Marine Terminals
Jornada Latinoamericana
Operadores de Monoboyas

Septiembre 1, 2009

Operator inputs into the Design Requirements / Specifications of the Marine Loading Terminal

SOFEC Inc.

- Engineering and Construction Company based in Houston, Texas
- Founded in 1972
- Acquired by MODEC, Inc. in December 2006
- Core Technologies
  - Floating Production Systems
  - Permanent Internal Turret Moorings
  - Disconnectable Internal Turret Moorings
  - External Cantilevered Turret Moorings
  - Spread Moorings
  - Tower Yoke Moorings
  - Keel Integrated Transfer Systems (KIT)
  - Marine Import/Export Terminals

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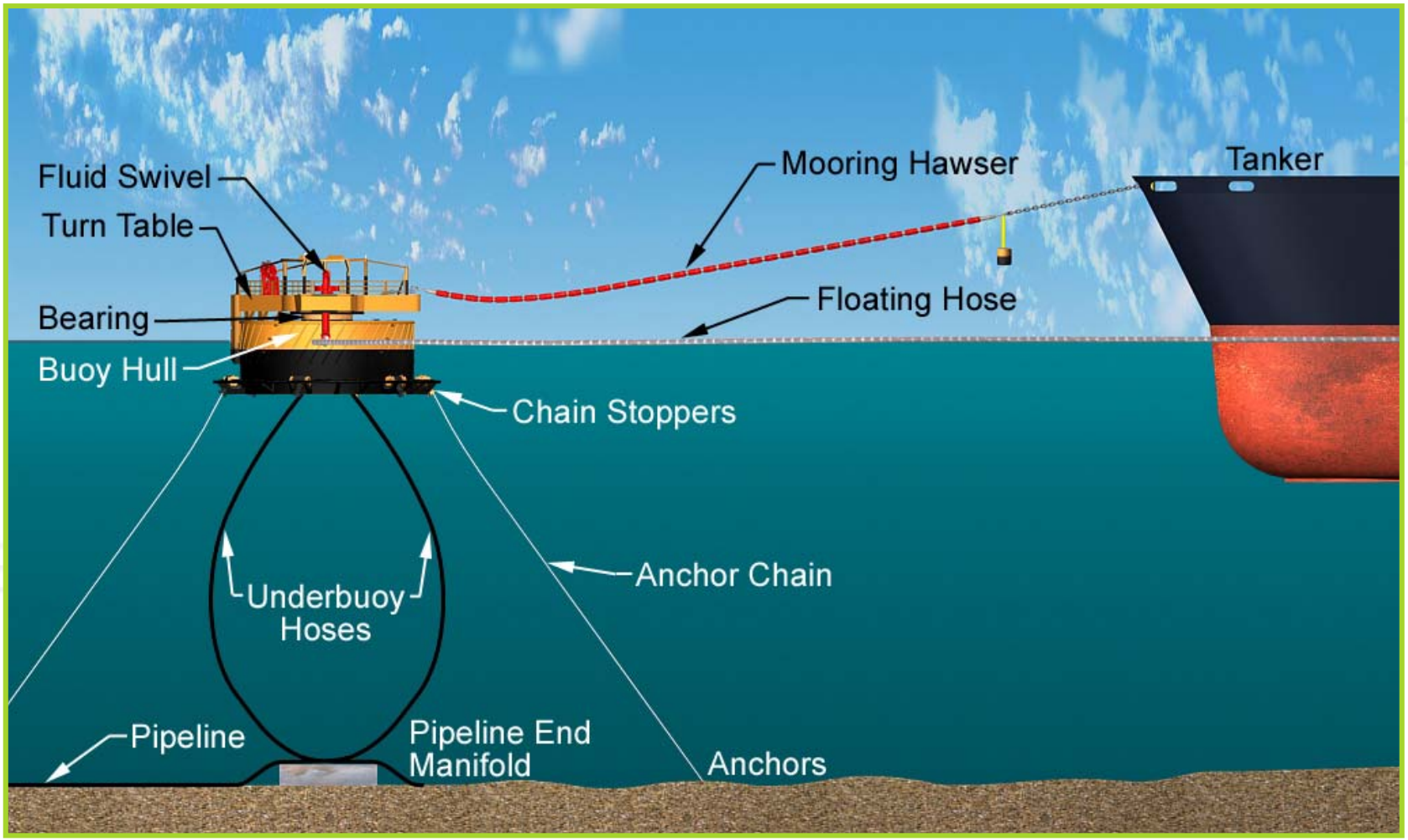
Catenary Anchor Leg Mooring
CALM

CALM Terminal Components



Catenary Anchor Leg Mooring (CALM)

- Typical Scope of Supply
  - Equipment and Materials
    - Buoy Hull with Turntable & with Turntable Bearing
    - Fluid Swivel
    - Product Piping
    - Anchor Legs with Anchors or Piles
    - Cargo Hoses
    - Pipeline End Manifold (PLEM)
    - Tanker Mooring Equipment
    - Navigation Aids
    - Painting and Cathodic Protection

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Design Considerations

Design Considerations

There are two key areas that a perspective CALM Buoy owner or operator can influence to lead to a successful project.

