QALHAT LNG PROJECT

GASTECH 2005

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1. INTRODUCTION
Chiyoda-Foster Wheeler and Company LLC (CFW), a joint venture established in the Sultanate of Oman successfully constructed the first LNG plant in Oman (2 Trains x 3.3 MTPA LNG grass root plant) in the year 2000 before the contractual completion dates of 38 and 42 months, for the first and second train respectively. After completing the project, CFW was awarded the EPC contract from Qalhat LNG S.A.O.C. (QLNG) for a single train expansion (3.3 MTPA) in January 2003. The construction site is at Qalhat near Sur, 350 km away from Muscat.

The governance of the project is undertaken by an independent Owner team, referred to as the “Qalhat LNG project team”. Resources, including the Project Director (M. Merzian) are supplied by the Project Technical Advisor: Shell Global Solutions International BV. The Qalhat LNG project team manages the EPC contract with support as required from their Technical Advisor.

The QLNG Project has the following special features.

- Fast Track Project of 34 months with Long Lead Equipment (MCHE/ Main Cryogenic Heat Exchanger and Refrigerant Compressors) to be ordered after the EPC contract award.
- Flawless Start-Up (Trademark of Shell Global Solutions International BV). To cope with the short duration of the Start-Up period (1 month from Plant Completion to First Shipment), QLNG has adopted a new concept of Flawless Start-Up with the guidance of QLNG and its Technical Advisor Shell Global Solutions International BV (SGSI).
- Accomplishment of high Omanisation ratio (ratio of Omani employees against total employees). 35% is adopted while 15% was applied for the previous project.

The plant construction is ahead of schedule, with a high performance of objectives and high HSE record, and will near completion in the last quarter of the year 2005.

2. FAST TRACK PROJECT
Scope of the project is as shown below:

1 x 3.3 MPTA LNG Train composed of MCHE licensed by Air Products and Chemicals, inc. (APCI), Frame-6 Propane (C3) Compressor and Frame-7 MR Compressor manufactured by GE Nuovo Pignone (NP)
2 X Frame 6 Gas Turbine Generators
1 X Sea Cooling Water System
1 X Instrument Air Compressor
1 X Air Separation Package
1 X Feed Gas Receiving Station

In many LNG plant projects, since plant completion is dominated by the manufacturing duration of the Long Lead Equipment (MCHE and Refrigerant C3, MR Compressors), the clients order the Long Lead Equipment in advance of the EPC contract award and it is assigned to the contractor in order to reduce the project duration. In the case of the QLNG project, and also the previous project, this Long Lead Equipment was ordered after the EPC contract.

The 1st train of the existing LNG plant took 38 months from the contract award to Ready for Start-Up (RFSU), while the QLNG Project is scheduled to be completed in 34 months.

To achieve this shorter project duration, the full string tests of refrigerant compressors at the shop have been waived due to the identical design with the previous project, while the gas turbine solo run and compressor mechanical running test were performed. Extensive inspection items are reviewed and conducted in order to maintain integrity. To increase further integrity, the manufacturer's packing information data is merged into the contractor's site material control system (MARIAN oracle based software) with extensive packing inspection compared with the sub-supplier's
original design drawing. The MCHE was erected 21 months after the contract and the Refrigerant Compressor after 22 months. Comparison below with the previous project, using the parameter of remaining months after site erection to RFSU, shows that the Long Lead Equipment delivery does not adversely affect subsequent construction activities. Namely, the saved time is allocated for construction work in the QLNG Project.

