CREATING MARVELS FOR THE PETROCHEMICAL INDUSTRY





Delivering Execution Excellence to Mega Petrochemical Projects

L&T Hydrocarbon Engineering (LTHE) is an engineering, procurement, fabrication, construction and project management company providing integrated 'design-to-build' solutions for large and complex Offshore and Onshore hydrocarbon projects worldwide.

A wholly-owned subsidiary of Larsen & Toubro Limited (L&T), the Company continues to draw on the parent Company's organisational strengths and experience.

The Company caters to the needs of its client base in multiple geographies.

Integrated **Project Execution**

The Company's end-to-end capabilities across the hydrocarbon value chain cover upstream oil & gas processing, refining, petrochemicals, fertiliser, cryogenic storage including LNG and pipeline sectors. Our project management teams efficiently execute all projects, meeting the most stringent targets of safety, quality, cost and time.

Global projects benefit from three decades of the Company's inhouse capabilities in engineering, procurement, fabrication, construction and commissioning (EPCC).

We also execute projects on a License + EPCC package basis, depending on customer's requirements. These projects are executed through alliances with process licensors.

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Customer focus and responsiveness	Proven track record and trusted industry leader
Cost-optimal solutions through integrated approach	Strong commitment to Quality and HSE
Dedicated project management resources	Technology focus and specialized design & engineering expertise
Supply chain Management with sourcing expertise	Innovative construction with cutting edge technology
Capability for mobilization of large resources and quick ramping-up	Extensive IT-enablement for virtual, single-office operations

The L&T Hydrocarbon

Engineering Advantage

LINEAR ALKYL BENZENE PROJECT

Large-Scale Petrochemical Complex in KSA

Farabi Petrochemicals Company is one of the world's leading producers of paraffins and linear alkyl benzene.

Project Name	Normal Paraffin & Derivatives Complex Project	
Project Location	Yanbu, The Kingdom of Saudi Arabia	
Plant Capacity	235,000 MTPA Paraffin	
	120,000 MTPA Linear Alkyl Benzene	
	82,600 MTPA Specialty Oils	
	30,000 MTPA Sulfonated Asphalt	
	33.6 MTPD Sulphuric Acid	
Client Client	Farabi Petrochemicals Company	
Licensor	UOP/ Technithon/ MECS	
Project scope	Engineering, Procurement, Construction & Commissioning (EPCC)	
	To Andre Marine	

3-D model of Normal Paraffin & Derivatives Complex Project for Farabi Petrochemicals Company

PROJECT CHALLENGES

- The schedule is 32 months from start to start-up.
- The footprint of the greenfield project is large, with an area 1800m x 430m comprising 19 process units, 16 utility units, and offsite facilities.
- A large number of approx.1000 tagged equipment have to be procured.
- HCIS 2017 regulations, which were released after contract award, must be implemented.
- Multiple interfaces with different contractors and integration of clientsupplied items (rotary valve, ASU, UOP internals, ACSS, PEP skid) – without affecting overall project schedule – has to be undertaken.
- A workforce (of approx. 6000 at peak) has to be mobilized, of different nationalities, including Saudi Arabian, in compliance with the Saudiazation norms.



As part of its ambitious growth plan, it is establishing a new n-Paraffin and Linear Alkyl Benzene facility in the Yanbu industrial area of the Kingdom of Saudi Arabia (KSA).

In May 2017, L&T Hydrocarbon Engineering bagged the prestigious contract for setting up this greenfield petrochemical complex on a lumpsum turnkey basis. It is the first large-scale Petrochemical Complex Project undertaken by the Company in KSA on EPCC basis.

The project is scheduled to be completed in April, 2020.



- Permits and RC (Royal Commission) approvals for executing jobs, construction and commissioning have to be obtained.
- Eight tie-ins from different customers from the adjacent plants within Yanbu industrial area have to be obtained. This includes hot tapping from the 24" Saudi Aramco Sales Gas pipeline.
- Multiple licensor coordination is required during the engineering, erection and commissioning phases.

© EXECUTION STRATEGIES

Being a fast-track project, the deadlines were very tight – 32 months for taking over (ready for start-up) and 36 months for commercial completion. Considering the complexity and size (1800 m x 430 m) of the project, it has been divided into four areas, each declared a sub-project. Dedicated teams have been assigned to each area to execute engineering, procurement, construction and project management. The project team is implementing the latest digitalisation tools to plan and monitor an integrated EPCC schedule and the interfaces with all stakeholders.

