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Independent Market Operator of WA

Review of Fixed Fuel Cost for Maximum Reserve Capacity Price in the Wholesale Electricity Market

Diesel Fuel Storage and Handling Facility

24 November 2011

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Executive Summary

GHD has been commissioned by Independent Market Operator (IMO) of Western Australia to report on a concept design and costing for a diesel fuel storage and handling facility to provide for the 24 hour operation of a 160 MW gas turbine power station. The facility and power station are theoretical and this report is intended to form part of the information required by IMO for determination of the fixed fuel costs for the Maximum Reserve Capacity Price in the Wholesale Electricity Market.

The diesel storage and handling facility will have a gross capacity of 1100 tonnes and includes a 1000 tonne tank working volume plus a 100 tonne allowance for tank minimum working fuel level or dead volume.

GHD has prepared reports for IMO in the 3rd quarter of the previous four years covering the cost for the diesel fuel storage and handling facility. This report is similar to those reports with exception that the costs have been updated to a 2011 pricing basis.

The estimated capital cost for the fuel storage and handling facility as described in this report and including the value of a part-full working quantity of fuel is A$ 3.0M. This capital cost includes:

- A$ 2.3M portion for the engineering, procurement and construction of the facility,
- plus A$ 0.71M portion for the value of a base fuel storage quantity of 685 tonne (584 tonne working fuel quantity for a 14 hours operation plus 100 tonne minimum tank level quantity).

Costs are based on Year 2011 prices and exclude excise, GST and regulatory and compliance costs.

The estimate is of pre-feasibility or Type 1 quality as described in the Estimation Guidelines in Appendix B.

The price for diesel fuel is based on A$ 22.61/GJ (high heating value) and this corresponds to A$1.04/kg or A$ 0.874/L converted using diesel properties of 46 MJ/kg and 0.84 specific gravity. This price basis is obtained from Section 2 of IMO Final Report, “2011 Review of the Energy Price Limits for the Wholesale Electricity Market in the SWIS”, dated 14 September 2011”. This price includes transport costs and excludes excise and GST on the basis that both are rebated to the power generator.

The report describes the background, qualifications and conceptual basis for the scope, engineering and costing of the diesel storage and handling facility.

1. Introduction

1.1 Background

The Independent Market Operator (IMO) of Western Australia is required to periodically review the maximum prices in the Wholesale Electricity Market.

The Market Procedure for Determination of the Maximum Reserve Capacity Price details the methodology used by the IMO to calculate the Maximum Reserve Capacity Price. The Maximum Reserve Capacity Price is used in the Reserve Capacity Mechanism:

- to set the ceiling price or cap for the Reserve Capacity Auction if one is held, and
- is used in the determination of an administered price for capacity in the case where a Reserve Capacity Auction is not held.

Value for capacity in both cases is held in the notional construct called a Capacity Credit. Capacity Credits may be either traded bilaterally or can be bought and sold through the IMO.

The Maximum Reserve Capacity Price is based on the cost of procuring and installing an open-cycle gas turbine peaking power station within the South West Interconnect System (SWIS). The methodology uses a generic procurement scenario defined in the Market Procedure. Each year the IMO reviews the appropriateness of the values used to determine the Maximum Reserve Capacity Price.

One of the components in this process is the cost associated with the development and construction of an on-site liquid storage tank with sufficient capacity for 24 hours of operation on liquid fuel, including the cost of keeping the tank fuel content at a level sufficient for 14 hours operation at all times. This cost is denoted as Fixed Fuel Cost (FFC) in the Market Procedure.

The cost is to be expressed in Australian dollars and should include all design development and engineering costs.

GHD has prepared reports for IMO in the 3rd quarter of the previous four years covering the cost for the diesel fuel storage and handling facility. This report is similar to those reports with exception that the costs have been updated to a 2011 pricing basis.

