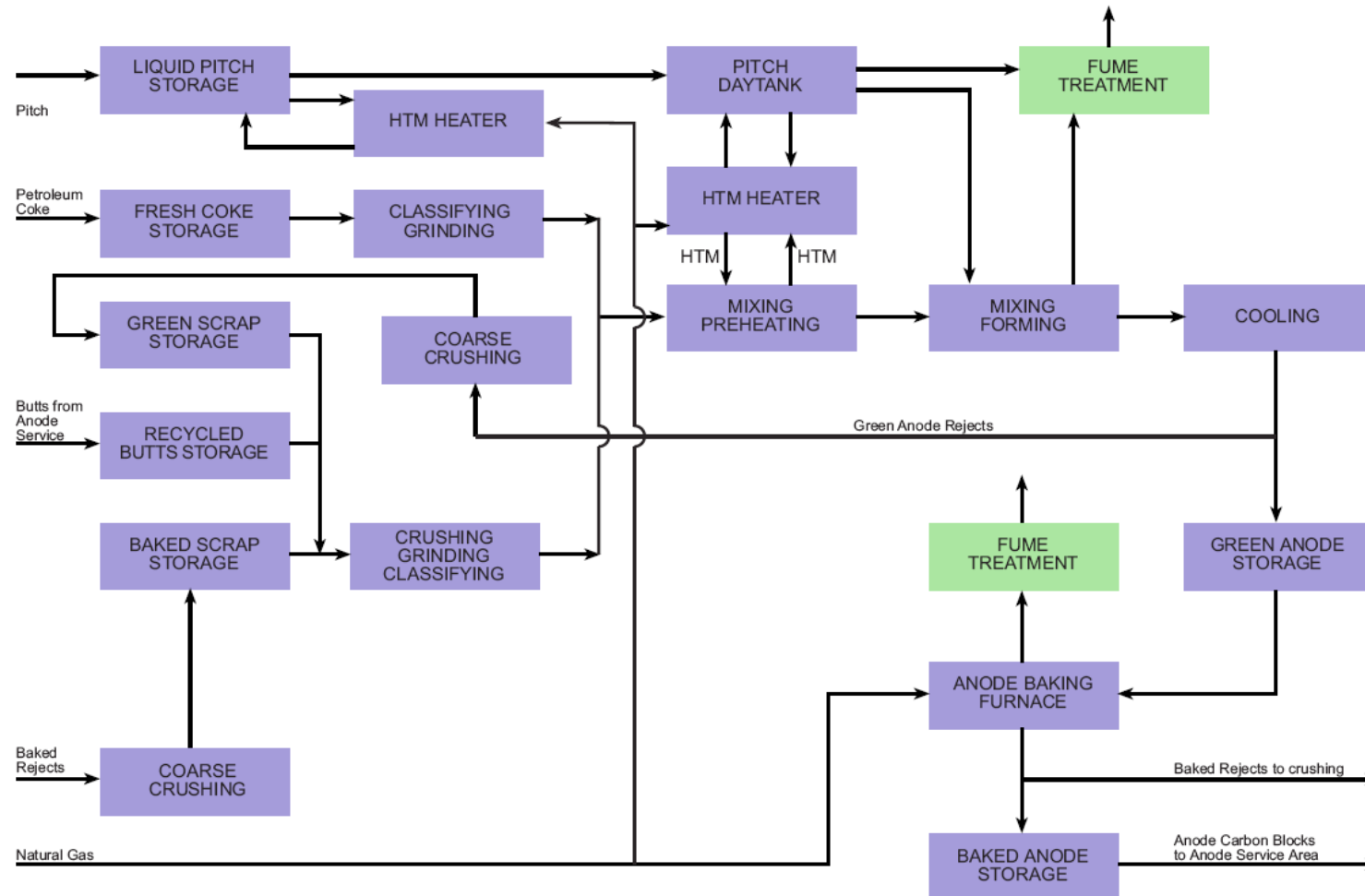
- 3.11.12 The green anodes are baked in two open, gas-fired, baking furnaces. A baking furnace is arranged in two parallel rows, with flue crossover channels at each end. The green anodes are stacked into pits of the baking furnace and packed with coke before undergoing a pre-heating, baking and air-cooling cycle. Baking is carried out by mobile fires fed with natural gas; temperatures reach a peak of 1250 °C in the flue gas and in excess of 1100 °C in the anodes. A general view of a typical anode open baking furnace is presented in Figure 3.10.
- 3.11.13 During the baking process, the pitch is partially carbonised and evaporated, leaving a dense, hard anode block. After air-cooling in the furnace, the baked anodes are conveyed to a cleaning station to loosen granular material off the surfaces and from the holes. Rejected anodes will be marked and diverted on a reject conveyor to the butt crushing system for recycling in the Paste Plant.
- 3.11.14 The Bake Plant furnaces are operated under negative pressure to ensure the collection of all emissions, which are treated in a dry scrubber system. Dust from material storage, handling and cleaning activities is also collected and treated. The dry scrubber and dust treatment processes are described further in the following section; the resultant emissions and wastes from the process are presented and summarised in Section 3.15.

Figure 3.10 – General View of an Anode Open Baking Furnace



Note – Figure provided courtesy of the EU BAT reference (BREF) documents for the non-ferrous metals industry⁷.

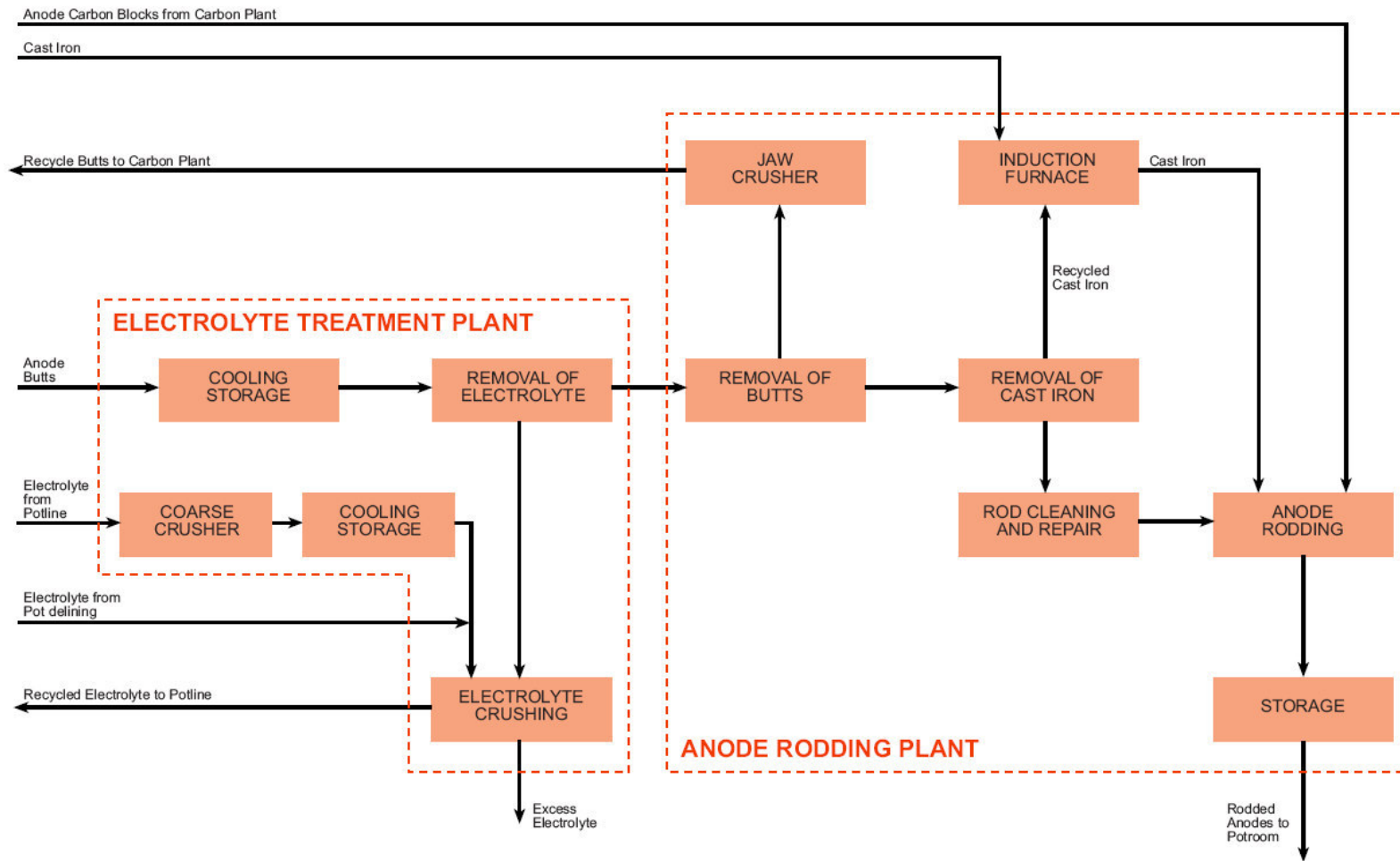
Figure 3.11 – Generic Block Diagram for Carbon Plant



Anode Service Area

- 3.11.15 The Anode Service Area (ASA) will meet the demand of rodded anodes and crushed electrolyte for the Reduction Area.
- 3.11.16 The ASA has two main functions:
- butt cooling and electrolyte handling; and
 - anode rodding.
- 3.11.17 The main operational interface between the Anode Service Area and the Reduction Plant is Electrolyte Treatment Plant, located close to the potlines. This consists of two buildings, which will receive the anode butts with electrolyte covering, electrolyte material from the potrooms and electrolyte from the pot de-lining process.
- 3.11.18 The anode butts are cleaned to remove the electrolyte and the cleaned butts are sent to the Rodding Plant. Recovered electrolyte material from the butts and the Reduction Plant is crushed, screened and stored in a silo prior to being returned as insulating cover material to the anodes in the potlines. Any surplus electrolyte will either be sold (recycled) to other potential users, in the event that supply out weighs demand, the any remaining electrolyte can be disposed of as a waste. The atmospheric emissions from the electrolyte crushing process (fluoride containing dusts) will be routed to the Fume Treatment Plant in the Reduction Plant.
- 3.11.19 The main operational interface between the ASA and the Carbon Plant is the Rodding Plant, which consists of one building. In the Rodding Plant, butts and iron thimbles are removed from the hangers. The hanger (rod) is cleaned prior to reuse in the rodding shop; the thimbles are also recycled. The clean carbon butt is transferred to the crushing unit in Carbon Plant for reuse in the Paste Plant. The cleaned and new hangers are “rodded” with fresh baked anodes from the Carbon Plant. All freshly rodded anodes (and empty electrolyte pallets) are collected from the ASA for use in the Reduction Plant.
- 3.11.20 The ASA will have dust control / collection systems installed at locations where dust generation is expected (e.g. crushing activities etc). Where feasible the collected dust will be recycled into the process. Other than dusts, there are no significant emissions anticipated from the ASA.
- 3.11.21 A schematic of the anode service plant is presented in Figure 3.12.

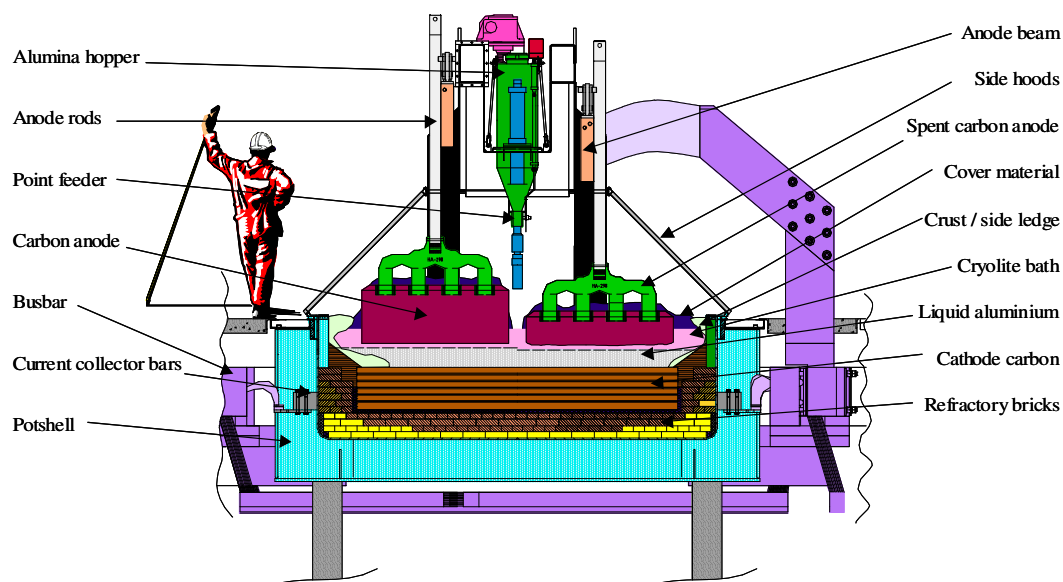
Figure 3.12 – Anode Service Area Schematic



Reduction Plant

- 3.11.22 Aluminium will be produced by the Hall-Héroult electrolysis process, using the Norsk Hydro reduction technology (HAL 275). This process occurs in large steel containers called pots or cells. The Reduction Plant will be housed in two long buildings (approximately 1,150 m in length), called potrooms. The two potroom buildings will be located adjacent and parallel to each other. Each potroom will house two rows, or lines, of 176 pots per row, giving a total of 352 pots in each potroom.
- 3.11.23 Each pot consists of a steel shell lined with refractory bricks, and carbon blocks serving as the cathode. The pot is fitted with a super-structure that supports the carbon anodes, and which stores and feeds alumina into the pots. A schematic drawing of a pot is shown in Figure 3.13 and a schematic of the Reduction Plant is presented in Figure 3.14.

