Sanha LPG FPSO Schedule

- Contract Execution: May 2002
- Fabrication Start – Shipyard: Nov 2002
- Keel Laying (Drydock): Feb 2003
- Launching (from Drydock): Nov 2003
- Gas Trials: Nov 2004
- Final Dry Docking (Singapore): Dec 2004
- Compressor Reinstallation (Cape Town): Feb 6-21, 2005
- FPSO Arrival in Cabinda: Mar 6, 2005
- Notice of Readiness (first LPG): Apr 12 – 14, 2005
- 72 hr. Run Test: Apr 21 – 26, 2005
- Turn over/System Acceptance: Apr 24 -25, 2005
DEPROPANIZER. Fractionates LPG into propane and butane (ratio approx 65/35). Max rate 37,370 bpd. Top of depropanizer column approx. 60m above the main deck.

CARGO TANKS. (6ea x23,050m³ (135,000 m³ total storage). Two tank halves, common vapor space. Design temp -50°C, dens 0.65 kg/m³. Type B, self supporting tanks with polyurethane foam panels. Butane/Propane cooled in refrigeration plant to enable storing and export at near ambient pressure. Deep-well cargo pump (550 m³/hr) ea tank half. Emergency/recycle pump (110 m³/hr) also provided.

HULL. Double hull, reinforced for side for side-by-side mooring of LPG tankers up to 85,000 m³. Port side primarily used for smaller pressurized carriers (2000m³+).

REFRIGERATION UNIT (PROPANE). Largest refrigeration package ever built. Cools down propane from ambient to approx -37°C.

REFRIGERATION (BUTANE) AND RELIQUEFACTION UNIT. Cools Butane cooled down to approx -7°C to permit storage at atmospheric pressure. The unit also houses compressors that reliquify LPG vapors from cargo tanks and shuttle tank returns.
**Manifold Arrangement.**

- 2 x 12" hoses for Propane
- 2 x 8" for vapor return
- 1 x 6" hose for Butane

Max discharge rate 34,000 bph for Propane and Butane simultaneously.
Pressurized Butane 3,750 bph.

**Moorings Equipment.**

- **Quick Release Hooks** are installed to enable efficient/ safe mooring and unmooring operation. Can be remotely released in an emergency.
- **Mooring Winches** with lightweight synthetic mooring lines strong as steel, but 1/7th of the weight (same material as in bullet-proof vests).

**Moorings Winches**

CRANES (8). Equipped with knuckle boom, providing low load movement, high maneuverability, and ultimate safety. Layout ensures ease of maintainability.

**Vent Tower.**

Tower height 77m above deck. Situated on Aft Mooring Deck to allow vapors, in the event of a release, to be safely dispersed clear of the vessel.

**Crane (8).** Equipped with knuckle boom, providing low load movement, high maneuverability, and ultimate safety. Layout ensures ease of maintainability.

**Thruster.**

Largest tunnel thruster ever built installed at stern. Enables FPSO to maintain heading during export operations, if sea condition unfavorable for ultimate safety.
ACCOMMODATION. Designed to accommodate 60 persons. Complete with medic area, gym, swimming pool, sauna, a 13th floor elevator and other facilities.

TURRET. Enables FPSO to weathervane 360°. To be moored with 9 anchors, each chain approx. 550m long. The anchors used are the largest drag anchors built. Two 6” flexible risers carry mixed LPG at ambient temp and one 4” flexible riser Fuel Gas for FPSO’s steam plant.

HELIDECK. Designed for a Bell 212 with low turbulence, wide obstruction-free approach.

FENDERS. 5 ea Yokohama 3.3mx6.5m + 1 ea susp foam filled). Launched by purpose built davits, designed to absorb shock loading of fenders bouncing in 3m seas.

LIFEBOAT. Fully enclosed motor lifeboats (60P) on each side. Remotely released, air supply provided.

