Yokogawa
LNG Supply Chain

Ichthys LNG Production Facilities
Photo courtesy of INPEX CORPORATION
A Trusted Partner With Proven Experience

Yokogawa's commitment to innovation in LNG projects worldwide dates back to the 1970s. Yokogawa keeps encompassing leading edge technology for the LNG industry to maximize productivity.

Providing the latest technology to the world's largest LNG terminals since 1973

The Tokyo Gas Sodegaura LNG terminal started operations in 1973 and is one of the world's largest LNG terminals, with a total amount of 4,509 million tons received per year (as of 2018), a storage capacity of 1.35 million kℓ and a vaporization capacity 1,455t/h. Yokogawa has since gone on to migrate the DDC to a Distributed Control System (DCS), changing panel operations to a centralized operation.

Never disturbing plant operations

The challenge of control system migration is to update systems without interrupting production. At LNG terminals, the temperature inside the tank has to be maintained at a constant -162°C to avoid generating boil-off gas (BOG). Yokogawa has more than 40 years experience providing customers with hot cutover.

Supporting Plant Integrity

The Sodegaura Terminal is currently divided into two areas (East and West), each with its own receiving berth, electrical, and supply system. This double-plant setup enables the two areas to back each other up, assuring a high degree of reliability. Yokogawa supplies integrated control and safety systems to the two independent areas, and achieve the centralized operation of both areas, improving operation efficiency and integrity of the plant.
Explore the Yokogawa capability in LNG industry

Yokogawa has long standing expertise providing solutions to the LNG industry

* FLNG: Floating LNG
* FSRP: Floating Storage & Regasification & Power-Generation
* FSRU: Floating Storage Regasification Unit

**Liquefaction** 76 Trains

**LNG Carrier** 83 Vessels

**Transportation**

**FLNG**

**Offshore Platform**

**Regasification** 51 Terminals

**Gas to Power**

**Digital Transformation**
- Digital Twin
- Performance Benchmark Optimization

**Plant Uptime**
- High Availability
- Alarm Management
- Predictive Maintenance

**Lower TCO**
- Advanced Process Control
- Modular Procedural Automation
- Operator training

**License to Operate**
- HSE
- Regulation
- Security

**Digital Twin**
- Performance Benchmark Optimization

**Yokogawa has a long history and wide variety of solutions to the LNG supply chain**

Data as of 2019

Yokogawa LNG Supply Chain
Liquefaction Experience

Yokogawa has installed 76 trains globally with a wide capability of products and solutions from sensors to modelling.

Dehydration and Mercury Removal
- Drier sequence control
- Regeneration gas compressor control

Liquefaction
- Feed Gas Pressure/Flow Control
- MR balance control
- Pre-cool refrigerant compressor and flow/temperature control
- MR refrigerant flow/temperature controls
- End Flash and pressure control
- LNG Rundown and Production control
- Anti-Surge Control

Acid Gas Removal
- Feed gas KO Drum pressure control
- Absorber Bottom Level/Flow control
- Absorber inlet lean amine flow control
- Pressure monitoring
- Temperature monitoring
- Treated gas quality monitoring
- Amine regeneration control
- Sulphur recovery unit control

NGL Recovery/Fractionations
- Feed Gas Pressure Control
- Bottom level and Disch. Flow control
- Reflux Flow control
- Reboiler temperature control

LNG Storage Loading
- Tank monitoring
- Loading sequence
- Circulation control for loading lines
- BOG compressor

Key technology for your benefit

Faster Start-up Contributes to Quick Production Delivery

Automated cool down of the Main Cryogenic Heat Exchanger (MCHE) using Modular Procedural Automation (MPA) shortens start-up time and avoids equipment damage.

The MCHE is the key component of an LNG plant. It consists of large bundles of tubes in an aluminum shell. At start-up, the MCHE has to be cooled down from ambient temperature to around minus 160°C where the natural gas is liquefied.