Figure 3.13 – Pot Cross Section Schematic

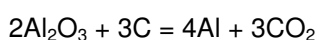


- 3.11.24 Lightweight aluminium side hoods are fitted over the superstructures to confine the pot gases. The pot off-gases are ducted to a gas collection system and transferred to a treatment system. The fume treatment processes include dry scrubbing and wet scrubbing; these are described further in Section 3.12; the resultant emissions and wastes from the process are presented and summarised in Section 3.15. The side hoods are only removed for anode changing, tapping of metal and pot servicing. During the removal of the side hood, additional suction is applied to the cell, from the pot gas collection system, to reduce the escape of pot gases directly into the potroom atmosphere.
- 3.11.25 Special overhead travelling cranes, called Pot Tending Machines, perform the necessary servicing operations to change anodes on the pots. Spent anodes and electrolyte debris are placed by the Pot Tending Machines on transport pallets, and are immediately transported to the Anode Service Area by special vehicles.

- 3.11.26 In addition to the main plant, the Reduction plant will house: four Fume Treatment Plant (FTP) units (comprising dry scrubbing with alumina and wet (seawater) scrubbing); materials storage and distribution systems; rectifiers to supply 300 kA DC current to the potlines; a pot relining workshop; a crane service workshop; main operations centre; and central control room.

Reduction Process

- 3.11.27 Electricity enters the pot via the anodes. The electric current flows through the electrolyte to the cathode, after which it flows to the anode of the following pot. The electrolyte consists principally of cryolite (Na_3AlF_6) and aluminium fluoride (AlF_3). The alumina (Al_2O_3), a white powder, is added automatically to the electrolyte. The alumina is dissolved in the electrolyte and reduced through the electrolytic process to form molten aluminium. The aluminium forms and accumulates at the cathode, below the surface of the electrolyte. The electrolytic reduction of alumina (Al_2O_3) occurs as follows:



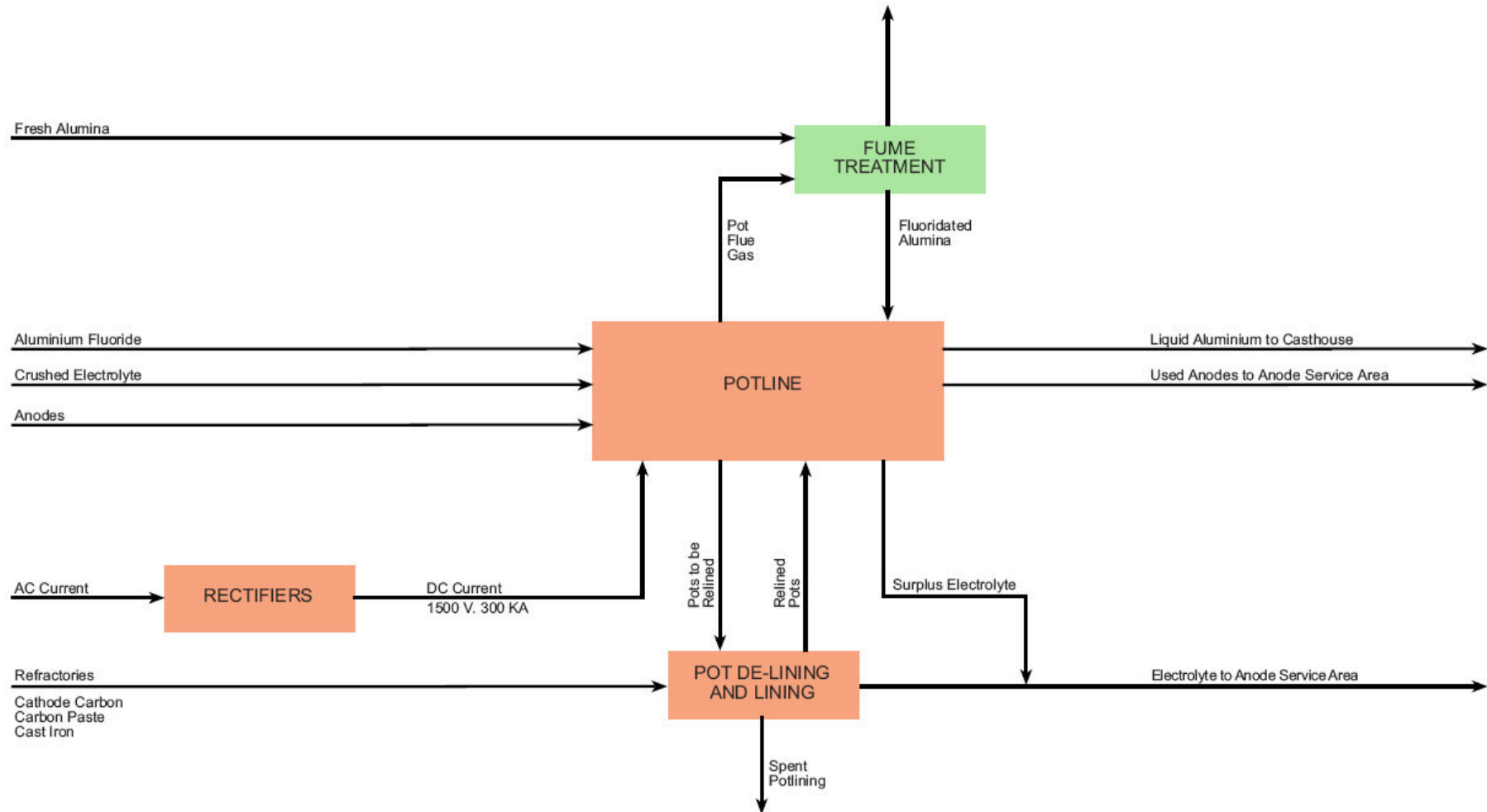
- 3.11.28 The carbon required for reduction is provided by the anode, which is consumed in the process. Molten aluminium from the pots is periodically siphoned out of the pots, by vacuum, into refractory lined crucibles. The crucibles are transported to the Casthouse by special tapping vehicles.

Pot Relining

- 3.11.29 The pot lining lasts on average for 5-7 years. During shutdown of a pot, electrolyte and metal is tapped out in a controlled manner and the emissions to the potroom are kept to a minimum. At the end of its useful life, the pot is removed from the potroom and conveyed to the pot relining shop to be relined. Owing to the quantity produced and the content of fluoride and cyanide, spent pot liner (SPL) is the main and most significant hazardous waste produced by an Aluminium Plant. Atmospheric emissions of fluoride containing dusts, arising from the de-lining process, will be routed to the Reduction Plant Fume Treatment Plant.
- 3.11.30 After some years of operation, relining of the pots will take place regularly at a rate of approximately one pot per potline per week. When the pot has been relined, it is transported back to the potline by overhead crane and re-installed. During the start-up of a new reduction cell, the cathode is first preheated with reduced electrical current for 46 hours. During this period the carbon ramming paste is hardened and the cathode is heated up to 850 °C. The pot is hooded during the preheating and the suction system is connected to prevent the off-gases, which contain PAH, from entering the potroom building.
- 3.11.31 When the pre-heat period is complete, the pot is connected to full current and liquid electrolyte is poured into the pot. After a while the pot then enters into a "start-anode-effect" mode that lasts for 45 minutes. The "anode effect" is a state where the voltage across the cell increases, causing increased heat release and increased generation of fumes and dust, including PFCs.

- 3.11.32 During the first two days of a start-up, the pot will have increased suction from the pot-gas collection system. This helps to control the temperature and the emissions to the potroom building. Despite the increased suction there will be increased emissions from the pot due to the many interventions that require opening of the cell during start-up. However, the contribution from one single pot in start-up mode is insignificant in relation to the other 351 pots in the potline.

Figure 3.14 – Reduction Plant Schematic



Casthouse

Overview

- 3.11.33 The Casthouse facility is designed to convert molten aluminium from the potlines into different products. The main products will be extrusion ingots (EI) and foundry alloys (FA), which will be cast as T-bars, standard ingots and mould ingots.

Casting and Moulding

- 3.11.34 Liquid aluminium is removed from the pots by tapping vehicles and transport to the Casthouse. Prior to casting, the molten aluminium, from the potlines, is treated in fluxing stations to remove impurities. Fluxing is carried out using aluminium fluoride and argon. The waste from fluxing activities, called dross, is cooled and packed for recycling elsewhere.
- 3.11.35 Casting takes place in the casting lines, which consist of casting furnaces and casting machines. Cold aluminium and alloying materials^{iv} are fed to the casting furnaces and preheated (with gas-fired burners) to ensure moisture removal. The furnaces are then charged with the molten aluminium from the fluxing area. The surface of the metal is then skimmed to remove further dross. After dross removal, the molten product is poured into moulds and cast into its final product forms. A schematic diagram of the casting plant process is shown in Figure 3.15.

Foundry Alloy (FA)

- 3.11.36 The selection of the casting machines for producing T-bars and standard ingots has not yet been finalised. Details of the casting machine for mould ingots are given below.
- 3.11.37 The mould ingot casting machine will consist of a continuous moving chain of moulds to produce ingots of aluminium foundry alloys. The molten metal is cooled as the chain of moulds moves along a water-quenching chamber. When solid, the ingot is removed from the mould and conveyed through a water spray chamber, to cool it further. The mould ingots are then automatically stacked into bundles, weighed and packed for storage and shipment.

Extrusion Ingots (EI)

- 3.11.38 Extrusion ingots will be moulded in a vertical direct chilled (VDC) casting machine, consisting of water-cooled casting moulds suitable for casting extrusion ingots up to 7.5 m long. As the metal is being cast, the casting mechanism is slowly lowered and the ingots are solidified by the continuous spraying of direct contact cooling water. After casting, the extrusion ingots are treated in gas fired homogenizing furnaces and sawed to the required length, weighed and transferred to the storage area. A schematic of the extrusion casting process is presented in Figure 3.16.

^{iv} The following alloying materials may be used: silicone, magnesium, manganese, iron, copper, strontium, titanium and Al-Ti-B (Aluminium-Titanium-Boron).

Figure 3.15 – Casting Plant Schematic

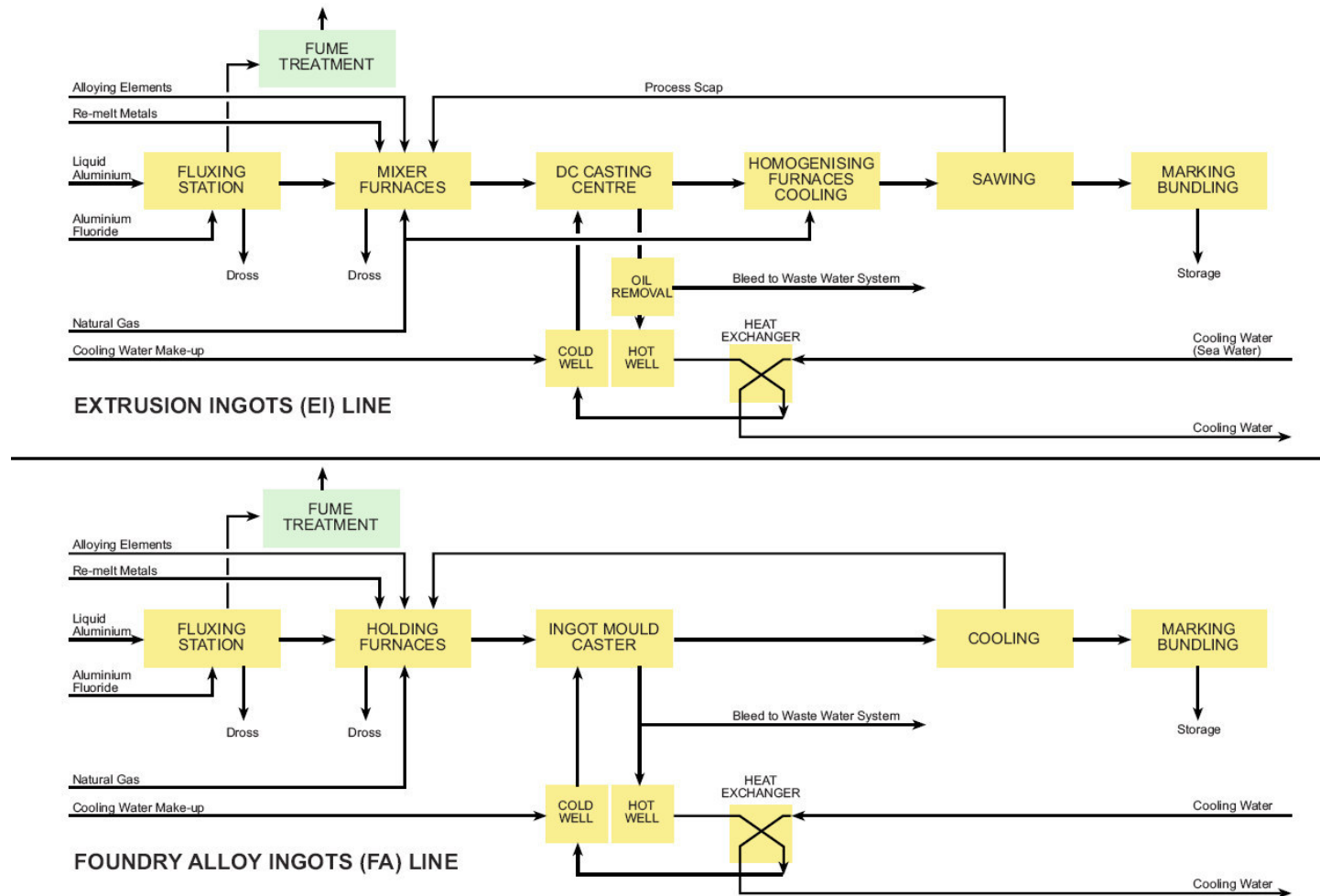
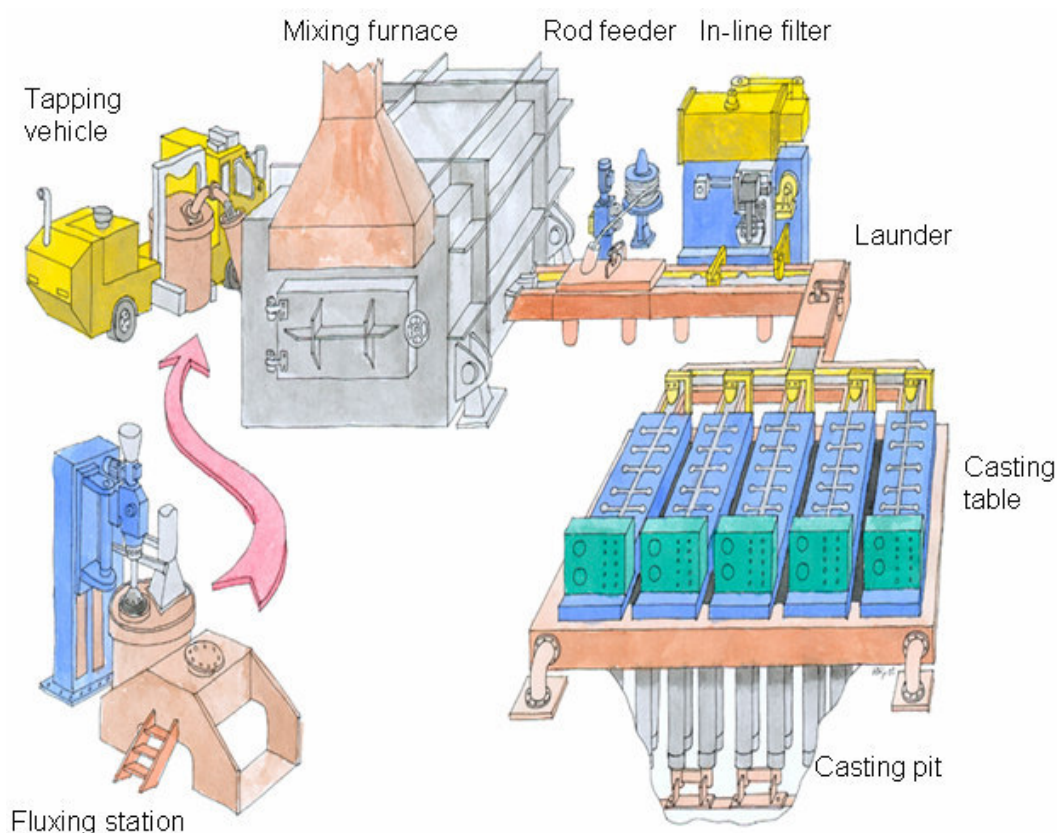


