ACID GAS OXIDIZER

A SUSTAINABLE DEVELOPMENT & CHALLENGES

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PROJECT BACKGROUND

PETRONAS Gas Berhad (PGB) was tasked to replace the existing Acid Gas Oxidizer (AGO) Units located at our Gas Processing Plant (GPP) 2, 3 & 4, Kerteh, Terengganu, Malaysia in order to comply with Environmental Quality (Clean Air Regulations 1978). These AGO units serve to oxidize acid gas consisting predominantly of Carbon Dioxide (CO_2) and small amount of hydrocarbon and Hydrogen Sulphide (H_2S) from Acid Gas Removal Unit (AGRU) in respective plants before discharging to the atmosphere.

The existing AGO units were installed and commissioned by Contractor in 1992 for GPP 2 & 3 and 1995 for GPP 4 respectively. However, the unit ceased to operate after sustaining various extensive problems during initial start-up.

In consideration of environmental concerns and to ensure compliance to Department of Environment's (DOE) regulations, it is vital for those units to be put back into performance. After series of studies conducted since June 2003, PGB Board had approved the implementation of AGO Project in November 2005.

In January 2009, the 1st AGO unit was successfully commissioned and subsequently 2nd and 3rd unit in March 2009 and April 2009 respectively.

ENVIRONMENTAL CARE IS OUR RESPONSIBILITY

PGB remains committed to add value to Malaysia's natural gas resource. Weaving together strong operational and people excellence for over 25 years, we continue to forge ahead with resilience amidst an increasingly challenging environment and deliver value to its stakeholders.

Underlying all activities within the PGB is its Health, Safety and Environmental (HSE) Policy. The HSE Policy dictate our priority in ensuring safety of our operations, caring for the well-being of our employees, the surrounding local communities and the environment, and safeguarding our investments at all times.

PGB is committed in limiting emission of greenhouses gases into atmosphere. The commitment to reduce Greenhouse Gas Emissions (GHG) from our operations is aligned with PGB's business objectives as well as adheres to the HSE policy.

PETRONAS' domestic GHG emissions for 2009 were 32.7 million tonnes of CO_2 equivalent ($MtCO_2e$), a reduction of 3.4 $MtCO_2e$ from the previous year. GHG reductions were achieved through various efforts to reduce flaring emissions from gas processing and liquefaction plants, which accounts for half of the PETRONAS' domestic emission (i.e. 16.6 $MtCO_2e$), while the combustion of fuel for these processes are the primary source of GHG emissions from these operations.

Among the main sources of fuel gas consumption by PGB are its acid gas oxidizer and generation of gas heaters. Both units had an increase in uptime for 2009 compare to previous year. However, the improved uptime increased the equipment's annual fuel consumption, and this resulted in the generation of an additional 1.0 $MtCO_2e$ for 2009.

Higher AGO uptime for that year also benefited PGB by reducing its H_2S emissions to less than 1ppm, which is well below the DOE requirement.

SIGNIFICANT CONTRACTING STRATEGY

A genuine challenge for non-profitable project such as AGO is to realize it in the most economic, cost effective and having added value to the company.

Unlike other common contracting strategy in oil and gas industry, the Project Management Team (PMT) proposed a strategy guided by the following goals;

a. Capitalization of Internal Capabilities,
b. Maximize Local Contents, and
c. Full compliance to the DOE requirements.

The overall contracting strategy was successfully crafted using the above criteria and was approved by Management in February 2006 as shown in Table 1.

The project was divided into five main contract packages which include Basic Engineering Design (BED), Detailed Engineering Design (DED), Procurement of AGOs, Glass Reinforce Epoxy (GRE) Pipes, Control and Shutdown Valves and Installation Works. Each package has its own unique strategy in optimizing the cost.

Each package has sustainable elements engineered and was executed with full commitment from the PMT with one focus of materializing it at low cost, safely and reliably.

Table 1 – List of Contract Packages.

Item	Contract Packages	Contractor	Mode of Contracting
1	Basic Engineering Design	Perunding Ranhill Worley Sdn Bhd	Single Sourcing
2	Detail Engineering Design for Balance of Plant	Perunding Ranhill Worley Sdn Bhd	Single Sourcing
3	Supply and Delivery of Acid Gas Oxidizer (AGO)	Preselected Bidders	Short listed Competitive Bidding
4	Procurement of Long Lead Items (Line Pipe & Valves sub-packages)	MITCO (Japan) Sdn Bhd (MJSB)	Competitive Bidding via MJSB
5	Construction and Installation	Preselected Bidders	Short listed Competitive Bidding

STRATEGIC ENGINEERING APPROACH

Both BED and DED for Balance of Plant (BoP) was out sourced to local engineering company namely Perunding Ranhill Worley Sdn Bhd (Ranhill) through Panel Consultant Service Agreement (PCSA).