TANDEM OPERATION. Tankers up to 135,000m³ can be moored in tandem to Smit Bracket at stern. A 60m hawser (BL 460t) used and 12” floating hose.
Propane Room. Ref. Compressors.
Butane Room. Ref & Reliq Compressors.
Sanha External Turret
<table>
<thead>
<tr>
<th><strong>Name</strong></th>
<th>SANHA LPG FPSO</th>
</tr>
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<tbody>
<tr>
<td><strong>Owner</strong></td>
<td>SONASING SANHA LTD</td>
</tr>
<tr>
<td><strong>Builder’s hull number</strong></td>
<td>1063</td>
</tr>
<tr>
<td><strong>Builder</strong></td>
<td>IHI Marine United Inc. Kure Ship yard</td>
</tr>
<tr>
<td><strong>IMO number</strong></td>
<td>9277462</td>
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<tr>
<td><strong>Nationality</strong></td>
<td>BAHAMA</td>
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<tr>
<td><strong>Port of registry</strong></td>
<td>NASSAU</td>
</tr>
<tr>
<td><strong>Date of keel laid</strong></td>
<td>FEB. 25, 2003</td>
</tr>
<tr>
<td><strong>Date of launching</strong></td>
<td>NOV. 21, 2003</td>
</tr>
<tr>
<td><strong>Date of delivery</strong></td>
<td>NOV. 4, 2004</td>
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<tr>
<td><strong>Classification</strong></td>
<td>AMERICAN BUREAU OF SHIPPING</td>
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<tr>
<td><strong>Notation</strong></td>
<td>+ A1 Liquefied Petroleum Gas Floating Processing, Storage and Offloading System</td>
</tr>
<tr>
<td></td>
<td>+ A1 Floating Offshore Installation – Depropanization, Refrigeration, and Reliquefaction Facilities; Ship Type 2G (-50deg C, 0.45 Kg/cm2, 650 Kg/m3), DLA, SFA</td>
</tr>
<tr>
<td></td>
<td>+ACCU (minus propulsion plant), UWILD, PMS</td>
</tr>
</tbody>
</table>
Length registered 220.80 M
Length overall (Loa) 262.65 M
Length between perpendicular (Lbp) 230.00 M
Breadth (Mould) 49.00 M
Depth (Mould) 29.30 M
Design draft (Mould) 13.20 M
Scantling draft (Mould) 13.20 M
Assigned summer draft (Ext.) 13.224 M
Deadweight Approx. 93,000 T
Gross tonnage Approx. 113,000 T
Net tonnage Approx. 33,900 T
Complement 60 Person
Production, Max. in total : 37,370 Barrels/Day (5,941 m³/Day)

From SCC, Max
  Pressure, Normal : 320 psig
  Pressure, Max. operating : 700 psig
  Temp., Normal : 65 deg F
  Temp., Design Max. : 100 deg F

From FGIP, Max
  Pressure, Normal : 310 psig
  Pressure, Max. operating : 700 psig
  Temp., Normal : 65 deg F
  Temp., Design Max. : 100 deg F

Propane : Butane : 0.65 : 0.35
GENERAL 4/7

Offloading Rate

**Side-by-Side (Refrigerated), Total**
- Pressure, Normal: 45 psig
- Propane: 22,750 Barrels/Hour (3,616 m³/Hour)
- Temperature, Minimum: -58 deg F
- Butane: 22,750 Barrels/Hour (3,616 m³/Hour)
- Temperature, Minimum: -5 deg F

**Side-by-Side (Pressurized)**
- Pressure, Normal: 116 psig
- Butane: 3,750 Barrels/Hour (596 m³/Hour)

**Tandem, Total**
- Pressure, Normal: 175 psig
- Propane: 18,750 Barrels/Hour (2,981 m³/Hour)
- Temperature, Minimum: -58 deg F
- Butane: 18,750 Barrels/Hour (2,981 m³/Hour)
- Temperature, Minimum: -5 deg F
• Cargo Tank
  – Type
  – Tank #
    – 1 atm, -50 Deg. C (98%)
• Ballast Tanks (100%)
• FWT (100%) (fresh water)
• DWT (100%) (drinking water)
• FOT (100%) (fuel oil)
• Manifold
  – Starboard
  – Port
  – Tandem
• SPB, IMO-type B
• 6
• 135,000 m³ (excl. dome top)
• 59,583 m³
• 459 m³ (2887 bbls)
• 413 m³ (2597 bbls)
• 5,104 m³ (32,104 bbls)
• 1 – Propane, 1 – Butane, 2 – Vapor Return, 1 Pressurized Butane lines
• 1 – Propane, 1 – Butane, 1 Pressurized Butane lines
• 2 – Propane or Butane
GENERAL6/7

MACHINERY

- Cargo pump
- Emergency Cargo Pump
- Butane Booster Pump
- LPG Recycle Booster Pump
- Inert Gas Generator
- N2 Generator
- Ballast Pump
- Central Cooling Sea Water Pump
- Cooling Fresh Water Pump
- Fire water Pump
- Fire and GS Pump
- Deluge Pump
- Emergency Fire Pump
- Utility Air Compressor
- Control Air Compressor
- Thruster