Figure 3.16 – Schematic of Extrusion Ingot Casting



- 3.11.39 In addition to the fluxing stations and casting lines, the Casthouse will contain: a crucible cleaning area, storage areas, container laboratories, maintenance area, service area, operations centre and control room.
- 3.11.40 Aluminium dross and bottom cake (8,000-10,000 t/yr), consisting mainly of aluminium, alumina, aluminium fluoride, cryolite, silica, and magnesium oxide, is generated as a by-product from the casting process. This is sold for refining to produce aluminium and metal salts which can be re-used.
- 3.11.41 Fumes from the fluxing stations and crucible cleaning are collected and passed to a gas treatment system. The gas treatment system consists of baghouse units, which are charged with lime (calcium oxide), to enhance efficiency and to remove any fluorides. During the preheating of cold metal and alloys, combustion gases are generated from the gas burners; these are released to atmosphere through dedicated stacks. Further discussion of the Casthouse emission sources and control measures are provided in Section 3.15 below.

Power Plant

- 3.11.42 The design and configuration of the Qatalum Phase 1 Power Plant and the associated seawater cooling tower concept is still under study and will not be known until selection of the EPC Contractor (currently scheduled for August 2007). The current basecase Power Plant has the following main features:

- combined cycle with single pressure steam turbines;
- four gas turbines;
- four heat recovery steam generators; and
- two steam turbines.

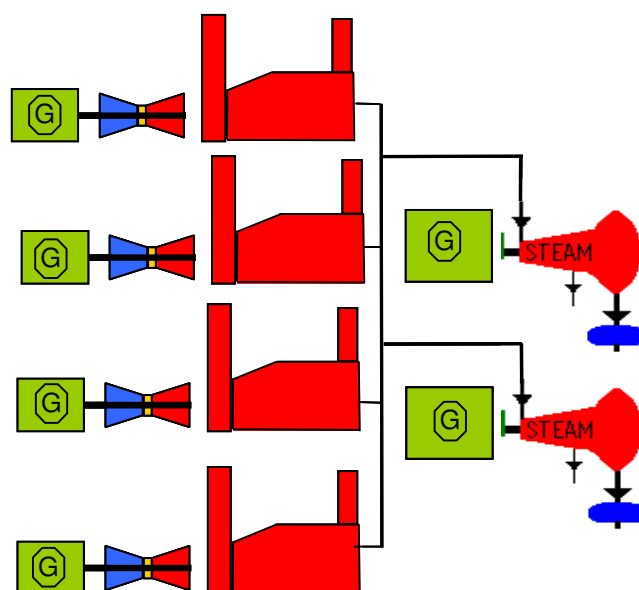
3.11.43 The power demand for the Aluminium plant is ~1000 MWe. The requirements regarding the regularity of supply are very high, since interruption of power supply for more than a few hours may cause the pots to start freezing, resulting in severe damage. Hence, the Power Plant will be designed with a significant spare capacity. The maximum gas turbine size will be in the order of 250 MWe, and the nominal total Power Plant capacity will be ~1350 MWe. The Power Plant will be connected to the grid as a secondary back-up and with the possibility for export, if this can be achieved without jeopardizing the security of the supply to the Aluminium Plant. Figure 3.17 shows a possible configuration for the basecase plant.

3.11.44 As the design process develops, the following possibilities for enhancing the capacity and/or the availability of production capacity will also be explored:

- supplementary firing; and
- evaporative cooling of the combustion air.

3.11.45 A power plant (Mesaieed A) to serve the grid in Qatar will be developed by an Independent Power Producer (IPP) to the north of, and adjacent, to the Qatalum Power Plant. A common gas supply line will be routed south of the Aluminium Plant to the power plants. Furthermore, the two power plants will have a common interface with the grid at a new substation to the north of the Aluminium Plant. A diagram showing the location and layout of the Qatalum Power Plant relative to the Aluminium Plant is presented in Figure 3.9.

Figure 3.17 – Basecase Power Plant Configuration



- 3.11.46 The gas turbines will be of low-NO_x design. The cooling water system is based on a seawater cooling tower concept. A full description of the turbine and cooling water system selection, emission sources and emission control measures are given in Section 3.12 (Technology Selection and BAT) and in Section 3.15 below (Emissions and Wastes).

Non-Routine Operations

- 3.11.47 Non-routine operations include shutdown, start-up and emergency/process upset scenarios. The only area of the Aluminium Plant, with potentially environmentally significant non-routine operation is the initial start-up of the potroom reduction cells. Once the potline is fully commissioned it will operate continuously for the lifespan of the Project.
- 3.11.48 During start-up of a new reduction cell, the cathode is first preheated with reduced electrical current for 46 hours. During this period the carbon ramming paste is hardened and the cathode is heated up to 850 °C. The pot is hooded during the preheating and the suction system is connected to prevent the off-gases, which contain PAH, from entering the potroom building.
- 3.11.49 When the potline is started for the first time, two pots will be started in each potline every day. This means that four pots will be started each day and eight pots will be in preheating mode every day until all pots have been started. In addition, pots that have come into regular production mode will be used to produce excess molten electrolyte to feed to the cells that are in start-up mode. This will also generate higher than normal emissions per tonne of aluminium produced. However, since the potlines will not have reached full production, the total emission levels will still be lower than those during normal full production for the majority of the start-up period. Towards the end of the start-up period, and during the following “fine tuning” period, emissions may be somewhat higher than those estimated for normal production.
- 3.11.50 During start-up and shut-down of Power Plant turbines, the systems have to be purged in order to avoid explosive mixtures. The purge gases, mainly natural gas, will be released to atmosphere. Valves and flanges etc. on the piping systems may give rise to occasional small leakages of hydrocarbons. All of these emissions are expected to be insignificant and have not been assessed further.

3.12 TECHNOLOGY SELECTION AND BAT

Introduction

- 3.12.1 Plant design and the emission control equipment selected for the Qatalum Project will take into account the principles of BAT (Best Available Techniques) and will aim to meet or exceed the present environmental requirements practiced for most aluminium plants in Europe and USA.

- 3.12.2 The principles of BAT are discussed in Section 2.7. BAT is achieved through applying a combination of design (i.e. specific technology/equipment selection), additional emissions reduction / abatement techniques (e.g. scrubber systems, bag filters etc), management systems and general good operating practices. Technology selection is a fundamental element of BAT; it is generally specific to a given industrial process and is a critical part of a Project's design. Abatement technology is usually considered after the selection of the main process technology, to further minimise emissions.
- 3.12.3 For the Qatalum Project, the main sources of emissions, and thus the main priorities for control through the application of BAT, are the:
- Potrooms (reduction cell technology, including anode changing process);
 - Carbon Plant (anode Bake Plant); and
 - Power Plant.
- 3.12.4 Casting technology and the techniques associated with control of emissions are relatively standard, thus the selection of specific "technologies" are not discussed further. The casting process and the proposed emission control techniques are described in Section 3.11 above and summarised in Section 3.15 below.
- 3.12.5 The determination of BAT has considered any relevant requirements stipulated within Law by decree No. 30 of the Environmental Protection Law³ and the draft MIC guidelines⁹. Conformance with BAT has taken into account the information contained within the following key reference sources:
- World Bank Pollution Prevention and Abatement Handbook (WB PPAH);
 - EU BAT reference (BREF) documents for the non-ferrous metals⁷ and power⁸ industries;
 - various PARCOM recommendations^{26&27}; and
 - The EU Large Combustion Plant Directive³⁰.
- 3.12.6 This remainder of this Section of the EIA assesses the types of process and abatement technologies that have been selected for the main elements of the Qatalum Project in relation to what is considered BAT for the aluminium and power industries. The focus is on the technological components of the Project with the potential to result in the most significant emissions/wastes; however, other elements of the Project, such as materials handling and storage and management techniques, are discussed briefly where applicable.

Reduction Process – Technology Selection

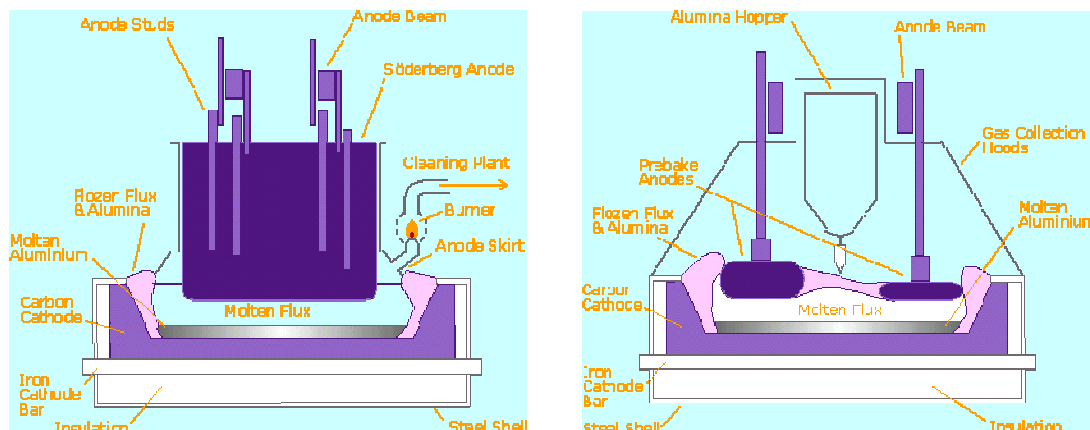
- 3.12.7 A full description of the reduction process has been presented in Section 3.11. As a result of the electrolysis process the formation of gases and particulates from the potrooms is inevitable. The main atmospheric emissions are gaseous (HF) and particulate fluorides, carbon dioxide, carbon monoxide, sulphur dioxide, polyaromatic hydrocarbons (PAH) and traces of perfluorocarbons (PFCs); these are described further below:

- fluorides in the form of gaseous hydrogen fluoride and particulate fluorides are emitted due to evaporation from the cryolite rich electrolyte (Na_3AlF_6);
 - particulates consist mainly of alumina (Al_2O_3) and cryolite. The finest of these materials are entrained in the flue gas from the pots. They are also generated in increased amounts during charging of the pots with alumina and other pot operations. The rate of generation is partly a function of the alumina quality (i.e. the content of fines);
 - sulphur dioxide originates from the sulphur content in the pitch and coke, which are the constituents of the anodes. In the combustion of the anodes, the sulphur is oxidized to SO_2 . The rate of release depends mainly on the sulphur content in the coke, which may be in the range 1.3 – 4%. Low sulphur coke is in limited supply, hence, for the purpose of estimating emissions a level of 4% S in the coke is used;
 - carbon dioxide is formed by the reaction of the oxygen in the alumina with the carbon of the anodes;
 - carbon monoxide is formed by the incomplete reaction of the oxygen in the alumina with the carbon of the anodes. Typically 5-10% of the carbon is released as CO;
 - perfluorocarbons (PFCs, mainly CF_4 and C_2F_6) are formed during anode effects in the pot, which are caused by too low content of alumina in the electrolyte. These anode effects increase the temperature in the pot, and PFCs are formed. PFCs are effective greenhouse gases;
 - polycyclic aromatic hydrocarbons (PAH) are tar compounds, which originate from the pitch. The tars are carbonised in the pre-baking of the anodes, hence there are insignificant releases of PAH from the anodes in the pots. Another source of PAH from the pots is the cathode lining, which contains some pitch that is released during the start-up of a new pot. Finally, anode paste is used to protect the nipples of the anode hangers, and a small amount of PAH is released from this.
- 3.12.8 As much of the pot off-gas as possible should be collected, via an extraction system, to minimise the amount of pot gases that escape into the potroom itself and vent to atmosphere through the building ventilation system (e.g. roof vents). Thus, the key features of primary emissions control are maintenance of stable process conditions and high extraction efficiency of the pot off-gases.
- 3.12.9 There are no direct aqueous emissions as a result of the reduction process itself. Wastewater discharges are typically associated with secondary processes, such as wet scrubbing abatement technology, and this is discussed below, in the Section “Reduction Process – Emissions Control.
- 3.12.10 Wastes produced as a result of the reduction process are not specifically governed by technology selection and are not discussed further in the BAT assessment. Waste generation and waste management are discussed in Sections 3.15 and 6.8.
- 3.12.11 There are two main types of electrolytic cells for the reduction of alumina to produce aluminium:

- Søderberg; and
- Prebake.