1.2 Scope of Work as Described by IMO

The following description of the scope of work is extracted from the Section 2.6 of IMO Report "Market Procedure: Maximum Reserve capacity Price", Version 5:

> "***2.6 Fixed Fuel Cost***
>
> *2.6.1 The IMO must engage a consultant to determine an estimate of the costs for the Liquid Fuel storage and handling facilities including:*
>
> *(a) A fuel tank of 1,000 t (nominal) capacity including foundations and spillage bund,*
>
> *(b) Facilities to receive fuel from road tankers,*
>
> *(c) All associated pipework, pumping and control equipment.*
>
> *2.6.2 The estimate should be based on the following assumptions:*

a) *Land is available for use and all appropriate permits and approvals for both the power station and the use of liquid fuel have been received.*

b) *Any costing components that may be time-varying in nature must be disclosed by IMO. Such components might be the cost of the liquid fuel, which will vary over time and as a function of exchange rates etc.*

2.6.3 The costing must only reflect fixed costs associated with the Fixed Fuel Cost (FFC) component and must include an allowance to initially supply fuel sufficient to allow for the Power Station to operate for 14 hours at maximum capacity.

2.6.4 Fixed Fuel Costs (FFC) must be determined as at April in Year 3 of the Reserve Capacity Cycle. Where Fixed Fuel Costs have been determined at a different date, those costs must be escalated using the annual CPI cost escalation factor determined in Step 2.5.6 (c)."

The above IMO Report defines the Power Station as an industry standard liquid-fuelled open cycle gas turbine (OCGT) power station with a nominal nameplate capacity of 160 MW prior to addition of any inlet cooling system. The diesel fuel tank full capacity of 1000 tonne is sufficient for 24 hours of continuous operation of such power station.

1.3 Scope Qualification by GHD

The concept design and cost estimate for the fuel storage and handling facility is based on the following qualifications.

- The fuel facility concept design would be reasonably typical for storage and handling of diesel fuel for service to an open-cycle gas turbine power station.
- The facility battery limits start from the loading bay and manifold for receipt of fuel from road tankers through to storage tank, diesel transfer pumps, diesel filtration and ends at a tie-in point on the fuel transfer pipe to the gas turbines, not further than 100 m and upstream from the turbine fuel train limits.
- The facility design complies within AS 1940 and includes for spillage bund containment and fire protection accordingly.
- The basis for fuel quantity to be included in the cost estimate (14 hours operation) and the cost of fuel per litre will be provided from IMO.
- The cost estimate will not include the additional costs of a dual fuel gas turbine plant over a gas fuel only gas turbine.
- The cost estimate will not include modified burners for the gas turbine, water injection facilities and associated demineralised water production and storage facilities should such facilities be required for distillate firing.
- The concept design and cost estimate quality will be a Type 1 estimate as described in the GHD Estimation Guidelines shown in Appendix B.
- The concept design will be described in the report by schematic process block diagrams and schematic plot plan diagram of the facilities.

- The cost estimate in this report is prepared to a Year 2011 basis and IMO are to apply indexing to adjust the cost to the basis as required by the Market Procedure.

2. Engineering Basis

The scope and engineering basis for the conceptual design and indicative costing of the diesel fuel storage and handling facility are described in this section.

2.1 Design Standards

The facility is designed in accordance with AS 1940 “Storage and Handling of Flammable and Combustible Liquids” and also AS 4041 “Pressure Piping”.

The stored fluid is hydrocarbon automotive distillate (or diesel) and is classified as “combustible liquid Class C1”. The facility design assumes that the fuel is conditioned further by filtration and separation of any free water to a quality suitable for the gas turbine service.

The physical and thermal properties of diesel vary depending on grade or source. This report uses a high heating value of 46 MJ/kg and a specific gravity of 0.84.

The tank structural design is in accordance with API 620 “Design and construction of large, welded, low-pressure storage tanks”.

2.2 Facility Process Configuration

The conceptual fuel storage and handling facility schematic process block diagram and battery limits are shown in Figure 1 in Appendix A. The facility process scope includes:

- Road tankers unloading manifolds and pumps for fuel supply,
- Fuel storage tank of volume determined based on working fuel quantity and additional operational margins,
- Fuel transfer from tank to power station using pumping units, fuel conditioning (filtration and free water separation) and metering to be delivered to the fuel train inlet of the turbines at a suitable fuel quality and pressure (piping to a maximum of 100 m from facility boundary and upstream of fuel train),
- Oily water treatment for site drainage water, spillages and process drains,
- Spillage bund containment for main tank and all process areas,
- High plant availability on demand (duty and standby arrangement),
- Basic instrumentation for local pressure, temperature and level measurement,
- Fuel transfer control from the power station control centre,
- Electrical power provided to the facility switch box inlet terminals,
- Clear water drainage outlet provided to the facility boundary,
- Oily sludge collected by road tanker for off-site disposal.