<table>
<thead>
<tr>
<th>Remaining Months to RFSU</th>
<th>Previous Project</th>
<th>Qalhat LNG Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Cryogenic Hest Exchanger</td>
<td>12 months</td>
<td>13 months</td>
</tr>
<tr>
<td>MR Compressor with Driver</td>
<td>9 months</td>
<td>13 months</td>
</tr>
<tr>
<td>C3 Compressor with Driver</td>
<td>10 months</td>
<td>14 months</td>
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The overall strategy of the QLNG Project is to save the time on engineering and procurement, fully utilizing tangible assets from the previous project during construction, without a loss in quality. Engineering was concentrated on the modification area, and vendors were selected in consideration of the impact on re-engineering in the case of new vendors’ selection. Consequently, the same vendors as with the previous project were selected, except in the case of static equipment. Lessons learned from the previous project were analyzed and categorized phase-wise. These were implemented at each EPC phase. The progress curves below show that this strategy has achieved success.

For construction, in order to allow a good environment and better productivity for the mechanical work, which involves higher risk activities, the joint efforts of CFW and QLNG were concentrated on earlier completion of the underground work compared with the previous project. The table below using the parameter of remaining months to RFSU, shows that this strategy is also being well achieved.
<table>
<thead>
<tr>
<th></th>
<th>Remaining Months to RFSU</th>
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<tbody>
<tr>
<td></td>
<td>Previous Project</td>
</tr>
<tr>
<td>Main Pipe Rack Completion</td>
<td>22 months</td>
</tr>
<tr>
<td>Process area Underground Cable</td>
<td>14 months</td>
</tr>
<tr>
<td>Installation</td>
<td></td>
</tr>
<tr>
<td>Main Equipment Erection Completion</td>
<td>13.5 months</td>
</tr>
<tr>
<td>except for MCHE, Refrigerant Compressors</td>
<td></td>
</tr>
</tbody>
</table>

Qalhat LNG Project :
22 Months till RFSU (As of January, 2004)
- Amongst World Record? -

Previous Project :
15 Months till RFSU (As of September, 1998)
3. **FLAWLESS START-UP (Trademark of Shell Global Solutions International BV)**

Aiming for a short Start-Up Period (1 month from Plant Completion to First Shipment), QLNG has adopted a new concept of Flawless Start-Up, with the Guidance of QLNG's Technical Advisor, Shell Global Solutions International BV (SGSI). This is explained below.

To ensure a successful execution of the project and a successful first production cycle of the new assets Shell Global Solutions applies a proprietary methodology entitled **Flawless Start-up Initiative** during project execution. This methodology entails two steps:

**Operations Implementation Planning (OIP)** which aims to prepare the future asset operator for all aspects of the production phase. This includes but is not limited to: operations and maintenance philosophy, organization & manpower, prototype and risk assessment, competence development & assurance, manuals, check-lists and instructions, development of management system (ISO-9000 model), etc. This OIP process ensures that at the moment of asset hand-over the Plant, the People and the Procedures are in place and fit-for-use. OIP development is normally done by the future asset owner and falls outside the scope of the EPC contractor. The graph below gives an impression of how OIP develops and matures during the project preparation and implementation.

**Quality Execution Plan.** Problems encountered during initial operation of many previous projects have been analysed for root causes which were captured in Lessons Learned databases, subdivided by relevant disciplines. These lessons learned are accounted for in all stages of today’s projects: from Basis of Design through Detailed Engineering and Procurement right through to Construction and Commissioning. Examples of these lessons learned for an LNG project include: Build Clean program, tightness (internal & external), functional testing and integrity, operability/maintainability/accessibility, etc. The execution schedule reflects the integrated execution of identified activities in construction, commissioning and start-up whilst respecting the Inspection and Test criteria. As an important feature of this Execution Plan a number of Key Success Area’s (KSA) are identified and each KSA is assigned a focal point.
This structured approach of the Quality Execution Plan has led to a first-time-right commissioning & start-up resulting in a considerable gain in time and money. Not only is the contractual delivery date ensured, but early production adds significantly to Return on Capital Investment.

The Flawless Start-up Initiative® as described requires full involvement and commitment from the FEED contractor as well as from the EPC contractor during the project. For the QLNG project this has been the case, and a selective FSI program was devised and agreed with CFW, the details are further described in the next chapters. In addition, team members with extensive background and experience in the FSI activities were assigned to the Owner’s project organization to work with CFW on the agreed program.