3.12.12 Schematics of the two types are shown in Figure 3.18²⁸.

Figure 3.18 – Søderberg (LHS) and Prebake (RHS) Cell Schematics



- 3.12.13 In Søderberg cells, the anode consists of one single large carbon block, which is made *in situ* by filling a paste of coke and pitch on the top. In the lower part of the anode, calcination takes place by the heat of the molten electrolyte. As the anode is gradually lowered, to keep constant distance between anode and cathode, the anode studs have to be pulled up at regular intervals.
- 3.12.14 Most Søderberg plants that are still in operation are “VSS Søderberg Plants” (Vertical Studs Søderberg); another variant of Søderberg is “HSS Søderberg Plants” (Horizontal Studs Søderberg). However, all Søderberg plants are characterized by higher emissions, lower energy efficiency and higher labour intensity than the modern prebake plants. For these reasons, no new Søderberg plants are being built. About 20% of the world’s production in 2004 was from Søderberg plants.
- 3.12.15 In the prebake process anodes are manufactured and baked in a separate plant. Each cell has a large number of anodes, which are replaced individually or two by two, when about 80% of the carbon block has been consumed. There are two main types of prebake cells, Central Worked Prebake (CWPB) and Side Worked Prebake (SWPB), referring to whether the alumina is fed centrally in the cell or along the sides. Feeding along the sides involves opening the hoods, breaking the crust and then feeding alumina. These operations cause considerable emissions, and newer plants do not apply this technology.

3.12.16 A further refinement of the CWPB cells was the introduction of automatic point feeders of alumina centrally in the cells, combined with process controls that make it possible to maintain a steady composition of the electrolyte and stable process conditions. This cell type is called PFPB (Point Feeder Prebake). Other features of new plants are that the cells are oriented side-by-side, whereas earlier cell types were oriented end-to-end. This side-by side orientation has allowed increased cell size and higher amperage. Thus, the output of a modern potline has increased significantly without increasing the footprint of the potroom. About 70% of the world's production in 2004 was with PFPB technology, and almost all new capacity since the 1990s has been PFPB.

3.12.17 The typical pot off-gas capture for each of these cell types is presented below.

Table 3.3 – Pot Off-Gas Capture Efficiency

Cell Type	% capture
VSS Söderberg	65-95
HSS Söderberg	85-95
SWBP	85-95
CWPB	95-99
PFPB	>99

3.12.18 It can be seen from Table 3.3, that PFPB cells offer the optimum off-gas removal efficiency. The EU BREF note⁷ states that “the use of centre worked prebaked cells with automatic multiple point feeding of alumina is considered to be BAT for the production of primary aluminium”.

3.12.19 The 1994 PARCOM Recommendation²⁶ also states that BAT for new aluminium electrolysis plant should be based on Prebake technology, including:

- closed prebake pots, designed for high collection efficiency for fumes and minimal opening of enclosures during operation;
- point feeding of alumina, intermittently to the centre line of the cell; and
- efficient computer process controls to control electrolyte composition and limit anode effects.

3.12.20 Similarly, the WB PPAH²⁰ states that, “using the prebake technology rather than the Söderberg technology for aluminium smelting is a significant pollution prevention measure” and comments that computer controls and point feeding of alumina to the centreline of the cell (i.e. PFPB cells) will help reduce emissions. This publication also states that energy use per tonne of product is lower for Prebake technology.

3.12.21 The Qatalum Project will use the Norsk Hydro reduction technology (HAL 275), which is a PFPB cell technology that incorporates the above criteria for the EU and PARCOM definitions of BAT for aluminium reduction and follows the WB guidance. The key features of the Qatalum Reduction plant design and process controls that will be in place to minimise the escape of pot gases to the potroom atmosphere and to reduce the formation of certain pollutants, include:

- keeping the pot covers tight and maintaining sufficient suction to avoid fumes escaping into the potroom. The efficiency of fume collection within the pot hoods is secured by the high draft rate (6,000 Nm³/h per pot), by maintaining the airtight integrity of the pot hoods and by the pot superstructure design, which eliminates the need for opening the hoods during the feeding of alumina and other components, and during the siphoning of molten aluminium;
- minimising the time that covers are opened for anode changing and the use of increased suction. The mechanised changing of two anodes simultaneously with the pot tending machines (overhead cranes) minimises the time during which the hoods are removed for the anode changing operation. During this operation the suction from the pot-gas collection system is increased to about 18,000 Nm³/h per individual pot undergoing servicing. This technique has been specifically developed by Hydro Aluminium. A double ducting system is used to completely isolate the pots under increased suction from those under normal operating suction;
- consumed anode butts are removed from the pots and rapidly transported to a dedicated ventilated cooling room(s). The cooling room ventilation air is routed to the FTP (see below for a description of the FTP);
- the generation of pollutants is minimised by the pot design, the use of pre-baked anodes and by the micro-processor-control. This control helps to optimise the anode-cathode distance and the operating parameters by controlling the pot resistance and feeding of alumina. The result is a reduction of anode effect perturbations in the electrolytic process, which minimises emissions of perfluorocarbons (PFCs).

Reduction Process - Emissions Reduction and Control

General

3.12.22 Both the EU BREF note⁷ and the 1994 PARCOM Recommendation²⁶ define BAT for treatment of off-gases as having the following features:

- treatment to remove dust, particulate fluorides and HF using an alumina dry scrubber and fabric filter; and
- where local, regional or long-range environmental impacts require sulphur dioxide reductions, the use of either low sulphur raw materials for anode production or a sulphur dioxide scrubbing system.

- 3.12.23 The Qatalum Project design incorporates both of the above gas treatment techniques. All of the gases collected from the pots will be diverted to a dry scrubbing Fume Treatment Plant (FTP), where they will be treated with fresh alumina to adsorb fluorides, PAH and dust. The alumina will adsorb and retain ~99.7 % of the fluorides. The fluoride enriched alumina and dust is collected in baghouses and fed back to the pots via a closed system. Treated off gas from the FTP contains unchanged amounts of carbon dioxide, carbon monoxide, sulphur dioxide and perfluorocarbons; the off-gas will then undergo an additional treatment step (wet seawater scrubbing) to remove in excess of 90% of the sulphur dioxide. In addition, the seawater scrubber will also remove a portion of any hydrogen fluoride and dust that remain in the gas stream after the dry scrubbing gas treatment stage. The selection of wet seawater scrubbing as an SO₂ reduction technique is discussed further below.

SO₂ Abatement

- 3.12.24 The SO₂ emissions from aluminium plant mainly arise as a result of the sulphur content of the coke that is used in making the anodes for the reduction process. In addition, there are relatively small contributions to SO₂ from the pitch and other raw materials. A small portion of the SO₂ (<10%) is released from the anode baking while the majority is emitted from the pots as a result of consumption of the anodes.
- 3.12.25 Internationally, the regulations relating to SO₂ are strongly influenced by local and regional issues related to SO₂, such as acidification of lakes and rivers and effects on forests / acid sensitive vegetation. The WB PPAH²⁰, PARCOM Recommendation²⁶ and the EU BREF document⁷ also mention that these are factors to be considered when defining BAT for a specific site; however, acidification of surface water bodies and forests is not an issue that is relevant in Qatar.
- 3.12.26 There are no established regulations or standards in Qatar regarding stack emissions of SO₂ from aluminium plants. The only specific requirement is to meet the ambient air quality criteria, which could be achieved by the improving dispersion of the gases from the potroom room FTPs by building tall stacks.
- 3.12.27 Although the existing national and international standards / recommendations do not indicate that treatment of the potroom gases to remove SO₂ is a requirement, it is recognised that the magnitude of the SO₂ emission could potentially raise ambient SO₂ levels over a wide area, even if air quality in this area would still be below the ambient air health criteria. Furthermore, there is a trend in the Gulf region to take steps to reduce SO₂ emissions.
- 3.12.28 There are two main ways in which to reduce SO₂ emissions from aluminium production processes:
- at source, by selecting low sulphur raw materials for anode production; and
 - secondary treatment (e.g. scrubbing) of the off-gases prior to release to atmosphere.

- 3.12.29 The option of using of low sulphur (LS) coke was considered and was discounted for the following reasons. LS coke is difficult to obtain in the required quantities for the Qatalum Project, in addition, there is an increasing price premium for LS coke. Only 10 – 15% of the world coke production generates LS coke; this is mostly produced in Europe, China and South America and is, to a large extent, already committed for local use. The coke produced in the Middle East region generally contains in the region of 3 – 3.5% S, with the trend in S content increasing further. The use of local (Middle East) materials has the added advantage of reducing the regional emissions associated with transport of materials over greater distances.
- 3.12.30 The two main secondary SO₂ removal techniques involve wet scrubbing with either seawater or lime. Both techniques involve absorption/dissolution of the SO₂ into the scrubbing medium. Scrubbing with lime will generate gypsum which precipitates from the scrubber effluent, and has to be disposed of as a waste.
- 3.12.31 Seawater scrubbers (SWS) utilise the natural alkalinity of the seawater to enhance the absorption of SO₂ into the water and to then neutralise the acidic effluent that is produced. The process is widely used in Northern Europe, where the conditions are good for this process.
- 3.12.32 Seawater has a high natural alkalinity, mainly because of its content of carbonate and bicarbonate. The pH of seawater is typically ~8.2 and alkalinity is ~2.5 meq/l. Alkalinity increases in proportion to salinity, which is high in the Gulf. The absorption takes place in a vertical counter-flow scrubber with internal packing to maximise contact surface and involves the following reactions:
1. $\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}^+ + \text{HSO}_3^- \rightarrow 2\text{H}^+ + \text{SO}_3^{2-}$
 2. $\text{HCO}_3^- + \text{H}^+ \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
 3. $\text{HSO}_3^- + \frac{1}{2} \text{O}_2 \rightarrow \text{HSO}_4^- \rightarrow \text{H}^+ + \text{SO}_4^{2-}$
- 3.12.33 The end products are therefore CO₂ and sulphate, which are natural constituents of seawater; however, depending on the amount of seawater used per unit of SO₂ absorbed, the pH will be lowered and there will be an increase in chemical oxygen demand (COD) due to the oxidation of sulphite (SO₃²⁻) to sulphate (SO₄²⁻). Furthermore, there will be a slight temperature increase of the scrubber effluent compared to the intake water temperature.
- 3.12.34 The process can achieve over a 90% efficiency of SO₂ removal, which is consistent with the BAT requirements for coal fired power plants in Europe. In Europe, SWSs are often considered BAT, over lime-based scrubbing, for plants that are situated on the coast, where a plentiful supply of naturally alkaline water is readily available. SWSs have also been used in some instances for this purpose in the Gulf region (e.g. at a coke calcining plant in Bahrain) and is a technique that is considered for other aluminium plants.

- 3.12.35 In the case of the Qatalum Project, the seawater scrubber system can be designed to re-use the seawater already used in the cooling systems; thus a large proportion of the seawater supply would come from the Aluminium Plant cooling water and the Power Plant cooling tower blow-down water. This has the advantage of limiting the use of natural resources (fresh seawater) and minimising discharge volumes. A further advantage of using the blow-down water is that it contains a higher concentration of salt and alkaline components than fresh seawater, which further increases its SO₂ absorption capacity. A water balance for the SWS system is given in Section 3.13, Figure 3.20.
- 3.12.36 There are a number of related lime-based scrubber techniques; the most common and applicable technique for the Qatalum Project, being wet limestone scrubbing. Lime scrubbing systems generally have a lower optimum SO₂ removal efficiency in comparison to seawater scrubbers. Limestone scrubbing is often applied to large (> 500 MWe) coal fired power stations, where the sulphur level of the coal can not be reduced and that are situated away from the coast. This technique uses large quantities of raw materials (limestone) and produces a significant amount of solid waste (gypsum). In addition, the delivery of the raw materials and removal of the waste produced will result in emissions from the additional transportation requirements. It is also worth noting that lime-based scrubbing processes are considerably more expensive than seawater scrubbing.
- 3.12.37 Since the intention of BAT is to protect the environment as a whole, in determining the appropriate SO₂ reduction technique, the BAT assessment should include consideration of the quantities of raw material (e.g. limestone / seawater) consumed and the production of effluent and waste residues in addition to the reduction in sulphur dioxide emissions. As noted above, the seawater scrubber system does not require significant use of raw materials, such as limestone, and does not generate solid waste; both of the scrubbing techniques discussed above result in a liquid effluent.
- 3.12.38 On the basis of the above, and Hydro Aluminium's extensive experience with seawater scrubbing, SWS has been selected for reducing SO₂ emission from the Qatalum Project potrooms.
- 3.12.39 In terms of emissions from the SWS system, Table 3.4 below shows the mass reduction of SO₂ emissions that can be achieved as a result of installing the seawater scrubbers. It can be seen from the table below that the installation of a SWS after the potroom FTPs, with a relatively conservative scrubber efficiency of 90%, would reduce overall plant SO₂ emissions by over 80%, saving nearly 15,000 tonnes per year of SO₂ from being emitted to the atmosphere. Stack gas concentrations would be reduced from 350-400 mg/Nm³ down to 35-40 mg/Nm³.