2.3 Facility Layout

The conceptual fuel storage and handling facility schematic layout diagram and battery limits are shown in Figure 2 in Appendix A. The facility layout scope includes:

- Road tanker loading bay with sealed road surface,
- Fuel loading manifolds and pumps,
- Fuel storage tank of steel construction and with spillage bunds of concrete construction,
- Fuel transfer pumps including filtration and water separation,
- Oily water treatment system including sump pump and oily water separator,
- Connection to utilities such as power and drainage at the facility perimeter,
- Perimeter fence and gates.

Other infrastructure such as access roads, external site utilities, control centre, site security, and the like have been excluded on the basis that such will be provided as part of the overall power station infrastructure.

2.4 Fuel Storage Capacity

The stored fuel is required to operate the 160 MW gas turbine power station for an equivalent period of 24 hours at full load. The working fuel quantity of 1000 tonnes is calculated using a fuel high heat value of 46 MJ/kg and a fuel to electrical energy efficiency of 30% for an open-cycle turbine.

The tank gross capacity of 1,100 tonne is calculated based on a 10% allowance or 100 tonnes for a tank minimum working fuel level (or dead volume).

2.5 Tank Characteristics

The tank overall volume (floor to upper rim) is 1,443 m^3 calculated from the gross tank capacity using a fuel specific gravity of 0.84 and adding a 10% allowance for an ullage space above the maximum tank working fuel level.

A height to diameter aspect ratio of 0.5 is used and the calculated tank shell dimensions are 15.4 m diameter and 7.7 m height.

The tank arrangement is a vertical above ground tank with fixed roof. The material of construction is carbon steel and is externally coated using epoxy system.

The tank ground geotechnical properties are assumed to provide good foundation and therefore a conventional concrete ring foundation is used.

A spillage bund is provided for containment of the full tank gross volume. The bund walls and floor are constructed from reinforced concrete. The bund internal area is 35 m x 35 m and the bund wall height is 1.4 m being the sum of 1.1 m maximum containment level and 0.3 m additional allowance.

The tank structural accessories include fixed stairways and platforms for external access and manholes in the roof and side for internal access. The tank process accessories include inlet, outlet with floating suction header, vent and drain nozzles and instrumentation for level and temperature level.

2.6 Road Tanker Loading Bay

The fuel supply loading bay includes for a B-double loading area and two fuel loading manifolds with pumping units.

The loading zone is a sealed road surface and the manifold area is bunded with humps all around and drained to the main tank bund. Road access to the loading bay is excluded from the scope of this report.

The loading pumps are sized to transfer the 46 tonne B-double load to the tank within about 1 hour which equals to about 7.5 L/s through each of the two loading manifolds.

2.7 Fuel Transfer to Gas Turbines

Fuel is transferred from the storage tank to the gas turbines on demand by means of the pumping facility located adjacent to the main tank bund. The pumps are arranged in a duty run and standby run with each run including valves, pump and electric motor set, filter and coalescer/separator.

Each pump is powered by a variable speed drive unit included in the scope of the facility.

The transfer pumps instrumentation includes basic pressure gauges and metering. Pump operation and control is by the power station control centre.

The estimated fuel flow rate is 13.8 L/s for the power station full load condition of 160 MW and an operating pressure as required to suit the gas turbine fuel train specification.

The pumping piping also includes a bypass arrangement to allow circulation and mixing of the fuel in the storage tank if left stagnant for a lengthy period.

The pumping area is 5 m x 5 m with a concrete floor and a 0.25 m high bund wall.

2.8 Site Drainage

The drainage design includes oily water containment to capture any fuel leaks. All stormwater, flushing water and spillages are drained into the main tank bund sump where the collected water will be directed by manual inspection and control. Contaminated drainage will be diverted to an oily water separation unit and only clear water will be discharged to the main site drainage system.