The project has achieved 12 million LTIfree man-hours as of 15th May, 2019.

Detailed Engineering

L&T Chiyoda executed detailed engineering for this project in 18 months at its office at Vadodara in India. Farabi's Integrated Project Management (Farabi IPMT) team was present during this phase, and expedited the process of engineering deliverables, engineering resolutions and faster approvals on the engineering documents.

The joint efforts of the LTHE and Farabi IPMT teams laid the strong foundation of the project with effective coordination with licensors and on-time completion of major engineering, including timely completion of approx. 25 special studies.

Global sourcing

One of the big challenges has been supplying approx.1000 tagged equipment - reactors, compressors, air fin coolers, multi tube exchangers, towers, vessels, pumps and utility packages, such as waste water treatment package, boiler, cooling tower, DM plant, etc. Farabi also novated critical longlead items, like heaters, 3.3 MW screw compressor and Packinox exchanger, to the Company.

Considering the quantity of equipment to be supplied, LTHE identified the items coming under the critical path and prioritized ordering accordingly. First-priority items (approx.110) included reactors, switchgear, utility packages and compressors, and were ordered within three months from the date of the award of the contract. Secondpriority items (approx. 160), included ICSS, telecom, multi-tube exchangers, columns, API and non-API Pumps, and were ordered within five months of the award of the contract. As the equipment were procured from different parts of the world – and at different times – the logistics management role assumed cruciality.

Construction

Multiple sub-contractors as well as inhouse resources undertake construction. Considering peak manpower of almost 6000 personnel at site, sub-contract management is highly crucial.

Piping fabrication is undertaken at LTHE's yard at Kattupalli. Materials Management is undertaken through IT tools such as e+ALPS (Activity Planning System) and spool management through AUTO Spool. The QR Code system is being used for piping and structural material for efficient handling from fabrication and storage to erection.

For various services, the project utilizes a wide variety of UG piping materials -HDPE, CPVC, GRE and CS+ FBE coating lines. All FBE-coated pipes (up to 82000 IM) are fabricated and FBE-coated by a KSA-based vendor, then sent to the site for erection.

Up to 5800 MT of the structural steel required for the plant was fabricated in prefabricated shops and supplied from the two agencies located in KSA. In order to reduce construction time, 21 shelters were considered as PEB (preengineered buildings).

Tank Farm

The tank farm contains 56 tanks with diameters varying from 6 m to 22 m. The tanks have different types of roofs, e.g. fixed-cone roof, floating roof and dome roof. The tank farm has state-of-the-art facilities like tank farm management system, fire-protection systems, etc.

Buildings

The complex contains several buildings - Process Area (five sub-stations & main control room) as well as Non-process Area (Admin Building technical, canteen, laboratory, fire station, flare houses). The entire plant is controlled from the main control room. Pre-casted roof slabs have been used for substations. To reduce construction time and provide the thermal protection required by KSA norms, all buildings are made of insulated bricks instead of conventional bricks.

MELAMINE PROJECT

The Largest-Capacity Melamine Plant for India's Sole Melamine Producer

GUJARAT STATE FERTILIZERS & CHEMICALS LTD., INDIA

In March 2016, Gujarat State Fertilizers and Chemicals Ltd. (GSFC) awarded to L&T Hydrocarbon Engineering a project for installation of a 40,000 MTPA melamine plant on EPCC basis at GSFC-Vadodara, India. Casale SA is the technology licensor for this unique project, which involves an off-gas treatment section and a high-pressure melamine plant, both integrated, consequently optimizing energy and utility consumption. This is Casale's first plant as a licensor for melamine using the high-pressure Borealis technology.



8 PROJECT CHALLENGES

- Space constraints neccessitated a compact, vertical design. (OGT unit: 26.25 m x 64 m, Melamine unit: 44.75 m x 64 m)
- Three sides of the site were locked due to facilities at this brownfield project. This restricted movement and positioning of cranes.
- Licensor-specific vendors were mandated, largely from Europe (18 suppliers), for critical packages, equipment and instruments. These included a molten salt heater from APACO, Switzerland, a flash dryer from GEA Denmark / India, a vacuum drum filter from Andritz, Germany, a pneumatic conveyer by

Geroldinger, Germany, a bagging plant from H&B Germany, level transmitters (zirconium diaphragm type) from WIKA, Germany, high-pressure reciprocating pumps from Peroni, Italy, axial flow pumps from Egger Switzerland, jacketed control valves from Parcol, Italy.