Table 3.4 – SO₂ Emissions and Reduction with Seawater Scrubbing

	SO ₂ kg/hr		SO ₂ t/yr	
	No SWS	With SWS	No SWS	With SWS
Potroom Stacks (after FTPs)	1,893	189	16,583	1,658
Potroom Roof Vent	20	20	175	175
Anode Bake Plant	191	191	1,673	1,673
Total aluminium plant SO ₂ emissions	2,104	400	18,431	3,507
Overall reduction of SO ₂ emissions	-	1,704	-	14,924

- 3.12.40 Depending on the amount of seawater used in the scrubbing process, the wastewater exiting the scrubber system will be acidic (around pH 3-4); the sulphite will be partially oxidised to sulphate and the discharge will contain elevated levels of COD (25-30 mg/l) and additional heat load. Prior to discharge, the scrubber effluent will be mixed with the cooling water discharge from QASCO, in the QASCO channel, where neutralisation and COD reduction will occur.
- 3.12.41 COD will be further reduced by the installation of an aeration system (air injection nozzles) along the bottom of the QASCO channel, downstream of the point at which the Qatalum discharge enters the QASCO channel. The objective of this will be to meet the required dissolved oxygen (DO) level of 2 mg/l; this is discussed further in Section 6.5.
- 3.12.42 The specifications for the aeration system are subject to further evaluation; however, the SWS system will be designed to achieve the following criteria for the aqueous discharge:
- pH >6 after neutralisation the QASCO channel water;
 - DO >2 mg/l at the outlet of the QASCO channel;
 - delta T (relative to seawater intake temperature) of < 3°C at the edge of the mixing zone; and
 - a maximum discharge flow rate of 16,000 m³/hr into the QASCO channel.

Summary

- 3.12.43 Atmospheric emission standards and achievable atmospheric emissions for the aluminium reduction at new plant are presented below and compared to those expected from the Qatalum Project.

Table 3.5 – Atmospheric Emission Criteria for Aluminium Reduction

	Type ^a	Units	SO ₂	PM	Total F	HF	PFC
Mass Emissions							
Qatalum (potrooms) ^b	na	kg/t Al	3.1	0.37	0.3	0.15	0.044
PARCOM 1994 ^{c26}	AL	kg/t Al	-	1	0.6	0.4	-
EU BREF note ^{d7}	AL	kg/t Al	-	-	-	-	<0.1

	Type ^a	Units	SO ₂	PM	Total F	HF	PFC
Stack Emissions							
Qatalum (potrooms) ^e	na	mg/Nm ³	35-40	2.0	0.2	0.1	-
World Bank ^{f20}	ES	mg/Nm ³	-	30	2	1	-
EU BREF note ^{d7}	AL	mg/Nm ³	-	1-5	<0.5	<0.2	-

Notes:

na – not applicable

- a Standard values are for either: “AL” - achievable limits for new plant; or “ES” - emission standard/guideline.
- b Total emissions from the potroom (i.e. potroom roof vent and pot gas treatment stacks combined), estimated on a conservative basis.
- c The PARCOM standards are achievable limits when applying BAT at new aluminium electrolysis plants, expressed as annual averages. The HF and total F values are expressed as fluoride.
- d Achievable limits are daily averages for collected and abated emissions (i.e. excluding potroom vent emissions).
- e Emissions from the pot gas treatment stacks only (i.e. excludes potroom roof vent), estimated on a conservative basis.
- f The WB ES values are maximum guideline emission concentrations that should apply 95% of the time, they are presented as emission from “aluminium smelting” and it is not clear whether these apply to an integrated plant with anode production, only total potroom gases, or potroom collected gases only.

3.12.44 Table 3.5 shows that the Qatalum Plant reduction process will meet all the achievable emission limits that have been defined as BAT for new plant by PARCOM²⁶ and the EU⁷. The World Bank²⁰ emission standards will also be met. The WB²⁰ also suggests achievable levels for SO₂, PM, total fluoride, HF and PFCs; these will be met with the exception of that for SO₂. The suggested WB achievable limit for SO₂ is 1 kg/t of aluminium produced; the Qatalum SO₂ emissions have been conservatively estimated to be in the region of 3 kg/t of aluminium. Although the Qatalum emission rate is higher than that suggested as “achievable” by the WB, the only practical option for the Qatalum Project, from an environmental and commercial perspective, is a seawater scrubbing system. A seawater scrubber has been incorporated into the Qatalum Project and its SO₂ removal efficiency has been optimised relative to overall plant design. Thus, SO₂ emissions from the potrooms have been minimised so far as is possible for this Project and can be considered to represent BAT.

3.12.45 Aqueous discharge standards and achievable emissions for new plant are presented below and compared to those of the Qatalum Project.

Table 3.6 – Criteria for Seawater Discharges

	Type ^a	pH	COD mg/l	ΔT °C	Residual Cl ₂	Oil & Grease
Qatalum Project ^b	na	6-9 ^c	Nil ^c	< 3 ^d	Nil	Nil
SCENR ⁴	ES	6-9	-	< 3 ^d	0.05	-
World Bank (Al Manufacture) ²⁰	ES	6-9	150 ^d	< 3 ^d	-	5 ^e

	Type ^a	pH	COD mg/l	ΔT °C	Residual Cl ₂	Oil & Grease
World Bank (Thermal Power Plant) ¹⁵	ES	6-9	-	< 3 ^d	0.2 ^f	10
EU BREF note ⁷	AL	-	37	-	-	0.8 ^e

Notes:

na – not applicable / no standard

- a Standard values are for either: “AL” - achievable limits for new plant; or “ES” - emission standard/guideline.
- b The seawater discharge contains wastewater from the two cooling systems and, subsequently, the SWS system.
- c Value to be achieved prior to release to sea; all sulphite will be oxidised.
- d Criteria applies after discharge to sea, at the edge of the mixing / dilution zone.
- e Criterion is for hydrocarbons.
- f “Chlorine shocking” may be preferable in certain circumstances. In this event, the chlorine concentration should not exceed 2 mg/l over a 2 hour period, not to be repeated more than once in a 24 hour period, with a 24 hour average of 0.2 mg/l.

3.12.46 Table 3.6 demonstrates that the aqueous discharge from the SWS system will meet all of the national, WB and EU BAT criteria.

3.12.47 In conclusion, it is considered that the reduction technology selection and emission control measures for the Qatalum Project have been undertaken in accordance with, and perhaps in the case of atmospheric emissions of SO₂, beyond, the typically accepted principles of BAT for aluminium plant.

Carbon Plant - Technology Selection

3.12.48 As discussed above, the Reduction Plant for the Qatalum Project will be based on Prebake cell technology, which requires a separate Anode Plant to produce anodes. A full description of the anode production process has been presented in Section 3.11.

3.12.49 The main sources of discharges during anode production are atmospheric emissions of:

- off-gas from the Paste Plant furnace, pitch fume^v (including PAH) and dust;
- off-gas from the Bake Plant furnace pitch fume (including PAH), sulphur dioxide^{vi}, fluorides^{vii} and dust;
- combustion gases (primarily NO_x, CO and CO₂) from firing natural gas to supply heat to the paste and bake plants;

^v Fume, including PAH compounds are generated from the pitch in the baking process, small quantities of pitch fume are also generated from pitch storage and the Paste Plant.

^{vi} Sulphur dioxide is generated in the baking process as a result of volatilisation and combustion of the sulphur compounds that occur naturally in the coke and pitch.

^{vii} Fluorides originate from the butts that are recycled as feedstock to the Paste Plant; the butts adsorb residues of the fluoride containing crust which forms in the pots. Prior to crushing the anode butts are mechanically cleaned to minimise the amount of fluoride residues transferred back to the Paste Plant.

- dust/particulates from materials storage, handling, crushing and cleaning activities etc; and
 - pitch fume from pitch storage.
- 3.12.50 Aqueous discharges from the process are limited to relatively small cooling requirements during the formation of green anodes. No releases to water are expected for a new installation; cooling requirements are capable of being operated on a closed cycle and this is considered to be BAT. For the Qatalum Project there will be no discharge from the recirculating direct water spray system in Anode Paste Plant, since all water used will evaporate.
- 3.12.51 Wastes produced as a result of the anode production process are not specifically governed by technology selection. The majority of wastes (e.g. coke dust, reject anodes) can be recycled back into the process. Thus, wastes are not discussed further in the BAT assessment. Waste generation and waste management are discussed in Section 6.8.
- 3.12.52 Techniques associated with control of emission from materials handling and storage activities and the Paste Plant technology are relatively standard, thus the selection of specific “technologies” for these elements of the Carbon Plant are not discussed further in this Section.
- 3.12.53 There are a number of proprietary bake furnace technologies on the market; however, they are all based on the same principles and may all be characterized as BAT. Two main types of furnace are:
- open ring furnaces; for example, as developed by as developed by Alcan-Pechiney and Alesa and
 - closed ring furnaces, for example, as developed by Riedhammer GmbH and Hydro Aluminium AS.
- 3.12.54 During anode baking, petroleum coke is packed round the green anodes; some of this will burn during the baking process and thereby contribute to the total energy consumption of the process.
- 3.12.55 The overall energy efficiency of the two furnace types is similar; however, open furnaces generally burn less packing coke and more fuel gas than a closed furnace. Thus, the emissions of sulphur dioxide will normally be higher from a closed furnace, as there is more sulphur in petroleum coke than in fuel gas. Conversely, closed furnaces give a flue gas with higher concentrations of tar and PAH. Since both furnace types can be considered BAT, and the differences between the two are marginal, the selection of fume treatment for either furnace type is of more importance for controlling emissions.
- 3.12.56 A bidding process was carried out to select the bake furnace technology for the Qatalum Project. All bids received were considered to comply with BAT requirements and ultimately an open furnace, supplied by Alcan-Pechiney was selected. The selection of fume treatment is discussed below.

Carbon Plant – Emission Reduction and Control

Paste Plant

- 3.12.57 The fume from the Paste Plant will be collected, filtered to remove dust, and treated in a regenerative thermal oxidiser (RTOs) to remove pitch fume (including PAHs). The RTO will achieve ~99% destruction of the pitch fumes and recovers 90 to 95% of the heat generated by the oxidation process. These techniques are considered consistent with general good practice and BAT.

Anode Baking

- 3.12.58 The WB PPAH²⁰ recommends control of fluoride emissions from bake furnaces through use of a dry scrubbing system, using alumina as the adsorbent. The system should be able to capture ~97% of the fluorides. This publication also notes that dry scrubbing may be combined with incineration for controlling emissions of tar and VOCs and to recover energy. Wet scrubbing is not recommended. This is generally consistent with the BAT techniques considered in the EU BREF note for non-ferrous metals⁷.
- 3.12.59 For the Qatalum Project, the waste gases from the anode baking process will be collected and routed to an independent dry scrubber for treatment with fresh alumina to remove fluorides and some PAH. This is the same process that is used to treat the off-gases from the reduction cells. As for the reduction process, the fluoride enriched alumina and dust will be collected and fed back to the pots. Since open furnace technology reduces the amount of tar / VOC / PAH produced in the baking process, relative to closed furnace technology, additional treatment of the gases (e.g. an RTO) is not necessary.

Combustion gases

- 3.12.60 Combustion gases from heating the paste and bake furnaces are unavoidable; however the use of natural gas as the fuel offers better energy efficiency and lower SO₂ emissions than oil fired furnaces. In addition, general good practice through operational controls (e.g. control of furnace firing to optimise energy use) and regular testing and maintenance will ensure that the furnaces operate as efficiently as possible with minimal emissions. Although the overall design has not been finalised (since this is in part up to the Contractor), it is likely that the paste and bake plant furnaces will be of a Low NO_x Burner (LNB) design.

Material Handling, Use and Storage

- 3.12.61 Sources of dust and particulate from material handling activities will be equipped with powerful vacuum systems which enable the dust to be collected and removed in baghouses. The collected dust will be recycled back to the Paste Plant via a closed system. The fume from the pitch storage tanks will be collected and treated in an anthracite oil scrubber to remove the VOCs. These techniques are considered consistent with general good practice and BAT.

Summary

- 3.12.62 Atmospheric emission standards and achievable atmospheric emissions for the Bake Plant at new installations are presented below and compared to those expected from the Qatalum Project.

Table 3.7 – Atmospheric Emission Criteria for Anode Baking.

	Type ^a	Units	PM ₁₀	HF	PAH
Mass Emissions					-
Qatalum (Bake Plant) ^b	na	kg/t anode	-	0.003	-
PARCOM 1992 ^{d27}	AL	kg/t anode	-	0.01	-
Stack Emissions					-
Qatalum (Bake Plant) ^b	na	mg/Nm ³	3.4	0.5	<1 ^c
EU BREF note ⁷	AL	mg/Nm ³	1-5	-	0.2-0.5 ^e

Notes

na – not applicable

There no World Bank standards / guidelines in the Section on Aluminium Manufacture specifically for anode production.

a Standard values are for either: “AL” - achievable limits for new plant; or “ES” - emission standard/guideline.

b Estimated on a conservative basis.

c PAH emission rates are based on the Norwegian definition of PAH, which includes 16 compounds – see Appendix H, Annex A for a full definition and a comparison to other international conventions for defining PAH.

d PARCOM recommendation for anode baking furnaces.

e Values taken from Table 12-13: Achievable Limits for plant with an afterburner, based on US EPA definition of PAH, text notes that the measurement and reporting of PAH emissions is complex and depends on number of individual PAH that are determined and reported.

- 3.12.63 For the Carbon Plant, both the technology selection for the bake furnace and the proposed emission controls / reduction techniques are in line with the requirements of BAT.