2.9 Oily Water Treatment System

The oily water treatment system includes the main bund sump, an oil separator unit and a 10 m^3 sludge tank provided with the fuel storage facility scope.

Oily water may be collected from tank bund drainage, loading area drainage, other bunds, storage tank or vessels bottom settled water or flushing of oil or fuel spillages. All oily water is directed to the oily water separation unit. Clear water may be discharged to the site drainage system while oily sludge is directed to the sludge tank for collection by road tanker and off-site disposal.

The oily water treatment area is 5 m x 5 m with a concrete floor and a 0.25 m high bund wall.

2.10 Fire Protection

The fuel is a Class C1 Combustible Liquid and requires basic fire protection equipment such as hydrant hose and fire extinguishers as per AS 1940.

A powder-type fire extinguisher is installed at two locations along the tanker loading bay and one location near the transfer pumps.

2.11 Tank Location

The tank is located within the spillage bund and the bund dimensions provide sufficient separation from the fill points, equipment and security fence (>7.5 m). The design assumes that any office, building, workshop and amenity blocks will be located with at least 18 m separation from the storage tank.

3. Fixed Cost Basis and Estimate

The estimated capital cost for the fuel storage and handling facility as described in this report and including the value of a part-full working quantity of fuel is A$ 3.0M. This capital cost includes:

- A$ 2.3M portion for the engineering, procurement and construction of the facility,
- plus A$ 0.71M portion for the value of a base fuel storage quantity of 685 tonne (584 tonne working fuel quantity for a 14 hours operation plus 100 tonne minimum tank level quantity).

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An estimate summary is shown in Table 1.

Table 1 – Estimate Summary

No.	ITEM DESCRIPTION	A$'000
1	Fuel Storage Tank – ➢ fabrication and construction of roofed vertical tank, externally coated, process nozzles, access manholes and concrete ring foundation, ➢ Spillage bund of concrete wall and floor, ➢ Stairways and access platforms, ➢ Instrumentation for level and temperature measurement, ➢ Geotechnical investigation, hydrostatic testing and cathodic protection.	1,057
2	Fuel Supply Loading Manifolds (two sets) – ➢ Loading manifolds including valves and coupling, ➢ Loading pumps and motors, ➢ Piping and electrical works.	43
3	Road Tanker Loading Bay of sealed road surface	22
4	Fuel transfer mainline piping (from pumps to the gas turbines including valves)	86
5	Fuel Transfer Pumping (duty run & standby run) – ➢ Two fuel pump runs each with motor, filters & oil separators ➢ Flow meters, ➢ Piping and basic instrumentation, including floating suction header in tank, ➢ Concrete foundation and bunded plant area.	394
6	Oily Water Treatment System – ➢ Sump pump, ➢ Oil separator unit, ➢ Piping and electrical, ➢ Concrete foundation and bunded plant area.	63
7	Site preparation and early works	15
8	Perimeter fencing (cyclone wire mesh)	14
9	Fire protection (including hose reels and fire extinguishers)	12
10	Lighting	12
11	Mobilisation and De-mobilisation	30
12	Engineering, procurement and construction management (12%)	210
13	Contractor risk, insurance and profit (15%)	294
A	**Sub-total for facility installation**	**2,252**
B	**Base fuel storage of 815 m^3 (685 tonne) @ A$0.874/L**	**712**
	TOTAL	**2,964**

Appendix A

Facility Process Diagram and Layout (Figures 1 & 2)