They have demonstrated that they are capable and experienced to perform the works especially in our GPP. Ranhill also has collaboration and received support from Worley Parsons Ltd based in Houston, Texas, USA.

A contract for BED and DED was awarded to Ranhill in April 2005 and May 2006 with the contract amount RM1.77million and RM3.5million respectively. The contract prices for both scopes derived from unit rates agreed in PCSA and was divided into two categories as listed below;

a. Fixed Lump Sum for Engineering Fee (manhours), and
b. Reimbursable Cost.

AGO project has benefited from smart collaboration between local and international reputable consultant particularly on thermal oxidizer. 90% of the Consultant's manpower was based in Kerteh, Terengganu. As a result, it has created a very competitive cost for AGO project. The rest of manpower were located at head office, Kuala Lumpur and one AGO specialist from Worley Parson stationed at Texas, USA.

BED took five months to be completed while DED was completed in September 2007 within seven months including nine months for interfacing period with AGO detailed engineering by John Zink Company LCC (John Zink), Tulsa, Oklahoma, USA.

As a result of the above, the average costs per manhour for both BED and DED are much lower than market price at award time as tabulated in Table 2.

Table 2 – Cost Comparison for Engineering between AGO Project and Other Projects.

Item	Project Name	Client	Year	Average Cost/Manhour (RM)
1	Acid Gas Oxidizer Project	PETRONAS Gas Berhad	2005	123.88
2	Plant Rejuvenation & Revamp 1 Project	PETRONAS Gas Berhad	2001	360.53
3	Kuantan Segamat Compressor Station Expansion Project	PETRONAS Gas Berhad	2002	162.78
4	Cogeneration Project	PETRONAS Penapisan (Melaka) Sdn Bhd	2004	229.76
5	Debottlenecking Project	PETRONAS Fertilizer Kedah Sdn Bhd	2005	333.77
6	Turkmenistan Gas Separation Plant Project	PETRONAS Gas Berhad	2007	204.16
Notes: Average cost per hour has rationalized to year 2005 and converted to RM equivalent.				

This engineering approach provides great opportunities for our engineers to be exposed by working together with Ranhill. This has put PGB one step ahead in developing capability of our engineers through this strategy. On the other hand, we also gain intangible benefit from this smart approach by creating an opportunity of having full direct control on engineering activities and managing interfacing between DED for AGO and BoP.

This approach is significantly important for plant operation improvement project which requires a lot of interfacing and coordination aligned with existing live plant operation philosophy. These efforts also facilitate in reducing engineering duration especially in getting plant data and information. Interfacing between both engineering activities for AGO and BOP can be easily controlled and monitored by the PMT.

Plant inputs and data such as gas composition are important elements to be used for basis of design and it is crucial for both engineering design for AGO and BOP. Accurate input will lead to a superior design in meeting regulatory requirements'. As an expert in engineering and proven manufacturer for thermal oxidizer, John Zink had managed to design the AGO according to the standard using inputs from plant.

PMT had actively participated in engineering activities such as design review, HAZOP, CDF Modelling, Dynamic Modelling including witnessing 'Scale Testing' at their facilities in Tulsa, USA.

Triggering factors for such testing are;

a. First single installation of thermal oxidizer unit in oil, gas and petrochemical plant within this region, and
b. First custom design by thermal oxidizer Vendor.

Our dedication in quality standard on the principle of “Right Things Right Every Time” has translated into this effort. We specified the requirements in the contract to ensure the design is working and reliable. It has proven that zero modification and/or redesign happened in this project.

INNOVATION IN MATERIAL SELECTION

A major contribution to the overall cost reduction of this project is our innovative material selection by using non-metallic material i.e. Glass Reinforced Epoxy (GRE) pipes instead of common practice using metallic material.

BED has shown that existing AGO location is not suitable to install a new AGO units due to safety distance requirement as specified in PETRONAS Technical Standard (PTS) and Industrial Risk Insurance (IRI).

The nearest suitable location for new AGO units are located approximately 800 meter via shortest pipe rack route in the plant. Therefore, additional pipeline shall be installed to transfer acid gas from AGRU at respective plant to the new location.