SGSI normally acts in a guiding role to facilitate the contractor’s work and/or assist the owner’s project team. This is done through awareness sessions, engagement workshops, detailing the Flawless program, guiding & mentoring the focal points in their role and in conducting so-called “health checks” as an independent second pair of eyes to review adequacy and compliance to the agreed Flawless Start-up program.

With the guidance of QLNG and SGSI during the Engineering and Procurement phase, the modified areas from the previous project and new technologies not employed on the previous project were thoroughly investigated and identified as “Novelty Items”. Since the interval between the completion of the previous project and the QLNG project is long (three years) and there have been new technology improvements during the period, there were 79 “Novelty Items” for Engineering.

These Novelty Items were fully analyzed and measures taken to ensure a smooth start-up and reliable operation.

At the initial construction phase, a Key Performance Indicator (KPI) was established to monitor the achievement of Flawless Start-Up in the following categories called “Key Success Areas”:

- Tightness (External & Internal)
- Cleanliness
- Mechanical Integrity
- Electrical Integrity
- Prototype
- Complex System
- Testing
- Handover, Deliverables and Plans

In accordance with the Key Success Areas, the workshops facilitated by QLNG and SGSI were conducted in a phased manner, in accordance with the mobilization of Key Personnel to site. QLNG, CFW and Subcontractor Key staff joined the workshops.
A part of the payments for "Change in the Work" in connection with additional activities required to achieve the selected KPIs are made in line with the level of the achievement of the KPI, as an incentive/penalty scheme. This scheme encourages CFW and its Subcontractors to attain higher score in the KPI.

During the workshops, action items are discussed and agreed. The first phase is mainly the incorporation of ITP (Inspection Test Plan) and change of MS (Method Statement) in order to achieve the KPI. The closure of workshop action items are measured continuously and the graph on the left shows that this has progressed well.

After the setting up of standard and measurable criteria, implementation at site was started. A symbol was chosen and banners, visible criteria and photos of good and bad examples were placed in many locations on the site. An incentive scheme for the workforce + supervisors has been introduced and a Daily Award and a Bi-Monthly Award are provided.
4. SUSTAINABLE DEVELOPMENT

Accomplishment of the high Omanisation ratio (35%) has been set up as the target for the QLNG Project. Also, based on Lessons Learned from the previous project, contribution to local society has been set up as another target.

Currently in the Sur area, two major projects are under execution. One is a fertilizer project and the other is the QLNG Project. The combined requirements of the Omani workforce are tabled as below.

<table>
<thead>
<tr>
<th></th>
<th>Total Work Force</th>
<th>Number of Omani</th>
<th>Omanisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer (Start 2002)</td>
<td>8,000</td>
<td>1,600</td>
<td>20%</td>
</tr>
<tr>
<td>Q-LNG (Start 2003)</td>
<td>3,500</td>
<td>1,200</td>
<td>35%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11,500</strong></td>
<td><strong>2,800</strong></td>
<td></td>
</tr>
</tbody>
</table>

Ref. Previous Project: Peak Number of Omani; 1000, Omanisation; 15%, Number of Trained Omani; 350

Since this scale of skilled Omani workforce was not initially available, extensive recruitment and training was required to achieve the project targets.

For the best contribution to local society, during the recruitment a Concentric Circular philosophy was adopted. That is, at first find candidates from the region near the site, if sufficient candidates are not available, select candidates from the next nearest region.

This has been achieved by the full support and close communication with the Director General of the Ministry of Manpower (MOM) in Sur.

The following five KPIs were set up by CFW in order to measure the quality of sustainable development in addition to the Omanisation ratio.
### KPI 1. Accomplishment of 35% Omanisation

### KPI 2. Employing Omani people from neighboring villages, Sur and Sharqiya region

### KPI 3. Off-the-Job training for Omani people

### KPI 4. Employing Omani people graduated from Off-the-Job training

### KPI 5. Local procurement and/or local subcontract from neighboring villages, Sur and Sharqiya region

CFW organized a dedicated Sustainable Development Team and an Omanisation Club with Subcontractors for bilateral communication and exchange in a successful way to improve its quality.