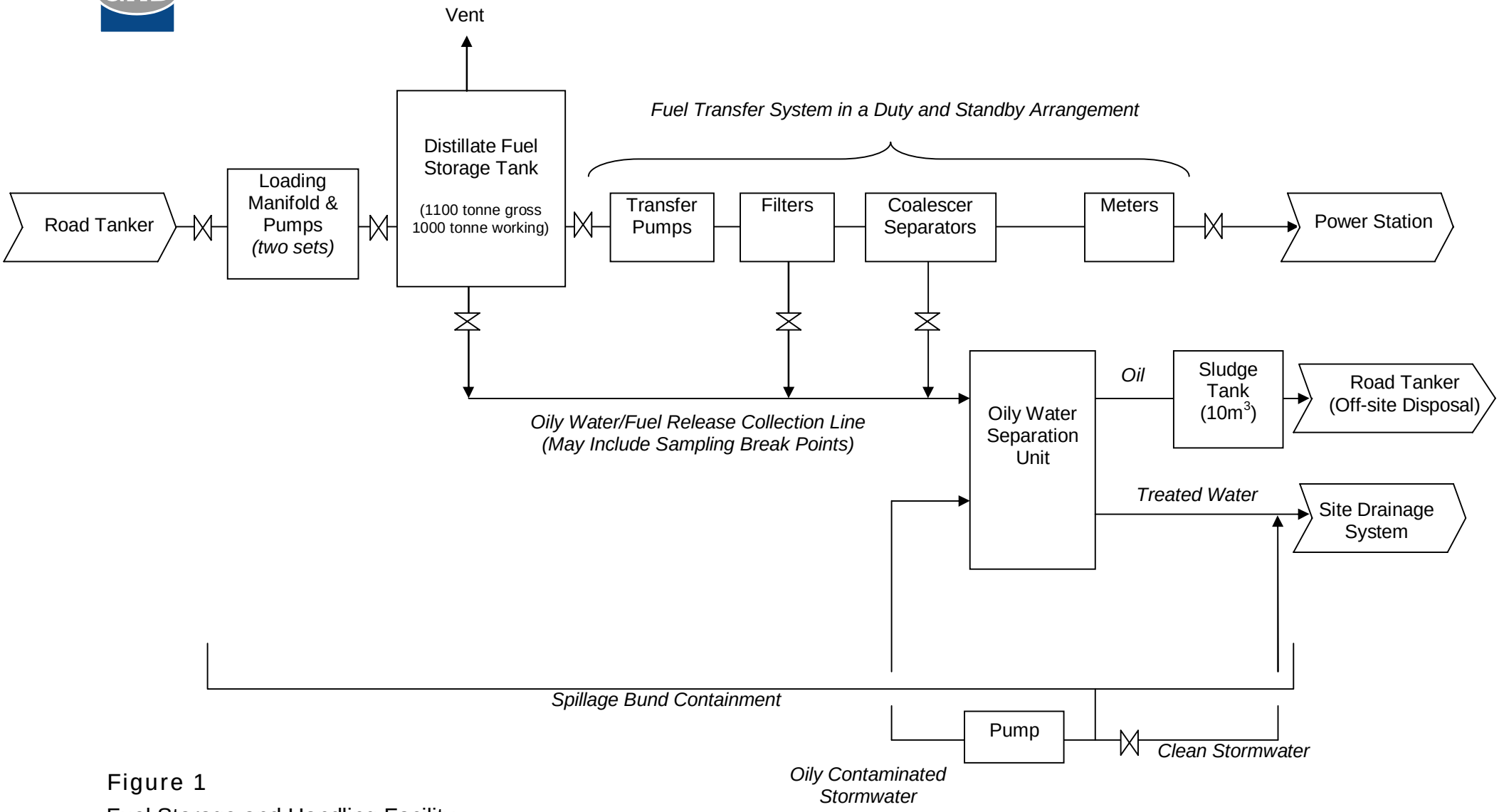


Figure 1

Fuel Storage and Handling Facility

Schematic Process Block Diagram

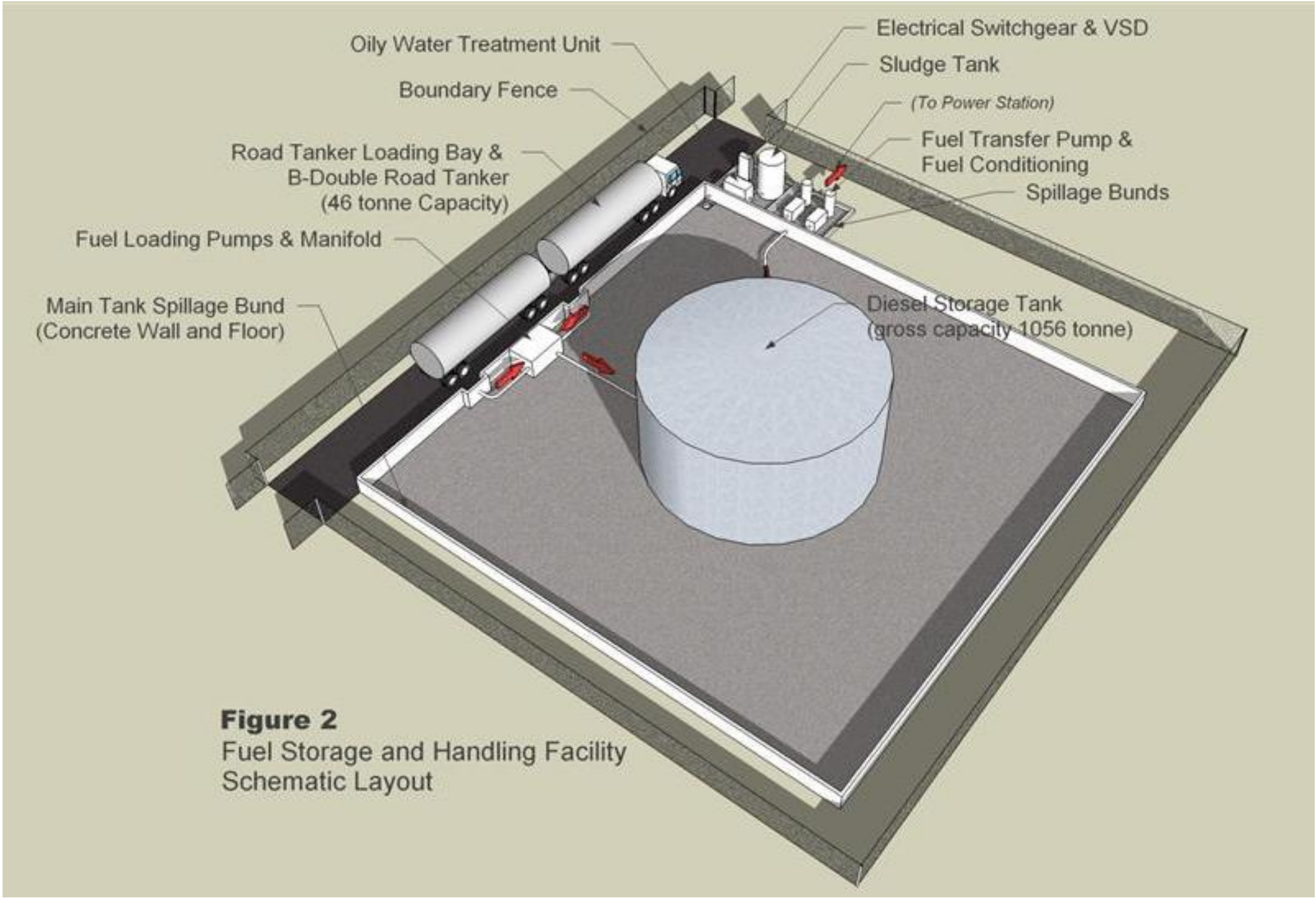


Figure 2
Fuel Storage and Handling Facility
Schematic Layout

Appendix B

Estimation Guidelines

Disclaimer:

GHD has prepared the cost estimate set out in this Report using information reasonably available to the GHD employee(s) who prepared this Report; and based on assumptions and judgments made by GHD as described in this Report.