Controlling the temperature of the MCHE according to the ideal temperature curve is challenging for the operator. Several valves need to be controlled at the same time while the process response changes as the cool-down progresses. Poor operation may result in exceeding the maximum allowable temperature change over time, which can damage the MCHE due to thermal expansion and contraction. However, slow cooling will delay the start of production. To avoid these risks, highly reliable and efficient automated operation is required.

Yokogawa’s Modular Procedural Automation (MPA) employs the best operators experience, process expertise, analyses of the existing procedure and historical data. Automated cool down is enabled as if an experienced operator were controlling the plant. The start-up time is shortened without damaging MCHE.

Next-generation Advanced Process Control maximizes throughput

Platform for advanced control and estimation optimizes production while ensuring stable control.

The liquefaction process is complex because it is affected by factors, such as gas composition, ambient temperature, separator level and compressor performance. To achieve steady process control, those variables need to be controlled by Advanced Process Control (APC). Yokogawa has been providing APC licenses and consulting for more than 20 years. Based on our expertise in process automation, Yokogawa’s next-generation of APC, called Platform for Advanced Control and Estimation, provides process optimization to maximize throughput while ensuring steady process control.
Transportation Experience
Yokogawa has installed 83 vessels with a wide capability of products and solutions from sensors to modelling.

Key technology for your benefit

Prepare for unexpected conditions
Dynamic simulator trains the operator to prepare for the unsteady operations
Yokogawa is driving the advanced usage of the dynamic simulator which can be used for multiple purpose throughout the lifetime of the LNG carrier. The dynamic simulator is ideal for operator training, and it can be a useful tool to validate the system design by allowing rigorous system testing under all operating condition. By combining the ICSS test function with the process dynamic simulator, process reaction can be predicted.

Power Management System
- Control of circuit breakers and monitoring
- Load Dependent Start/Stop
- Load Sharing
- Frequency Control
- Blocking of Heavy Consumers
- Load Reduction to Propulsion Drives
- Load Shedding (preferential trip)
- Automatic restarting after blackout
- Generator Control & Monitoring
- Propulsion Drive Interface
- Emergency Switchboard Interface

Machinery System
- Fuel Oil & Fuel Gas System
- Personnel Alarm System
- Extension Alarm System
- Reduction Gear System
- Fresh, Cooling, Feed Water System
- Brgag Level Monitoring System
- Air Ventilation and Fans
- Compressed Air System
- Lube Oil System
- Machinery Miscellaneous

Gas Management System & Fuel Gas Supply System
- Tank Pressure Control
- Fuel Mode Control
- GCU Control
- Fuel Gas Pressure Control
- Forcing Vaporizer Control
- N2 Purge Sequence
- Vent Control
- Master Gas Valve Control

Ballast System
- Ballast Pumps & Valves
- Automatic Ballast/Deballast Control
- Automatic Ballast Water Exchange

Regulation
- Sox monitoring for new IMO agreement

Vapor Handling System
- Fuel Gas Compressor
- Vapor Return Compressor
- Forcing Vaporizer
- LNG Vaporizer
- Gas heater

Cargo Containment System
- Temperature Monitoring
- Pressure Monitoring
- Level Monitoring

Cargo Control System
- Cargo Pumps Control
- Stripping/Spray Pumps Control
- Emergency Cargo Pumps
- Cargo Operation (Loading/Unloading)

Cargo ESDS
- ESD for Cargo Containment System
- Cargo Tank Protection System
- Fuel Gas Master Valve
- Ship/Shore Communication System

Re-liquefaction System
- Re-liquefaction Comapnder Control System
- Heat Exchange Control

Keep vessels safe anywhere they are located
Real-Time Fleet Monitoring System contributes to integrated monitoring of your fleet
Yokogawa provides a real-time base fleet monitoring system with secure data transmission. Real-time data contributes to monitor fleet conditions without delay and fully customizable KPI dashboard assists swift decision-making in fleet management.
LNG Unloading
- Recirculation Flow Control
- Return Gas Temperature and Pressure Control
- LNG Drain Drum Level Control
- Uploading lineup control
- Berth Monitoring System
- Unloading Arms Packaged System Function