1. OPERATOR SUPPLIED DATA:
   Detailed and accurate data during the bid phase.

2. OPERATOR PREFERENCES:
   Input from the operator's marine operations group to identify any field preferences that would allow easier operation or maintenance of the CALM Buoy.

Operator Supplied Data

Operator Supplied Data

Bid Data

- Soils Data
  - Geophysical investigation to confirm pipeline route and CALM Buoy location is free from any potential hazards. Can also be used to reduce number of required geotechnical borings.
  - Geotechnical investigation consisting of borings at anchor locations and PLEM and includes sample recovery for field and laboratory testing.

- Site Environment Conditions
  - Water Depth
  - Wind, wave and current data for both operating (1-Year) and survival (100-Year) environmental conditions.
  - Unique conditions such as seismicity, wind squalls, ice, etc.

Operator Supplied Data

Bid Data

- Minimum and Maximum Tanker Size
- Product Characteristics / Flow Rates
  - Number of Separate Products
  - Product Type and Chemical Properties
  - Maximum Pressure and Temperature
- CALM Piping Design Pressures
  - ASME Class 150 or ASME Class 300 rated components for piping
  - ASME Class 300 connection at Flexible Hose Interface with Piping
  - Flexible Hoses typically rated at 15.5 barg (225 psig) or 19.0 barg (275 psig)
  - Surge (Overpressure) considerations
- Pipeline / PLEM Interface
  - Number and size of pipelines
  - Pipeline thermal expansion taken by pipeline or sliding PLEM.
  - Pigging facilities? Permanent or temporary pig launcher/receiver. Dual pipeline pigging loop?

Operator Supplied Data

Bid Data

- Instrumentation and Control Requirements
  - Process & Instrument Diagram (P & ID)
  - Mooring Hawser Load Monitoring
  - Monitoring of various parameters such as Product Flow, Pressure, Temperature, valve position, etc.
  - Local and Remote Telemetry Control of Hydraulically Operated Valves.
  - Radio Telemetry and Control from onshore control room or portable unit.
  - Interface with onshore DCS.
  - Tanker Berthing System (DGPS)
  - Meteorological Data Gathering
  - Submarine Hose Leak Detection

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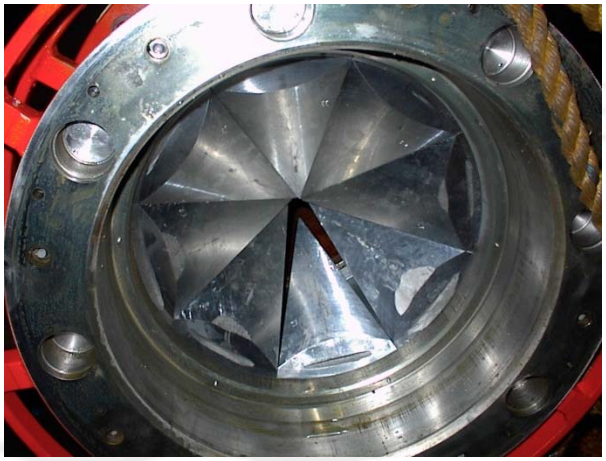
Operator Supplied Data

Bid Data

- Special Items
  - Break-Away Couplings
    - Single / Double Closure
    - Pressure Compensated (Separates under tension load only)
  - Surge Considerations
    - Break-Away Couplings as Surge Relief System (More Pollution)
    - Fully instrumented active surge relief system. On-Buoy surge relief system and control link to initiate various onshore commands to close ESD valves and trip discharge pumps.



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Design Considerations – System Complexity

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- Highly complex systems may include:
  - Load Monitoring
  - Pressure Monitoring
  - Weather Gathering Station
  - DCS Interface for Onshore ESD
  - Remote Valve Control
  - Piggability
  - Surge Protection
  - Hose Leak Detection
  - Subsea Valve Position Indication

Operator Preferences

Operator Preferences

- An operator will typically employ a technical services company to develop the requirements for a CALM Buoy project.
- However, marine operations personnel are usually not directly involved during the initial phase of a project to identify any field preferences that would allow easier operation or maintenance of the CALM Buoy.
- This results in a delivered product in accordance with project requirements, but not necessarily what the marine operations group would expect or require.

Operator Preferences

The following slides present examples of past issues that the operator had required or expected, but not been included by the project team.