- 12 – 550 m³/h x 120 m
- 6-110 m³/h x 120 m
- 2 -550 m³/h x 75 m
- 2 – 110 m³/h x 75 m
- 1 – 5400 Nm³/h
- 2 – 100 Nm³/h
- 2 -1800 m³/h x 35 m
- 2- 2100 m³/h x 14 m
- 3 – 1850 m³/h x 27 m
- 1 – 170 m³/h x 105 m
- 1 – 170 m³/h x 105 m
- 2 – 1000 m³/h x 105 m
- 2- 1200 m³/h x 105 m
- 2 – Nm³/h x 1.0 MPa
- 2 – Nm³/h x 1.0 MPa
- 1 – 3000 Kw
1. DEPROPANIZER

2- H2S Removal System (100 %)
2- LPG Inlet Filters (100 %)
1- LPG Surge Vessel (100 %) & 3- Surge Vessel Pumps (50 %)

Depropanizer Plant:
1- Depropanizer Column (100 %)
8- Depropanizer Condenser (air-cooled)
1- Depropanizer Accumulator (100 %) & 2- Reflux Pumps (100 %)
2- Depropanizer Reboilers (50 %)

Total Weight: 2,208 T (dry) / 2,448 T (op.)
Depropanizer column: abt 60 m tall, 450 T (dry) / 560 T (op.)

2. REFRIGERATION UNIT

3- Propane (50%)
2- Butane (100%)

3. RELIUEFACTION UNIT

2- Propane (100%)
1- Propane & Butane (100%)
1- Butane (100%)
DEPROPANIZER PLANT
REFRIGERATION/RELIQUEFACTION PLANT
Refrigeration and Reliquefaction Plant

- Butane & Propane Refrigeration Plant (Aerzener Wet Screw Compressors)
- Butane Re-liquefaction Plant (Howden Oil-free Screw Compressors)
- Propane Re-liquefaction Plant (Howden Oil-free Screw Compressors with Cascade System)
Refrigeration & Reliquefaction Plants

Propane Refrigeration Plant C1

Propane Reliquefaction Plant R1
LPG STORAGE (TANKS) & OFFLOADING
The vessel has (6) low temperature cargo tanks. Each cargo tank is designed to handle either butane or propane.

The vessel is able to offload to a shuttle tanker either on the Port or Starboard side. The Starboard side is preferred for offloading. The vessel has future capabilities to offload in tandem to accommodate larger shuttle vessels.

Propane and Butane have the property of becoming liquid at atmospheric pressure when refrigerated and reverting to gases when the temperature is increased.

The Sanha LPG FPSO utilizes this property and stores these products in the liquid state. Otherwise, it would take a vessel roughly 250 times as big to store the same volume if in a gas phase.
Offloading Equipment

- Side-by-side Offloading to all sizes of LPG tankers, from 2,000 m³ to 85,000 m³ capacity
  - Port Side
    - Pressurized Butane.
    - Refrigerated Propane & Butane simultaneously.
  - Starboard Side
    - Pressurized liquid Butane.
    - Refrigerated Propane & Butane simultaneously and vapor recovery.

- Provisions for Tandem Offloading to tankers from 30,000 m³ to 125,000 m³ capacity (future).
Cargo Containment System

View on cargo tank #2 from FPSO centerline
Cargo Containment System

View of Bottom Supports in Cargo Hold #3

Detail of tank support
IHI SPB

Self-supporting
Prismatic Tank
IMO Type-B
FWD MACHINERY SPACE
3RD MACHINERY DECK

Steam generation: Boilers No. 1, 2 and 3.
• Three Boilers made by Mitsubishi. Largest ever built of this type.
• The boilers are built to operate on dual fuel (Gas or MGO)
• Capacity is 90 ton/h each
• Saturated steam 25 t/h, 23 bar
• Superheated steam 65 t/h, 22 bar, 270 deg C (520 deg F)
• Three Boiler Operation
• Under all normal operating only two boilers shall be operating with the third boiler on warm standby
3RD MACHINERY DECK

• Three Steam Turbine Generators made by Shinko/Nishishiba,
• Total power is $3 \times 9000 \text{ kW} = 27,000 \text{ kW}$ or 27.0 Mega watt.
4th MACHINERY DECK

- Main Steam Turbine Condensor
- Control Air Compressors No. 1 & 2
- Utility air Compressors No. 1 & 2
Feedback Items of Interest

- Contracting
- Hull Fabrication
- Gas Trials
- Commissioning
- Site Team Organisation
- Safety
- Final Drydocking
- Tow to Angola