Power Plant

- 3.12.64 It is generally accepted that gas-fired combined cycle gas turbines (CCGTs) are the most efficient, and least environmentally damaging, method of power generation and are representative of BAT. Combined cycle units burn fuel in a combustion chamber; the exhaust gases are used to drive a turbine to produce electricity. Waste heat boilers recover energy from the turbine exhaust gases for the production of steam, which is then used to drive another turbine. Thus, the total efficiency of a combined-cycle system, in terms of the amount of electricity generated per unit of fuel, is greater than for conventional thermal power systems.

- 3.12.65 Gaseous emissions are formed during the combustion of natural gas in the gas turbines, and from supplementary duct firing (when this is applied). The main combustion products are CO₂ and water vapour. Gas-fired plants generally produce negligible quantities of particulates and oxides of sulphur oxides, and levels of nitrogen oxides are about 60% of those from plants using coal. Nitrogen oxides (NO_x) are formed by reaction at high flame temperature between the oxygen and nitrogen in the combustion air. Carbon monoxide (CO) is also formed by incomplete combustion of the natural gas. Gas-fired plants also release lower quantities of carbon dioxide relative to oil and coal fired plants; Carbon dioxide emissions are directly related to the amount of power produced and the thermal efficiency of the power generation process.

- 3.12.66 The Qatalum Power Plant design is based on 4 single pressure CCGTs (~250 MWe each), with four heat recovery steam generators; and two steam turbines. The key issues relating to CCGTs, from an environmental perspective, are the minimisation of NOx emissions, turbine (energy) efficiency and the selection of the cooling water system. These are elements are discussed further below.

NOx Control

- 3.12.67 Techniques for the reduction of NOx can be divided into two broad categories: primary and secondary measures. Primary NOx control measures suppress the formation of NOx during the combustion process. Secondary NOx control measures are those flue gas treatment technologies used to abate emissions of NOx, prior to their emission to the atmosphere. The following techniques are included in these two broad categories:

- Primary NOx Control Measures:
 - water or steam injection, and
 - Dry Low-NOx (DLN) combustor technologies; and
- Secondary NOx Control Measures:
 - Selective Catalytic Reduction (SCR).

- 3.12.68 As dry low-NOx combustors have become established, the need for water or steam injection has declined. For new power stations, this method of NOx control is now largely limited to water injection for NOx control when burning liquid fuels. In addition, this technique requires a supply of very high purity water, usually necessitating the installation of a high quality water treatment plant, and resulting in the use of a valuable natural resource. Furthermore the use of steam or water injection may also reduce the life expectancy of a gas turbine. Thus this technique has not been considered further.

- 3.12.69 Dry Low NOx burners (DLN) work by premixing combustion air with the fuel, and by staged combustion; in this process the peak flame temperatures are reduced to a level where only small amounts of NOx are formed. The control of combustion is difficult over the full range of loads and can result in combustion instability, 'flash back' and 'flame-out'. Thus these units often operate in dual-mode; operating as pre-mix burners under normal high load operation and without pre-mix (in 'diffusion' mode) during low-load operation (e.g. for start-up). In the latter mode, the characteristics of 'low-NOx' combustion are largely lost and NOx levels rise towards levels found in 'conventional' combustors (historically 250-400 mg/Nm³). However, careful management of turbine loading can reduce the time that a turbine operates at low load. DLN technology can generally reduce NOx levels to below 50 mg/Nm³, which is within definition of achievable emission levels identified in EU BREF⁸ for the combustion sector and below the limits specified by SCENR⁴ and the World Bank¹⁵ (see Table 3.8 below). The operational conditions for dry low-NOx burners will also ensure that emissions of CO will be well within the regulatory limit.

- 3.12.70 Many gas turbines use only primary measures to reduce NOx emissions, although SCR systems have been installed at some gas turbines in Austria, Japan, the Netherlands and the US. The SCR process is a catalytic process, based on the selective reduction of nitrogen oxides with ammonia or urea in the presence of a catalyst. SCR can readily remove 80-90% of NOx from flue gases; however, CAPEX and operating are high⁸. SCR also has the disadvantage of atmospheric emissions of ammonia (through ammonia slip), the generation of waste streams (e.g. spent catalyst) and the use of raw materials (usually liquid ammonia).
- 3.12.71 On the basis of the above, dry low NOx Burners (LNBs) have been selected to minimise NOx emissions at the Qatalum Power Plant, as these will allow compliance with generally accepted achievable NOx emissions for new GT plant without the disadvantages associated with the other two techniques (i.e. waste generation and raw material use) and the high costs of SCR. The operational conditions for dry low-NOx burners will also ensure that emissions of CO will be well within any regulatory limits.
- 3.12.72 In order to determine what level of NOx emission concentration could be achieved for the Qatalum Project, Hydro commissioned Mott MacDonald to undertake a study²⁹ of available turbines and to advise on an achievable NOx emission concentrations.
- 3.12.73 The study determined that there are four main suppliers of "F-class" gas turbines (approximately 280 MW at ISO conditions); two of these suppliers may be able to achieve NOx concentrations as low as 9 ppm; although both suppliers state reservations regarding fuel composition and ambient conditions. The two other suppliers can achieve 12-15 or 15 ppm NOx, stating that lower levels may be achieved, but only at the expense of efficiency. These data have been provided without the supplier having information on the fuel specifications and/or the site details of the Qatalum Project. Based on this preliminary data, adopting a NOx target of 9 ppm was not recommended, since it would restrict the number of suppliers who would be able to provide a compliant bid without the addition of SCR technology. Furthermore, the above NOx levels may not be guaranteed once the specifics of the Qatalum Site setting, and/or fuel specification are accounted for.
- 3.12.74 The study concludes that the industry standard is currently 35 mg/Nm³ (17 ppm) and recommends that, at this stage, 17 ppm or higher, be considered as a target for the Qatalum plant. Qatalum have adopted 17 ppm as the basecase emission target for the Project and this is compared to the various standards / criteria for thermal power plant in Table 3.8 below.

Table 3.8 – NOx Emission Criteria for Thermal Power Plant.

	Type ^a	NOx mg/Nm ³	NOx ppm
Qatalum Power Plant	na	35	17
SCENR ^{b4}	ES	55	~27
World Bank ¹⁵	ES	125	~61
EU (LCPD) ³⁰	AL	50 ^c	~25

Notes

na – not applicable

bold figures are those stated in the regulations / guidelines.

Unless otherwise stated, emission concentration in units of mg/Nm³ are assumed to be expressed for dry gas at 101.3 kPa, 273 K, and 15% O₂.

- a Standard values are for either: "AL" - achievable limits for new plant; or "ES" - emission standard/guideline.
- b For new plant generating more than 25 MW of power. Gas turbines should include units to recover the lost heat.
- c Limit is for new gas turbines >50MWth at >70% load.

Efficiency

- 3.12.75 The hot climate and high cooling water temperature in Qatar reduce the thermal efficiency of CCGTs, compared to what can be achieved in more temperate climate zones. The efficiency will vary through the seasons according to the natural variations in ambient temperature and humidity. The basecase efficiency of the Power plant will be 51% at worst operating conditions, including deterioration of the turbine.
- 3.12.76 As noted above CCGTs are one of the most energy efficient forms of power generation; however, extra efficiency could be achieved through the use of triple pressure steam cycle units, rather than single pressure units. A study³¹ was undertaken to determine the applicability of triple pressure units for the Qatalum Power Plant. The study determined that, although a triple pressure system could theoretically increase the efficiency by 1-2 percentage points, this system was not economical for the Qatalum Plant (higher power costs), and would have a reduced availability as a result of the considerable increase in complexity of the steam system.
- 3.12.77 Efficiency is also related to the operational mode of the gas turbines, specifically the load factor. The turbines are most efficient when they are operated at high load. However, it may be necessary to operate the Power Plant with more turbines running at part load rather than having one cold stand-by generator. This is due to the vulnerability of the aluminium production, which requires protection against any interruption of the power supply. Further analyses will be undertaken to determine the optimum operational modes for the turbines.

Cooling System

- 3.12.78 The seawater cooling water is circulated through spray towers, where it comes in to contact with the counter flow air, evaporation occurs and this causes a reduction in the temperature of the cooling water. During this process, small droplets of seawater will become entrained in the airflow, and a small proportion of these may escape through the mist eliminator on top of the cooling tower.

- 3.12.79 The key environmental issues associated with cooling water systems are the volume of water required and the increased temperature load / presence of biocide (hypochlorite) compounds in the discharge. A study³² of cooling water system alternatives was carried out at the concept selection stage of the design. As a result of this study, it was concluded that the design for Qatalum Power Plant cooling system should be based on a seawater cooling tower concept. The main alternative was direct seawater cooling; however, the shallow water adjacent to the Mesaieed area is already heavily loaded with cooling water discharges from existing industry, causing concerns about local environmental effects related to the heat load of the discharges and the use of biocides. Long intake and discharge pipelines could reduce these problems, but would be too expensive; in addition, this solution would result in impacts to the marine environment as a result of the construction of the pipelines and would merely shift the additional heat load from one area to another, currently unaffected, area.
- 3.12.80 The circulating cooling water has to be treated with biocide (chlorination) to avoid bio-fouling. Chlorination will be applied periodically in the towers. As noted above, the bleed (blow-down water) from the Power Plant cooling towers will be routed to the seawater scrubber for the potroom off-gasses and will not be directly released to the marine environment. Any residual chlorine will be destroyed by the sulphite formed through the seawater scrubbing process. The discharge characteristics of the seawater from the scrubbers, and a comparison with emission standards, have been presented in Table 3.6 and are not discussed further here.
- 3.12.81 The cooling towers will generate emissions of salt aerosol; these will be minimised by the design of the cooling tower itself and by applying effective mist eliminators. An emission level of 0.0005% of the circulating water can be achieved. This is equivalent to approximately 25 kg/hr of salt "emissions".

Environmental Management

- 3.12.82 As noted at various points above, BAT extends to, and includes, consideration of how a plant is operated and managed. For the Qatalum Project an Environmental Management System (EMS) will be developed and implemented, based on the concepts of ISO 14001. This is considered to represent BAT for management techniques.

3.13 ANCILLARY PROCESSES, SERVICES AND UTILITIES

Overview

- 3.13.1 Auxiliary services / processes and utilities will include:
- the Port Area;
 - materials handling and storage;
 - potable water;
 - process water and process water cooling systems;
 - seawater and seawater cooling systems;
 - surface drainage systems;
 - sewerage system;

- fuel supply;
- emergency power;
- fire protection;
- compressed air and nitrogen supplies;
- laboratories;
- spare parts warehouses;
- maintenance shops;
- plant operation and administration centre;
- fire station;
- medical centre;
- mosque; and
- local services buildings (for wash and change facilities, eating rooms, prayer rooms etc).

3.13.2 At this stage in the Project, details of some of the above systems and services have not been finalised as their implementation and design will be the responsibility of the Contractor(s). However, the main auxiliary services (for example, cooling water systems, potable / process water supply and fuel supply) are discussed further below.

Port Facilities

3.13.3 The Port Area will have all necessary equipment required to enable loading and unloading of raw materials and products and their subsequent transportation to the Main Site (e.g. ship loader / unloader, conveyor system and storage units). The maximum ship size will be 65,000 dry weight tonnes (DWT). The storage and handling facilities to be located at the Port are discussed further below.

3.13.4 For the Original Port concept, all materials would be imported and exported from the Berth. For the Alternative concept, the Jetty (Berth No. 8) would be dedicated to bulk handling of raw materials and part of the planned new MIC Berth No. 7 would be allocated to Qatalum for export of products.

Materials Storage and Handling

3.13.5 Storage facilities for chemicals and materials will be designed and operated in accordance with regulatory requirements. Storage areas will be properly ventilated and protected against fire, and will have effective drains and spill containment systems. Chemicals that may react with each other will be properly segregated. For the storage of dangerous chemicals stored in quantities exceeding the limits stipulated in EU directive 96/082/EEC "Control of major accident hazards involving dangerous substances" (as amended by directive 2003/105/EC), the accident prevention and protection principles of the directive shall apply. Tanks, vessels and pipelines carrying liquids, which may be harmful to the environment, will be designed in order to minimise the risk of spills.

- 3.13.6 The main storage facilities will be established on the Main Site for raw materials, and in the port area for finished products. A storage area for solid waste containers will be set aside at a suitable location. Emissions and waste generation and the emission control measures associated with materials handling and storage are given in Section 3.15 below. An overview of the main storage and material transport systems is provided below.
- 3.13.7 Two alumina storage silos will be constructed, each with a capacity of 65,000 tonnes. One silo will be located in the Port Area and one will be located at the Main Site. A minimum store of 14 days of alumina consumption will be needed in case of delivery delays.
- 3.13.8 Three coke storage silos will be constructed, each with a capacity of 25,000 tonnes. One storage silo will be located in the Port Area and two storage silos will be located at the Main Site. A minimum store 14 days of coke consumption is needed in case of delivery delays.
- 3.13.9 A rail mounted travelling pneumatic ship-unloader will operate on the Qatalum Berth; this will be used for transporting both alumina and coke. The movable length for the unloader will be approximately 160 m. Alumina and coke will be discharged from the ship-unloader onto a conveyor belt and transferred to the port alumina and coke silos.
- 3.13.10 From the port storage silos, alumina and coke will be transported on the common conveyor system to the reloading station located by the Main Site storage silos. The reloading station diverts alumina and coke to the silo feeding systems via air slides.
- 3.13.11 An aluminium fluoride silo will be located at the Port and a day silo will be situated at the Main Site. Aluminium fluoride will be imported via the Qatalum Berth in big bags or containers; these will be lifted by a pneumatic system to the top of the Port storage silo from where the aluminium fluoride will be discharged to the silo. Aluminium fluoride will be transferred to the day tank by truck and blown into the day tank.
- 3.13.12 There will be two pitch storage tanks in the Port Area and a day tank at the Carbon Plant. All pitch storage tanks are traced with hot oil and insulated. The pitch storage tanks at the Port will be surrounded by a common bund, the day tank will also be bunded. Both bunds will be designed with sufficient capacity to contain at least 110% of the volume of the largest tank.
- 3.13.13 The hot pitch will be unloaded by use of an unloading pump on the vessel. The pitch is routed to one of the storage tanks in the Port Area via a loading arm and a common pipeline. The unloading time is about 15 hours. During unloading, the line will be heated (traced) by hot oil and insulated in order to keep the pitch temperature at 220-230 °C. Two separate hot oil loops are anticipated to be necessary to maintain the temperature. Vapour return from the storage tanks will be rerouted to the vessel via a vapour return line connected to the vessel manifold via separate loading arms.
- 3.13.14 After unloading, the loading arm will be disconnected and raised to drain the remaining pitch back to the vessel. All piping in the vessel will be sloped back to the vessel tank. The pitch line is not drained, but kept warm by circulation of hot oil. When draining is necessary, for maintenance etc., the line will be drained towards the pitch tanks.