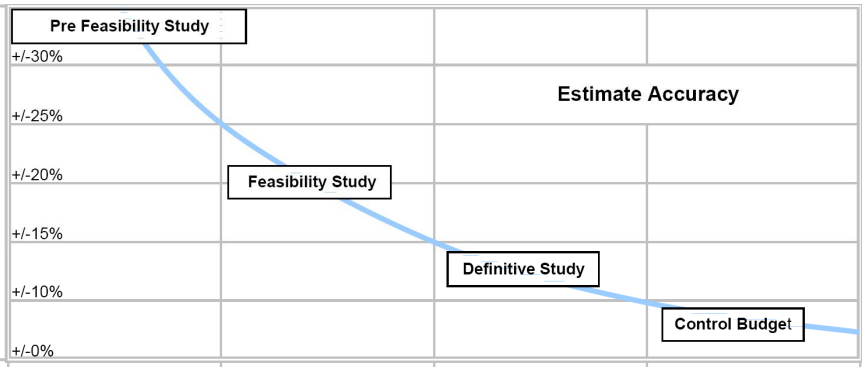
The Cost Estimate has been prepared for the purpose as described in this Report for use by IMO only and must not be used for any other purpose.

The Cost Estimate is a Type 1 pre-feasibility estimate only as defined in attached "Estimate Basis Guideline". Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. GHD does not represent, warrant or guarantee that the works as described can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. IMO should therefore select appropriate confidence levels to suit their particular purpose and risk profile.

GHD MANAGEMENT ENGINEERING ENVIRONMENT

Estimate Basis Guideline



		Type 1 "Order of Magnitude"	Type 2 "Feasibility"	Type 3 "Definitive"	Type 4 "Control"
Type of Estimate					
Purpose of Estimate		**Options Comparison**	**Economic Feasibility Study**	**Commitment & Funding Approval**	**Project Budget Confirmation**
Basis of Estimate		**Site**			
	Location	Assumed	Preliminary	Optimised	Confirmed
	Maps & Surveys	Nil	Preliminary	Detail	Final
	Geotech Data	Nil	Preliminary	Advanced	Confirmed
	Site Visits	Maybe	Desirable	Essential	Mobilised
		Process			
	Plant Capacity	Assumed	Preliminary	Final	Optimised
	Energy & Material Balances	Estimated	Advanced	Optimised	Confirmed
	Process Flow Sheets	Assumed	Decided	Optimised	Confirmed
		Engineering			
	Scope of Work Status	Conceptual	Probable	Confirmed	Complete & Signed Off
	Equipment Selection	Assumed	Preliminary	Optimised	Confirmed
	General Arrangements	Nil	Outline	Detail	Confirmed
	Piping & Electrical Drawings	Nil	Preliminary Single Line	Detail Single Line	Detailed
	Detailed Design Drawings	Nil	Nil	Some	15% Complete
	Specifications	Nil	Preliminary	Advanced	Final
	Status of Engineering Completion	<1%	1% to 5%	up to 10%	+15%
		Environmental & Safety			
	Status of EIS	Assumed	EIS part complete	EIS approved	Consent Conditions Complied
	Safety Plan	Assumed	Preliminary	High Level Hazop	Detailed Hazop
	Constructability	Assumed	Preliminary	High Level Analysis	Detailed Analysis
		Execution Plan			
	Schedule	Bar line	Bar line	Detailed	In Place & Operational
	Procedures & Controls	Assumed	Preliminary	Basis Agreed	In Place & Operational
		Capital Cost Status			
	Cost Approach	Factoring	Factoring and Preliminary QTO	Detailed QTO & Contractor Pricing	Optimised Pricing
	Major Equipment	Historical Costs	Single Source	Multiple Source	Optimised Tenders or Let Contracts
	Mechanical, Piping & Instrumentation	Factoring	Preliminary Takeoff	Detail Takeoff or Contractor Pricing	Tenders
	Civil, Structural Work	Rough Quantities, $ per unit volume	Preliminary Takeoff	Detail Takeoff or Contractor Pricing	Tenders
	Electrical Work	$ per KW	Preliminary Takeoff	Detail Takeoff or Contractor Pricing	Tenders
	Indirects	Factoring	Preliminary Calculation	Detailed Analysis	Optimised
		Estimate Features			
	Allowance for Growth	up to 30%	15% to 25%	10% to 15%	<10%
	Accuracy (90% Probability)	+/-30%	+/-25% to 15%	+/-15% to 10%	better than 10%
	Relative Cost of Study	X	5X to 10X	25X to 100X	varies

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A (DRAFT)	R.Romanous	J.Broadway				23.11.2011
B	R.Romanous	J.Broadway		J.Broadway		24.11.2011