- The project involved placing 930 Purchase Orders on over 360 vendors – many for the first time for LTHE.
- Special metallurgy was involved (alloy-59, 25.22.2, urea grade) for which there are limited international vendors
- Dedicated teams were required to expedite critical packages, equipment

and exotic materials to ensure timely deliveries in order to meet the challenging construction sequence.

- Vertical plant construction posed challenges in sequential construction.
 Eight vertical levels in the plant with different equipment and piping were to be sequentially erected.
- Peak manpower was 1540 personnel with over 140 staff.
- High pressure, high temperature and harmful fluids made precommissioning and commissioning a major challenge. Maintaining the highest HSE standards in the field was of utmost importance.



UNIQUE VALUE-ADDITION THROUGH EXECUTION O STRATEGIES

- As the plant was blocked on three sides, it was a unique challenge to position the cranes required. The Company mobilized a 650 MT ringer crane for heavy lift erection at site, positioning it on the main road of the GSFC plant for eight months.
- Unconventional methods were used for installation of plant and machinery. A tower crane was used to ensure continuous feeding of structural and piping material for erection at higher elevations.
- Quick movement across different levels in the plant was facilitated by construction elevators.
- Bar-coding was implementated for piping-spool storage, identification and erection.
- Early start of electrical & instrumentation activities was facilitated by a continuous front-generation drive.
- Completion of substation building on priority resulted in early energization.
- An average of 8% construction progress for six months during peak time resulted from microplanning and monitoring.

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- An early switchover was made from construction completion to systembased monitoring.
- Centenary Completion Management System (CCMS) expedited and monitored the system-based plant precommissioning and commissioning.
- Trouble-free start-up and reduced commissioning problems resulted from the implementation of the Flawless Project Delivery concept during installation in the areas of flange and valve management, cleanliness ('Build it clean'), preservation and interface management.

MANGALORE AROMATICS COMPLEX

India's Largest Single-Train Paraxylene Complex – One of the World's Largest

ONGC-MANGALORE PETROCHEMICALS LIMITED

In March 2010, L&T won the prestigious contract to execute the Mangalore Aromatic Complex Project (MARC) of ONGC Mangalore Petrochemicals Limited (OMPL) – a company promoted by ONGC and MRPL.

L&T was given the responsibility of executing all the nine process units of this project, viz. Naphtha Hydrotreating Unit, Continuous Catalytic Regeneration Unit, Platforming Unit, Parex Unit, Isomar Unit, Xylene Fractionation Unit, Shell Sulpholane Unit, Tatoray Unit and Benzene & Toluene Fractionation Unit.



The project involved many criticalities and large work volumes which had to be executed in a stringent time schedule. The project's multiple complexities included a large number of rotating machinery with various types of compressors and high capacity pumps, modularization of a CCRG structure exceeding 80 m height, large capacity furnaces including the platforming heater built to UOP proprietary design and other high-capacity fired heaters, various ODC columns and the complex adsorbent chamber circuit.

In addition to the huge quantum of work involved in the project, Mangalore's local conditions, including heavy rains and infrastructure constraints, added to the challenge. Various innovative measures were adopted to minimize the effect of rainfall on the progress and to limit any loss in productivity. As the project site is in rocky terrain, there were also several challenges in civil construction, design and execution because of slushy soil (during the monsoon), the discovery of rocks at unpredictable depths, etc.

The project involved the shipment of over-dimensional consignment (ODC) from eight countries. Infrastructure challenges at the Mangalore port and the non-availability of proper facilities (roads, railway crossings, etc.) posed a major challenge during execution.

O EXECUTION STRATEGY

L&T is one among the few companies worldwide that has in-house capabilities to execute a project of this magnitude in an integrated manner.

L&T's internal strengths were leveraged by the project management team, using the platform of SAP's integrated network, multi-locational working, integrated 3D modeling and reviews, constructability studies and integrated EPC execution.