Open Rack Vaporizer (ORV)
- LNG Flow Control
- Seawater Flow Control
- Seawater Pump Control
- Start/Shutdown Sequence Control

Submerged Combustion Vaporizer
- LNG Flow Control
- Packaged System Functions

HP Send-out Pump
- Pump Start/Stop Control
- Discharge Control
- Kickback Flow Control

Send Out Control
- Send out Header Pressure Control
- Send Out Gas Calorie Control
- Gas Odorization Flow Control

BOG Compressor/Recondenser
- Compressor Start/Stop Control
- Suction Drum Temperature Control
- Kickback Flow Control
- Recondenser Control
- Packaged PLC Functions
- Capacity Control

Fuel Gas and Service Gas
- Fuel Gas Pressure Control
- Fuel Gas Heater Control

LNG Tank
- Tank Inlet Mixing Line Valve Control
- Tank Pressure Control
- Level, Temperature, and Density Monitoring
- In-tank Pump (LP Pump)
- Pump Start/Stop Control
- Kickback Flow Control
- Supply Chain Scheduler

Regasification Experience
Yokogawa has installed 51 terminals globally with a wide capability of products and solutions from sensors to modelling.

Yokogawa’s LNG Supply Chain
of products and solutions from sensors to modelling

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Yokogawa LNG Supply Chain

Consolidated Operation
G a s  c o m p a n y
P o w e r  c o m p a n y
Moni tor &  B a c k u p
Mirro r &  B a c k u p

Highly Automated and Highly Reliable Systems Ensure a Stable Gas Supply
Yokogawa provides field-proven software and redundant configurations.

Advanced terminal unit control (ATUC) is a group of software modules on FCS® developed through Yokogawa’s extensive experience working with gas companies. ATUC is specialized for LNG terminal control, optimizing load sharing according to demand changes and achieves immediate control during unexpected conditions. ATUC also enables automated supply volume without the operator’s intervention, lowering the load on operators. By implementing ATUC in redundant configuration, continuous supply is ensured in case of unexpected incidents and during maintenance.

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Future Path Embracing Digital Technology

As a genuine MAC (Main Automation Contractor), Yokogawa brings digital transformation to LNG plants at each stage of the plant lifecycle.

**Operational Readiness**

**Agile Project Execution**
Plant startup time is reduced and plant integrity is improved by validating the control logic and setting the tuning parameters using Yokogawa’s digital twin technology.

**Digital Twin**
- **Simulated Data**
- **Tuning Parameters**
- **Optimized Parameters**
- **Predictive Maintenance**
- **Operation Sequence**
- **Quick Operation Start**

**FEED/Design**
Operational and process behavior can be evaluated and verified using Yokogawa’s simulator during the design phase.

**Engineering/Procurement/Construction**
Control logic and design can be validated using the plant simulator. Smooth startup and plant operation using various scenarios are confirmed before actual operations start.

**Commissioning**
Parameter tuning on the simulator before actual startup contributes to safe and quick control.

**Training**
Using the actual operation windows, operators are prepared to face all operational scenarios by self-training and automatic evaluation before actual startup.

**Maintenance**
Maximizing asset availability is the key to plant profitability. Yokogawa provides AI-based predictive maintenance solutions based on our plant asset management experience.

**Operation**
Unexpected downtime is the enemy of profitable operations. By predicting process behavior using the simulator, operators can take prompt action in case of sudden process changes.

**Optimization**
Supply chain scheduling and real-time optimization maximizes production outputs and improves operation efficiency.

**Business Readiness**
**Profitable Operation and Maintenance**
Highly reliable control systems are the basis of plant integrity; however, optimization of assets and resources is required to increase business profitability. Yokogawa’s digital twin contributes to plant optimization.

**Upgrade**
Risks during modification are reduced and assessed using the plant simulator.
LNG Experiences and Global Network

230 service offices in 80 countries
2,000 service engineers
(Data as of 2019)