As recommended in the standard and common practice in oil and gas industry, a metallic pipe such as stainless steel pipes instated of carbon steel pipes shall be used to transmit waste gases consisting major composition of fluids with 80-99% wet CO_2, 2-15% hydrocarbon and 3-6% water contents. The characteristic of these waste gases will easily corrode a metallic pipeline especially for carbon steel pipe.

PMT had explored alternative options on how to reduce the cost because using stainless steel pipes will drastically increase the project cost. Since this is not a profitable investment to PGB, it imposed a huge pressure and challenged the PMT to minimise the cost and at the same time to comply with the regulatory requirement.

Moving forward with the ideas generating from our engineers in utilizing the non-metallic piping material, we had engaged PETRONAS Research Sdn Bhd (PRSB) to conduct a study on this option including undergoing material prequalification testing by non-metallic composite manufacturer. The study and its application were conducted within 3 months consuming 144 manhours at the cost of RM50,000.00 only.

Rationales in using non-metallic composite piping concluded from the study conducted by PRSB are;

a. Cost effective corrosion resistant solution to transfer wet CO_2, and
b. Estimated weight 1/3 of metallic piping, ideal option to install on existing supports and structures in brown field environment.

Nevertheless, bigger challenges awaiting the PMT for this application are; Designing the 1st large diameter composite pipes for gas application and installation of new 32" gas pipeline on existing pipe rack 20 meter above ground in a live plant (brown filed).

This innovation has resulted huge cost saving to the project in terms of piping material cost as well as the construction cost as shown in Table 3.

Table 3 – Cost Comparison between GRE Pipe and Metallic Pipe.

Item	Piping Material	Cost/M (RM)	Estimated Cost (RM)	Delivery (Week)	Remarks
1	32" Carbon Steel	3,800.00	8,360,000.00	20	- Cost Estimate in Jan 2006 - Total Length 2.2KM - Pipe only excl. fittings
2	32" Stainless Steel	8,100.00	17,820,000.00	20	
3	32" GRE	1,800.00	3,960,000.00	12	

A SIGNIFICANT PROCUREMENT VENTURE

Direct procurement by owner for long lead equipment and supplying them to the Contractor has reduced the overall procurement cost for AGO project. This approach has indirectly eliminated potential profit margin and reduced the overhead margin normally priced by the Contractor, if the scope for procurement were part of their contract. This practice has been part of our system and implemented many times in our projects.

In general, procurement cost for normal project is within 40% to 55% of total project cost. An effort in cutting the cost will give a significant impact in reduction of the overall project cost.

Believing in that principle, PMT has put an effort to capitalize our internal advantage by appointing our sister company namely Malaysian International Trading Corporation (Japan) Sdn Bhd (MITCO) to carry out the procurement of selected material and equipment on behalf of PGB.

Being an established trading company, we have benefited via a very competitive price provided by MITCO for GRE Piping System, Control Valves and Shutdown Valves. This is due to alliance, price agreement and network with many vendors, stockist and suppliers around the world.

A major critical component for AGO project was the supply and delivery of AGO itself. The contract for this package has been awarded to John Zink amounting to USD7.64 million.

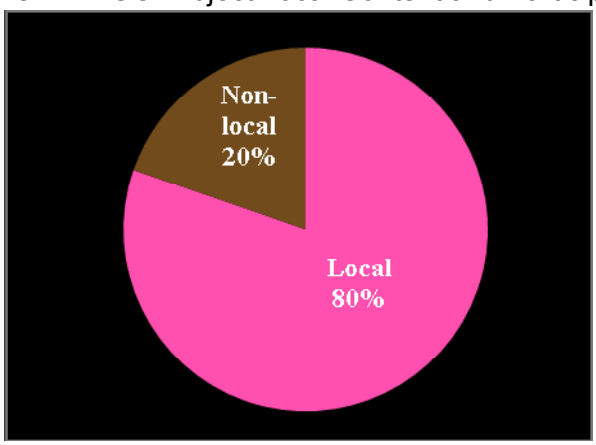
In this contract, PMT manage to save USD220,000.00 by introducing a flexible schedule as part of the contract for Supply and Delivery for AGO. We adopted a 'just in-time' concept while adjustment of delivery time are aligned with the 'Require on Site (RoS)' by the installation Contractor.

The owner doesn't have to pay additional cost to vendor for fixed delivery date. In normal circumstances, the RoS dates are always uncertain upon award of contract. This concept has totally eliminated the storage, preservation and loading/unloading cost at site.