L&T's project management philosophy, which revolves around the key concept of becoming a Centre of Excellence, enables the Company to maximize productivity and efficiency and allows for maximum integration. This, in turn, results in adherence to safety, quality, and timeliness standards along with the budgetary constraints.

PROJECT CHALLENGES

The magnitude and complexity of the project can be gauged from the followina:

- Engineering: >1 Million man-hours
- A workforce (6554 at peak) had to be mobilized
- Lack of access and infrastructure facilities and delay in availability of ODC route
- Unprecedented and extended monsoon
- Complex piping system with various metallurgies and high volumes
- Synchronized sequence of highly interconnected 9 process units

The challenges were managed through various project management philosophies and approaches such as:

- 'First Time Right' approach
- Dedicated expeditors at vendor shops to ensure timely delivery of equipment
- Effective Logistics Management
- Automation of construction activities
- Work-pack approach to planning and a construction-driven approach
- Management of workloads through use of various off-site fabrication facilities
- Smooth turnover of systems after mechanical completion to start-up and commissioning

The project was executed in the following broad phases:

The first phase included basic planning and conceptualization and substantial completion of civil work and technological structures to make the plant ready for equipment and piping integration, with 85 to 90% engineering completion.

The second phase involved integration of equipment to the project and connecting them by way of piping and cabling, followed by testing.

The third and final phase included loop completion, pre-commissioning and commissioning activities. This is the phase where the construction work moves to process systems.

TEREPHTHALIC ACID PLANT

One of India's Largest Single-Stream Purified Terephthalic Acid Plants

INDIAN OIL CORPORATION LIMITED, PANIPAT

In January 2003, Indian Oil Corporation Limited (IOCL) awarded an order to Larsen & Toubro (L&T) for a Purified Terephthalic Acid (PTA) plant of worldscale size at its Refinery & Petrochemical Complex at Panipat. This is one of the largest single-stream PTA units in India. Technologically, this is one of the most advanced plants in the country, with the technology from DuPont, UK (now Invista). EIL was the Project Management Consultant (PMC).

This was L&T's first major EPC LSTK project in the petrochemical sector and single largest LSTK order at that point of time. L&T formed an experienced task force to execute this challenging project, which had a stiff delivery schedule for mechanical completion.



<mark>ᄗ</mark> PROJECT CHALLENGES

The project involved global procurement, with 44 critical mandatory equipment (including 15 critical package systems). Most of the sourcing was from Europe, the Far East and North America. A large warehouse (420 m x 105 m) with stateof-the-art storage and bagging facilities was also a part of the overall project scope.

The engineering required a deep understanding of all fluid phases including gas, liquid, slurry and solid handling, and highly corrosive services including high concentration acid lines (acetic acid, hydro bromic acid, etc.) A variety of exotic metallurgies including titanium, hastelloy and duplex stainless steel were used, which required clean environment for welding and stringent quality control.





O EXECUTION STRATEGY

The PTA Plant has two sections, viz. Crude Terephthalic Acid Section and Purified Terephthalic Acid Section, viz.

Crude Terephthalic Acid Section

- Oxidation Reaction Section
- Crystallization Section
- Separation & Drying Section
- Off-gases Recovery Section
- Solvent Recovery Section
- Catalyst Recovery Section

Purified Terephthalic Acid Section

- FEED Preparation Section
- Reactor Section
- Crystallization Section
- Separation & Drying Section
- PTA Storage & Warehouse

Being one of the Approved Design Engineering Contractors for Invista Technology, Aker Kvaerner (now Aker Solutions) undertook the residual process and detailed engineering for the project at their UK and Mumbai offices, under the supervision of L&T's Engineering Management Team.

L&T implemented the project using innovative engineering and construction techniques, with Zero Lost Time Accidents, earning IOCL's 'Best Safety Award' and 'Silver Award for Occupational Safety' from The Royal Society for the Prevention of Accidents (RoSPA), UK. The successful commissioning of the PTA plant in June 2006 affirmed L&T's capabilities in helping mega projects move from concept to reality through its internationally benchmarked capabilities in engineering, fabrication, procurement and construction.



Operating Centre of Onshore Business at L&T Knowledge City, Vadodara, India



L&T Institute of Project Management (IPM) at Vadodara – a registered educational provider of PMI, USA – develops project managers across EPC domains



Safety Innovation School at Hazira, Gujarat – part of multiple initiatives for the propagation of a safety culture company-wide





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