- 3.13.15 The two pitch storage tanks in the Port Area will normally be open to atmosphere and purged with nitrogen. An anthracitic oil scrubber will be installed for treatment of the purge gas. During unloading the connection to atmosphere will be closed and vapour returned to the vessel. Pitch from the Port storage tanks will be pumped to the day tank as required. Pitch will be circulated in the day tank and to the Carbon Plant via the pitch feed/circulation pumps. Fume from the day tank will be treated in an anthracitic oil scrubber.
- 3.13.16 The aluminium products will be stacked at the Casthouse and transported to the Port Area for storage and export. Product storage in the Port Area will be in containers or on pallets.

Potable Water

- 3.13.17 Potable water will be used for all domestic uses (for example, canteens, laboratories, wardrobes, hand wash, toilets, safety showers, etc.) and for subsequent purification, for analytical and battery usage.
- 3.13.18 Potable water will enter the site at the south easterly boundary of the Aluminium Plant and will be routed to the potable water tank. The water will be distributed through buried pipelines via the potable water pump. The potable water storage tank will have a capacity of one-day consumption for all domestic consumers (design capacity 42 m³/h); the system load is expected to be 16 m³/h on average, with a peak load 35 m³/h.
- 3.13.19 The potable water pump will also deliver potable water to the safety shower storage vessel, water from this vessel will be distributed to safety showers by the safety shower circulation pump. Blow-down from safety shower system will be routed to the process water tank.

Process Water and Mass Balance

Process Water

- 3.13.20 Process water is required for internal use in the Aluminium and Power Plants. It will be supplied via the Potable Water System to the process water storage tanks and will be distributed to the consumers by the process water feed pumps. There will be dedicated water storage tanks for the Power Plant and for the Aluminium Plant.
- 3.13.21 The typical process water demand for the Aluminium Plant will be ~32 m³/hr; this is mainly required as make-up for the Casthouse direct contact cooling systems. The average demand for the Power Plant will be ~21 m³/hr; required primarily as make-up water for the boiler feed water system.

Process Wastewater System

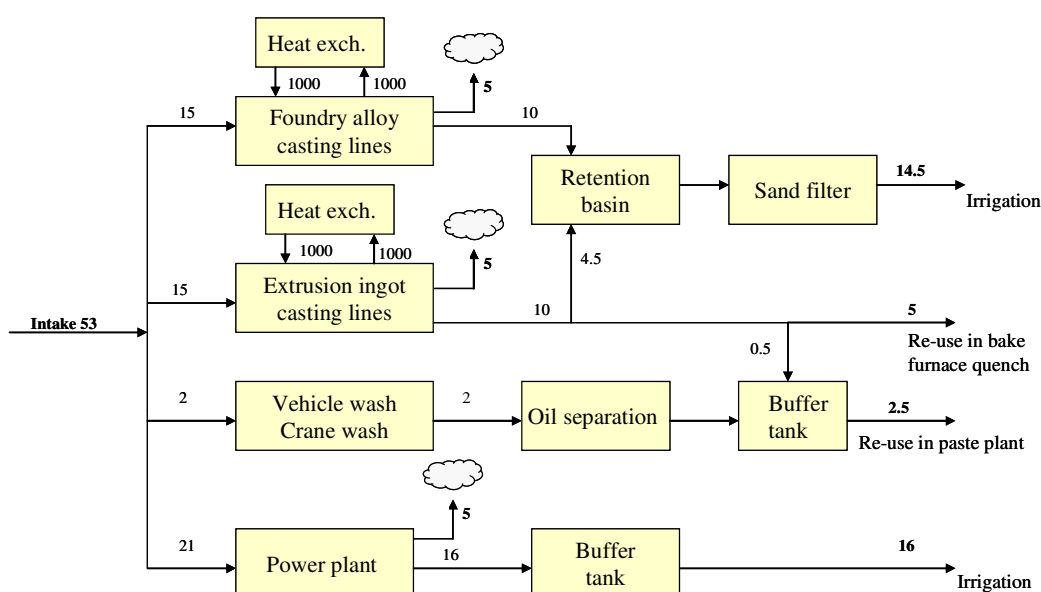
- 3.13.22 The objective of the process waste water system for the Qatalum Project is to minimise the amount of wastewater by internal recycling and re-use, where this is possible.

- 3.13.23 Oil contaminated drains water from the crane and vehicle wash areas will be routed to an oil separation / treatment plant. Any hydrocarbon sludge will be disposed of as oily waste. The treated water will be routed to a buffer tank for re-use in the Paste Plant for direct cooling of green anodes, along with a part of the bleed from the Casthouse extrusion ingot cooling water system. The water used for this process will evaporate; any residual oil that follows the green anodes will ultimately be calcinated in the anode baking furnace.
- 3.13.24 The anode furnace off-gas will be cooled, by quenching with an injection of water, before the off-gas enters the alumina dry scrubber. The remainder of the bleed from the extrusion ingot cooling water system can be re-used for this purpose. All the water will evaporate; any residual casting oil will be adsorbed onto the alumina, together with tar from the anode baking furnace. These organics will be destroyed when the alumina is fed to the pots.
- 3.13.25 It is anticipated that the remaining wastewater from the aluminium plant will be clean enough to meet irrigation water standards without further treatment. However, at this stage a retention basin and a sand filter are foreseen prior to distribution to the irrigation system.
- 3.13.26 The boiler blow down water from the Power Plant will be relatively pure, with a low content of some phosphate and ammonium salts. Once cool, this water can also be directly used for irrigation. Other small wastewater streams from the Power Plant, such as that from ion-exchange regeneration and cleaning operations, are expected to be mixed with the blow down water prior to use for irrigation purposes.

Process Water Mass Balance

- 3.13.27 The mass balance for fresh process water use is outlined in Figure 3.19 below. In summary, of the 53 m³/hr of intake water, 15 m³/hr will evaporate to atmosphere, 7.5 m³/hr will evaporate during re-use in the Carbon Plant and the remaining 30.5 m³/hr will be used as irrigation water.

Figure 3.19 – Fresh water Use Schematic (units in m³/hr)



Seawater System and Mass Balance

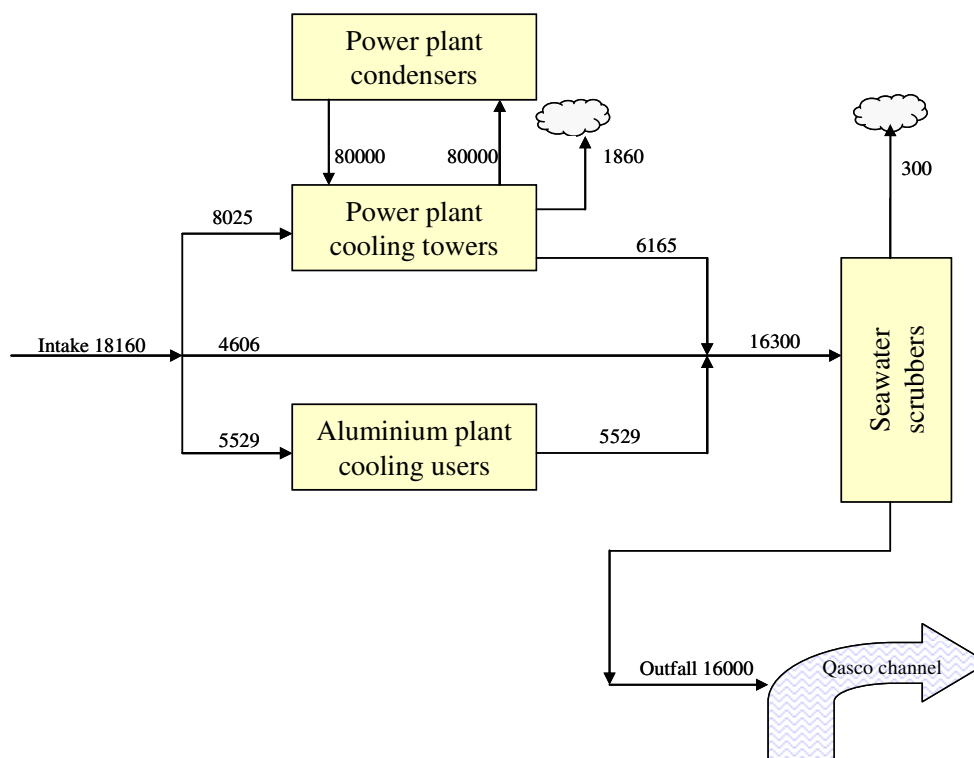
Seawater System

- 3.13.28 Seawater will provide make-up water for the Power Plant cooling tower system, the Aluminium Plant once-through cooling system and additional make-up water for the SO₂ seawater scrubbing system.
- 3.13.29 The seawater intake, including strainers and pump basin, will be shared between the Aluminium Plant and the Power Plant and will be designed with sufficient capacity for future expansion of the Qatalum Project. For Phase 1 of the Project, three pumps will be installed to distribute the seawater to the Aluminium and Power Plants. Design flow is anticipated to be in the region of 18,160 m³/hr. A further three pumps would be installed for the planned future expansion of the Qatalum Project. The location of the seawater intake has not been finalised, as this depends on which Port concept is ultimately selected; however, the intake will be located in the vicinity of the Qatalum Berth.
- 3.13.30 The cooling tower system will have side filtration and the necessary equipment for chemical dosing of the circulating water.
- 3.13.31 Used Aluminium Plant cooling water and the blow-down from Power Plant cooling towers will be routed to the SO₂ scrubbers, along with additional make-up water. Discharge from seawater scrubbers will pass, via the seal pit, into the QASCO channel at the point indicated in Figure 3.4. The characteristics of the seawater effluent are discussed further in Sections 3.12 and 3.15.

Seawater Mass Balance

- 3.13.32 A seawater mass balance for the basecase design is presented below in block diagram format. In summary, of the 18,160 m³/hr of intake water, 2,160 m³/hr will evaporate to atmosphere and the remaining 16,000 m³/hr will be discharged to the QASCO channel.

Figure 3.20 – Seawater Use Schematic (units in m³/hr)



Surface Drainage System

- 3.13.33 The surface water drainage system will collect clean stormwater from paved areas and roofs of buildings. To comply with Qatari statutory requirements, “all facilities shall have adequate capacity to hold potentially contaminated stormwater” and, if necessary collected stormwater should be, “directed through appropriate treatment facilities to meet the discharge criteria”.
- 3.13.34 Based on the above requirements the drainage system is foreseen to include:
- a pattern of open channels routed along main corridors and enveloping the Plant periphery;
 - common collection areas; and
 - a system for re-circulation and reuse of water (e.g. for irrigation).
- 3.13.35 Drainage from areas where the water can be contaminated with oil or chemicals shall be collected separately and treated before it is disposed of in accordance with the requirements of the local authorities. The design of the system shall cater for:

- safe and regular operation of the Plant;
- collection of excessive surface water where harmful to the regular operation;
- a free draining, flood protected external ground storage areas for spares, equipment, raw materials and products;
- protection and integrity of technical installations, electrical equipment in particular;
- adherence to authority requirements with respect to control of effluents in the surface water; and
- the MIC Authority requirements regarding retention basin for stormwater

Sewerage System

- 3.13.36 Domestic sewage will drain by gravity, supplemented by pumping where necessary, to a local sewage tank. The local sewage tank feeds into a sewage collection tank with sufficient capacity for two days sewage production. The sewage collection tank will be equipped with an emergency overflow discharge to sea as an ultimate emergency control measure. Under normal circumstances, the sewage will be collected from the collection tanks on a routine basis by trucks, equipped with self-carried suction pumps, and transported to the MIC treatment plant. The average sewer system load is 16 m³/h; peak load and design capacity is 35 m³/h.
- 3.13.37 In the future, it is understood that the MIC Authority plans to install a pipeline system for the direct transport of sewage from the plant boundary to the MIC sewage treatment plant. If the pipeline transport route becomes available, a piping system from the collection tanks to the MIC pipeline at the site boundary would be installed.

Fire Water

- 3.13.38 A part of the process water storage tanks capacity will be dedicated to the supply of firewater. Firewater ring mains will be continuously supplied with water from the water storage tanks by the firewater jockey pumps. In the event that the jockey pumps cannot maintain the required water pressure, due to release of firewater from a hydrant or a sprinkler system, the main firewater pumps will be designed to supply firewater at a high consumption rate.

Fuel Gas Supply

- 3.13.39 Fuel gas will be supplied from the terminal point to the Aluminium Plant consumers. System capacity for the Aluminium Plant is based on a design consumption of 87,54 MJ/s, corresponding to 9,879 Sm³/h.
- 3.13.40 The Aluminium Plant fuel gas system includes gas emergency shut-down (ESD) valves, filter/separators, ultrasonic metering and fuel gas heaters before distribution to the consumers. Gas pressure will be reduced to Aluminium Plant net pressure. A blow-down system and vent to atmosphere is included as part of the system. Any condensate collected in the local consumer filters will be manually drained and discharged as hazardous waste.