DEDICATION IN SOCIAL OBLIGATION

As a public listed company in Malaysia and being a subsidiary of the national oil company, social obligation is part of our agenda. The AGO project makes PGB visible and transparent to maximizing local contents and participation of local companies as illustrated in Figure 1.

Figure 1 – AGO Project Local Content and Participant.



AGO and BoP were successfully installed by a 100% 'bumiputera' owned local Malaysian Contractor namely Aqeel Engineering & Construction Sdn Bhd (AEC) which was established since 1995. As a new player, AEC managed to secure their biggest contract for the Procurement, Construction and Commissioning Assistant (PCC) amounting to RM54million through shortlisted competitive bidding.

In October 2007, the PCC works commenced by AEC. Fourteen (14) months later, in January 2009, the 1st AGO unit for GPP 2 was successfully commissioned and continued with 2nd unit for GPP 3 and 3rd unit for GPP 4 in March 2009 and April 2009 respectively.

As a local contractor with small paid up capital, AEC requires a strong financial background and cash flow to run the project smoothly. We introduced payment incentive in this contract to support the contractor and at the same time ensuring our interest is well protected.

We also designed the term of payment and progress measurement to minimize dispute and allowing payment to be made on time. With this system, we manage to shorten these activates within a week and paid the Contractor less than a month upon receive of their invoices. This approach helped Contractor to maintain their cash flow and performing their works effectively.

All fabrication works for AGO stack was fabricated by John Zink's subcontractor; i.e. a Malaysian company, Syarikat Steelcon Sdn Bhd. This company contributes nearly 22% of total contract price amounting RM5.8million for the supply and delivery of AGO. This

scenario had again proven that Malaysian company is capable to produce high quality product and is trusted by the international and well establish company like John Zink.

This approach was achieved from flexibility introduced in the condition of contract between PGB and John Zink which allowed participation of local company and at the same time reducing the cost for supply and delivery of AGO.

John Zink had also appointed a local agent namely TriSystem Engineering Sdn Bhd to represent them in Malaysia especially to liaise with regulatory bodies/authorities and communication with their appointed sub vendor or sub-contractor in Malaysia.

Another factor that link to a high local content is the manufacturing of GRE pipes that were manufactured in Senai, Malaysia. Ameron Malaysia Sdn Bhd (Ameron), Singapore based company was awarded a contract to Supply and Delivery of GRE Piping System with value RM5.5million through our procurement arm i.e. Malaysian International Trading Corporation (Japan) Sdn Bhd (MITCO).

The state-of the art factory and first in this region is capable to produce high quality GRE pipes and fittings for oil and gas industry including it testing facilities. Vigilant process in choosing a local manufacturer and fabricator like Ameron and Steelcon has tremendously reduced the shipping and transportation cost, and at the same time created business opportunity to local transportation companies.

A SATISFACTION JOURNEY; ECONOMIC, SAFE & RELIABLE

The six years journey of the AGO project which was completed in April 2009 with total project cost at completion amounting RM107million or equivalent to USD30.57million including project supervision cost which was well within our budgeted cost.

The strategy, innovation and team work are the essence to the success of the AGO project. Besides low engineering cost, tremendous cost saving using GRE piping system and well-organized procurement strategy, PGB had managed to save estimated RM8million compared to only RM4.5million (4.2% of total project cost) that PGB had spent for PMT cost instate of engaging PMC.

The AGO project had achieved its objective not just in economic aspect but also in HSE as well. The AGO project has recorded an excellent HSE track record with zero Lost Time Injury (LTI) with nearly one million working safe manhours. Due to that reason, AGO Project received the MSOSH Gold Merit Award from Department of Occupational Safety & Health (DOSH), Malaysia. This award is recognition to the collective efforts by all parties in the project towards compliance and adherence to HSE requirements' and practice.

On top of that, AGO units installed in this project are equipped with Continues Emission Monitoring System (CEMS) with additional features that ready to be connected with DOE monitoring system. This system will allow DOE to monitor emission of oxidize waste gases of AGO units online direct from their office.

Executing a project in a live plant is not an easy job. A lot of challenges facing by the PMT such as working at height, confine spaces, limitation of space and tie-in works should be managed and to be resolved amicably without unnecessary interruption to the plant operation. Flawless start-up and commissioning was always our main target to reduce plant downtime and a key success is the integration between PMT and the Operation personnel.

Having that as a goal and being the first project to have a joint commission of all AGO units between PMT and Operation personnel with assistance from the Contractor, was a big achievement to this project. As highlighted by Contractor during the project lessons learnt, this approach has indirectly reduced unnecessary and uncertain cost and risk quoted by Contractor.

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