For Off-the-Job training, which is mainly applied to the skilled workforce, the majority of Subcontractors are taking advantage of a training subsidy from the Government and sending their trainees to training institutes, and some Subcontractors utilize their own training course. The number of Omani people trained as of November 2004 exceeds 700.

<table>
<thead>
<tr>
<th>Subcontractor</th>
<th>Graduated Trainees</th>
<th>Under Training</th>
<th>Number of Total Trainees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Work</td>
<td>76</td>
<td>0</td>
<td>76</td>
</tr>
<tr>
<td>Mechanical, Electrical and Instrumentation Work</td>
<td>241</td>
<td>110</td>
<td>351</td>
</tr>
<tr>
<td>Paint and Insulation Work</td>
<td>164</td>
<td>83</td>
<td>247</td>
</tr>
<tr>
<td>Waterfront and Marine Work</td>
<td>8</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Heavy Rigging Work</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Catering Service</td>
<td>11</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Operation and Maintenance</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL TRAINEES</strong></td>
<td><strong>509</strong></td>
<td><strong>193</strong></td>
<td><strong>702</strong></td>
</tr>
</tbody>
</table>

To maintain a high HSE standard with the many new trainees entering the construction site, HSE training refresher courses for all Omanis at site were held continuously. These refresher courses were held in addition to ordinary HSE induction and specific HSE education courses. CFW introduced English and IT training courses for their Omani staff in order to increase their communication with expatriate staff and help familiarize them with office work. College graduate students were provided with on-the-job training in the company organization.
The graph on the left shows the track record of trainees starting from the stage of recruitment up to conversion to the actual workforce. In short, 32% of trainees were converted to the actual workforce.

The total trainees were 168 selected from 324 candidates through MOM and trained. Among 168 training candidates, there were 94 drop-outs before graduation because of lost interest or mismatching of expectation and 74 graduated/joined site work.

During approximately one year (Nov’03 to Oct’04), 20 graduated workers quit and 54 employees finally became “experienced workers”.

To extend the Omani employment as long as possible, work force transfer from a company to another was considered among the concerned companies in the project and some successive employment was made. Also, a list of Omani employee is submitted to the Ministry of Manpower two month prior to the demobilization from the project to enhance next job opportunity of Omani engaged in the project.

CFW has a supporting system called a Sustainable Development Help Desk (SD Help Desk) for easy communication between Omani Staff and Expatriate Staff. The SD Help Desk is composed of experienced Omanis. In case of difficulty of explanation of a work request from an expatriate, the work is explained by this SD Help desk. The SD Help desk and Sustainable development team became members of the CFW SD Committee and feedback from Omani Staff and expatriate staff is discussed weekly.

To increase the local procurement from neighboring villages, CFW published a list of locally available materials and resources, and leaflets about the QLNG project.

Based on this feedback from subcontractors and local suppliers, a local content database was prepared and the database was shared with subcontractors at the Omanisation Club. CFW/ Subcontractors made such local procurement and sublet work with an annual sum of over one million Omani Rials.
Leaflets introducing the QLNG project were distributed through the Oman Chamber of Commerce and Industry, Sur Municipality, the Office of the Walli and directly to shops and contractors in this region.

CFW received an honorable award of “Best Omanisation Company” from the Minister of Manpower in commemoration of the remarkable performance of “Omanisation” as one of the ten best companies on 9th February ’2004, under the full support of the Ministry of Manpower and QLNG.

5. SUMMARY

Currently, the Project is proceeding smoothly and we are making every effort to complete it successfully. Fortunately, the project programs for Sustainable Development and Health, Safety and Environment are progressing well, so far. CFW is performing the project to the satisfaction of the client, Qalhat LNG S.A.O.C. under the assistance of SGSI.
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