Emergency and Essential Power

Emergency Power

- 3.13.41 A 6 kV emergency generator will be connected to an emergency and essential grid, which will be connected from a switchboard, located in the substation for the air compressors, to the emergency consumers inside the plant. The size of the generator will be approximately 1 MVA. The Aluminium Plant consumers that require emergency power supply are:

- the baking furnace emergency suction and safety system inside the Anode Bake Plant;
- the fire water booster pumps inside the Paste Plant; and
- one main fire water pump.

Essential Power

- 3.13.42 Essential power will be supplied from 11 kV black-start generators at the Power Plant. The generators will be connected to the 6kV emergency and essential grid through an 11 kV to 6 kV transformer. Identified consumers that will require essential power backup are the:

- pots (anode jacket motors);
- crane above the Induction furnace inside the Anode Service area;
- one main fire pump;
- operating centre; and
- ship unloader and the Jetty cranes.

Uninterrupted Power Supply (UPS)

- 3.13.43 In each process area an UPS will be installed for all consumers that need uninterruptible emergency power. Consumers will include emergency lights, SAS equipment, all automation equipment and other critical equipment. A 110V DC UPS for switchgear control voltage will be provided in all main substations.

Fire Protection

- 3.13.44 Fire alarms will be installed to alert personnel in the event of a fire. Every fire alarm system will be associated with a fire alarm control unit, located adjacent to the main building entrance on the ground level. In areas containing more than one building the control unit will be located in a building as close as possible to the access gate normally used by the fire service.
- 3.13.45 A master control unit will provide centralised monitoring and alarming of all fire alarm systems installed on the plant. The status of the master control unit will be available in the Central Control Room (CCR), main gate and fire station.

Compressed Air and Nitrogen

- 3.13.1 The main compressor plant, serving Reduction Plant, Carbon Plant and Casthouse, will consist of four centrifugal air compressors, each with a capacity of 33% of total design flow, with after-coolers, filters and air driers. The design flow for the system is

approximately 76,440 Sm³/h, which is the sum of the required continuous flow and ~30% of the maximum intermittent flow requirements.

- 3.13.2 One (or two) compressors will also be installed to supply compressed air to the Qatalum Jetty / Berth, to serve the seawater intake utility stations. In addition, a temporary compressor plant will be installed to supply sufficient air for simultaneously cooling a total of 20 cathode shells; the requirement for this is 2,100 Sm³/h and a pressure of 4.5 bara.
- 3.13.3 Nitrogen is required for purging of the pitch tanks; it will be stored on-site in bottles.

3.14 OPERATIONAL MATERIAL AND RESOURCE USE

Main Materials Usage

- 3.14.1 The main raw material usage for Phase 1 of the Qatalum Project is summarised in Table 3.9. Process water and seawater use has been presented separately in Section 3.13 - Ancillary Processes, Services and Utilities. Gas use is presented in Table 3.11 below.
- 3.14.2 The raw materials consumed in the Paste Plant will be supplemented with recycled materials, including:
- butts, 63 kt/yr;
 - baked scrap, 6 kt/yr;
 - green scrap, 10 kt/yr; and
 - dust from the anode cleaning station (from the sawing of slots in the baked anodes).

Table 3.9 – Main Use of Raw Materials (Phase 1)

Plant	Raw Material	Quantity	Units
Paste Plant	coke	216	kt/yr
Paste Plant	liquid pitch	50	kt/yr
Bake Plant	packing coke	3	kt/yr
Reduction Plant	alumina	1130	kt/yr
Reduction Plant and Casthouse	aluminium fluoride	10	kt/yr
Casthouse	argon	0.6	kt/yr
Casthouse	re-melt metal	19	kt/yr
Casthouse	Alloy metal elements	7.5	kt/yr
Casthouse	silicon	22	kt/yr

Secondary Materials Usage

- 3.14.3 The table below gives a preliminary list of the other raw materials used and their approximate annual consumption.

Table 3.10 – Other Raw Materials (Phase 1)

Raw Material	Quantity	Units
Refractory bricks	2,800	t/yr
Cathode blocks	2,480	t/yr
Cathode bars	2,300	t/yr
Cast iron	500	t/yr
Cathode paste	1,000	t/yr
Silica carbide	560	t/yr
Soluble oil	160	t/yr
Lubricating oils	224	m ³ /yr
Lubricating grease	60	t/yr
Diesel fuel	680	m ³ /yr
Gasoline	160	m ³ /yr
Nitrogen	not yet determined	-
Propane	not yet determined	-
Water treatment chemicals	not yet determined	-

Fuel and Power

- 3.14.4 Phase 1 of the Project will result in the consumption of 8,500 GWh/yr of electricity; anticipated gas use figures are presented below.

Table 3.11 – Phase 1 Gas Use

Plant	Quantity	Units
Power Plant	1860	MSm ³ /yr
Paste Plant (hot oil heater)	3	MSm ³ /yr
Anode baking plant	24	MSm ³ /yr
RTO	4	MSm ³ /yr
Casthouse furnaces	22	MSm ³ /yr

3.15 EMISSIONS AND WASTE GENERATION

3.15.1 This Section seeks to summarise the principal sources of atmospheric process emissions, aqueous discharges and wastes associated with the operation of the Qatalum Project. This Section builds on (where necessary) and consolidates the information already provided in the Sections 3.11 and 3.12 (Process Description and Technology Selection and BAT). This Section also summarises the emission reduction and control techniques or mitigation measures have already been considered and adopted for the Qatalum Project. The potential environmental impacts of these releases and the assessment of their significance are addressed in Chapter 6.

Emissions to Atmosphere

3.15.2 The Aluminium Plant's atmospheric emissions will mainly originate from the:

- Reduction Plant potlines;
- the Carbon Plant;
- the Casthouse; and
- the Power Plant.

3.15.3 These are described in more detail Table 3.12 below. Following this, Table 3.13 quantifies the atmospheric emissions from the main sources. Finally a discussion on other, minor, sources of emissions is presented. The mitigation and control measures used to minimise these emissions have been discussed in Sections 3.11 and / or 3.12 and are summarised in Chapter 9. Preliminary proposed monitoring plans are presented in Chapter 8.

Table 3.12 – Summary of Main Atmospheric Emission Sources and Discharges

Emission Source Reference No.	Source	Activity	Emissions
1 & 2	Potroom – building ventilation	Aluminium reduction	CO ₂ , CO, HF, particulate fluoride, SO ₂ , PAH and traces of PFCs
3, 4, 5 & 6	Potroom – fume treatment	Aluminium reduction cells	CO ₂ , CO, HF, particulate fluoride, SO ₂ , PAH and traces of PFCs
7	Carbon Plant – Paste Plant process off gas	Mixing / forming / heating	Pitch fume (including PAH), dust
8	Carbon Plant – Bake Plant furnace off gas and combustion gases	Anode baking	Tar / pitch fume (including PAH), fluorides (HF and particulate fluoride), SO ₂ , dust and combustion gases ^a
9, 10, 11, 12 & 13	Casthouse	Fluxing, furnace charging, mixing and crucible cleaning	Metal oxides, dust & fluorides
14, 15, 16 & 17	Power Plant – gas turbines	Combustion of natural gas	Combustion gases ^a
-	Power Plant –cooling towers	Cooling	Salt aerosol

Notes:

- (a) Combustion gases from low sulphur natural gas combustion are considered to be comprised mainly of CO₂, CO, water vapour and NO_x.

- 3.15.4 A summary of the quantities of the main atmospheric emissions are presented in Table 3.13.

Table 3.13 – Annual Releases of Atmospheric Emissions (t/yr)

	CO ₂	SO ₂	NO _x	PM ₁₀	PM-F	HF	PAH ^a	PFC ^b
Potroom vents	-	175	-	157	76	88	0.02	
Potroom FTP / SWS stacks	880,000	1,658	-	60	5	5	0.07	175,000
Paste Plant	-	-	-	15	-	-	0.92	
Bake Plant	140,000	1,674	164	6	0.9	0.9	1.75	
Casthouse	40,000	-	18	40	-	-		
Power Plant	3,500,000	-	2,540	-	-	-		
Total	4,560,000	3,507	2,722	277	82	94	2.8	175,000

Notes:

- a PAH emission rates are based on the Norwegian definition of PAH, which includes 16 compounds – see Appendix H, Annex A for a full definition and a comparison to other international conventions for defining PAH.
- b PFCs are expressed as CO₂ equivalents

Other Minor Emission Sources

- 3.15.5 There are several plant operations that are associated with further, minor, potential sources of emissions:
- combustion gases from the gas-fired furnaces at the Casthouse and the gas-fired hot oil heaters at the Paste Plant and harbour;
 - unloading of ships (alumina, pitch fume and coke dust);
 - transfer points in material handling (e.g. Anode Service Area, Carbon plant); and
 - vents attached to storage silos and tanks for raw materials.
- 3.15.6 The Casthouse mixing and homogenising furnaces are fired by natural gas; this will give rise to combustion gases (CO₂, CO, water vapour and NO_x), which will vent to atmosphere from ~15 dedicated stacks. The two gas-fired hot oil heaters (one at the Paste Plant and one at the Port Area) will also generate combustion gas emissions. Emissions will be minor in comparison to the main sources presented in Table 3.12. Overall emissions will be controlled and minimised through good operational controls and regular maintenance and testing (to ensure efficient and optimum operation). In addition, the heater and furnace burners will be selected to ensure reduced NO_x formation. The use of gas as fuel will ensure that emissions of SO₂ and particulates are negligible and that, compared to oil fuelled furnaces / heaters, higher energy efficiencies and lower CO₂ emissions are achieved.

- 3.15.7 The ship unloading system, for both alumina and coke, will be based on suction unloading. This will minimise fugitive dust emissions compared to grab unloading systems. The alumina and coke are transported from the Port Area silos, by closed conveyor belts, to the storage silos on the site. Alumina is further transported to the feed silos of the FTPs by closed belt conveyors. From here, the alumina is distributed to the feed silos of the pots by a pneumatic system.
- 3.15.8 In addition to the fume and dust collector systems already specifically mentioned in Table 3.12, dust collectors are provided for all equipment and locations where dust is produced. Less than 10 mg/Nm³ of dust emissions are expected to escape from the dust collectors.
- 3.15.9 The pitch tanks at the Port will be connected to the ship via a vapour return line during unloading. During normal operation, the tanks will be purged with nitrogen, and the purge gas will be vented to atmosphere via an anthracitic oil scrubber. The vapour from the pitch day tank at the Carbon Plant will also be vented to atmosphere via an anthracitic oil scrubber.
- 3.15.10 The occasional operation of the emergency diesel generator units and the use of vehicles / ships will result in additional, but short-term, minor sources of combustion gases.

Aqueous Discharges

Seawater Discharge

- 3.15.11 As discussed above, the only source of seawater discharge during typical operation is the return of seawater, via the cooling systems, from the seawater scrubbers. The estimated rate of seawater discharge for the basecase design is up to 16,000 m³/hr tonnes per hour. The seawater return discharge point will be located at the bend of the existing QASCO discharge channel, as indicated in Figure 3.4.
- 3.15.12 As discussed in Section 3.12, paragraphs 3.12.40 onwards, the main characteristics of the discharge from an environmental perspective will be heat load, acidity and COD. Prior to discharge to sea, the scrubber effluent will be mixed with the cooling water discharge from QASCO, in the QASCO channel, where neutralisation and COD reduction will occur.
- 3.15.13 Biocide content will not be an issue as chlorination will be applied periodically at the seawater intake and in the cooling towers; any residual chlorine will be destroyed by the sulphite produced during the seawater scrubbing process. The cooling water from the towers may also contain solids (from the intake water and/or dust carried with the wind into the open system); however, the bleed will be filtered for suspended solids, prior to the seawater scrubber units.
- 3.15.14 A summary of the seawater discharge characteristics compared to discharge standards and achievable limits have been presented in Table 3.6. A preliminary proposed monitoring plan is presented in Chapter 8.
- 3.15.15 Discussions will be undertaken with QASCO and the MIC Authority; a communication system will be established regarding the discharge channel, also the legalities and split of responsibilities from a regulatory perspective will be established.

Fresh Water Process Effluents

- 3.15.16 The process water system and waste water treatment has been discussed in Section 3.13, paragraph 3.13.22 onwards and a mass balance has been presented in Figure 3.19.
- 3.15.17 There will not be any direct aqueous discharges resulting from fresh water use in the process. All used process fresh water that can not be re-used in the process will be treated to irrigation standards and stored in a buffer tank. The treatment processes will ensure that the Qatari standards for irrigation water are met and the water will be monitored to demonstrate compliance these standards prior to its use as irrigation water.

Sanitary Effluents

- 3.15.18 During operation, the Qatalum Project will have in the order of 1000 employees. Sanitary water from toilets, showers, washrooms, canteens etc. will be collected and transported to the MIC sewage treatment plant for further treatment. Initially, the sewage may have to be collected in tanks and transported by road to the MIC treatment plant; however, it is understood that MIC are planning to install a pipeline system that will enable the sewage to be pumped to the treatment plant.

Stormwater

- 3.15.19 The Contractor(s) will be responsible for the final design of the surface and stormwater drainage system; however, it is likely that stormwater from roofs and open areas will be collected in open ditches. According to the draft MIC Environmental Protection Guidelines, a system to collect, and if necessary, treat the first flush of stormwater is required; this will be taken into consideration during the finalisation of the drainage system design. Collected stormwater will be tested to ensure that it complies with the Qatari discharge criteria and used for irrigation purposes.

Wastes

- 3.15.20 The Qatalum philosophy on waste is to reduce, reuse and recycle all waste streams wherever possible. A full description and estimate of operational waste quantities and disposal options is presented in Section 6.8 and Table 6.12 – Waste Streams Generated During the Operational Phase of the Project. To avoid unnecessary repetition this has not been included here.