Operator Preferences

1. Rigging / Padeye requirements.

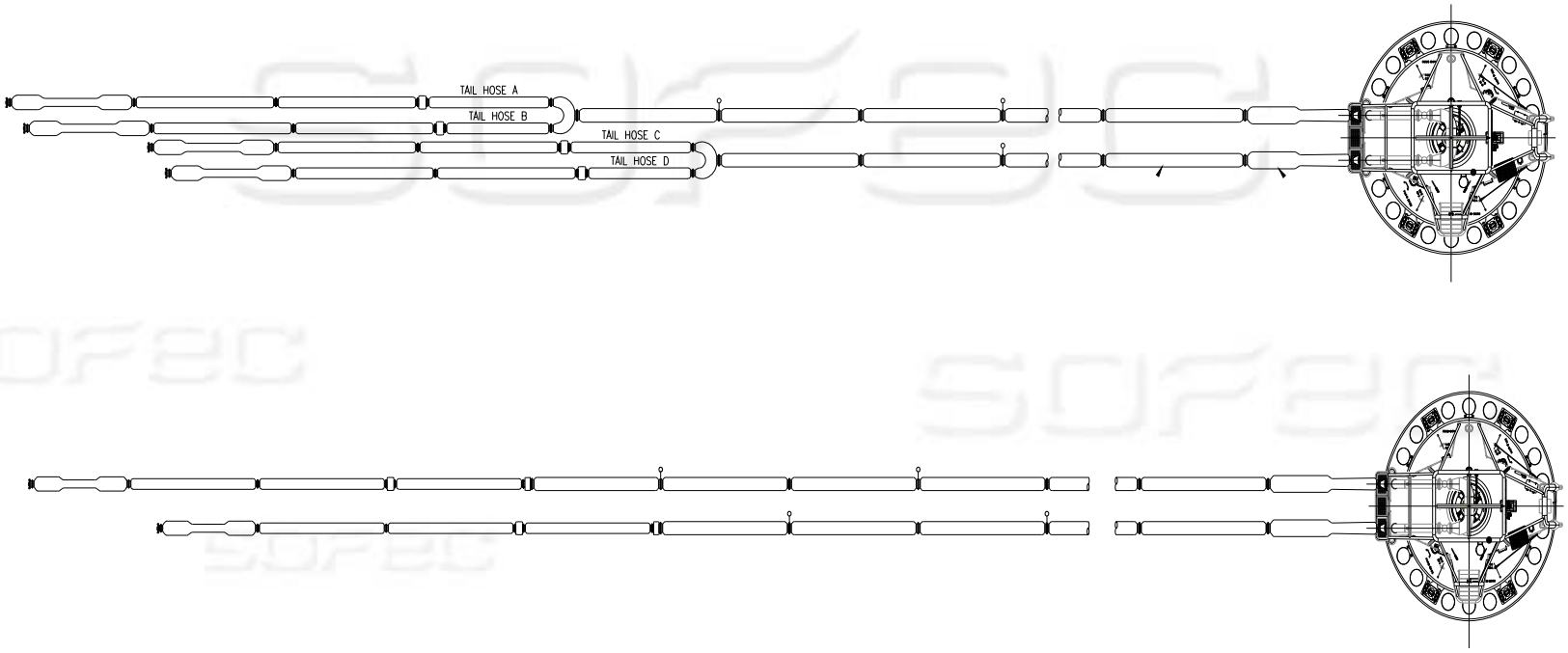
   A CALM Buoy is delivered with adequate rigging points and padeyes to perform required maintenance, but often times an experienced operator would like some of the following items based on their equipment or techniques:

   - Additional padeyes
   - Alternate rigging scenarios
   - Inclusion of hand winches
   - Additional access routes for use with an external crane

Operator Preferences

2. Floating Hose Configuration

   Many times a four (4) tail hose system is specified by a technical services company in order to reduce overall system pressure drop instead of the more traditional two (2) tail hose system.



Operator Preferences

2. Floating Hose Configuration (Continued)

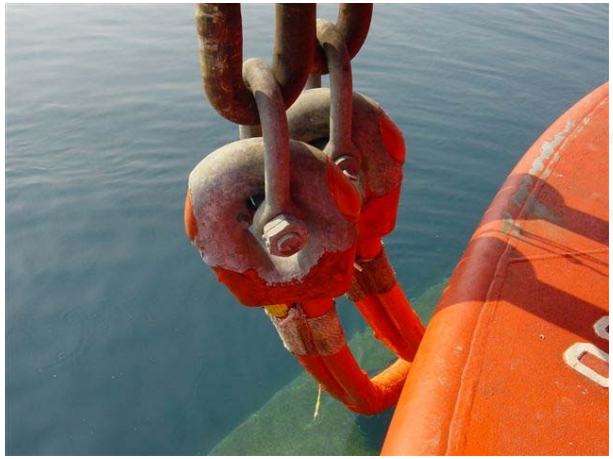
However, a four tail hose configuration often poses the following problems encountered by the marine operations group.

- Most tanker manifolds are configured with only three crude oil cargo connections. The fourth ‘non-connected’ hose will be either left free floating, **under pressure**, in the water causing possible clashing with the tanker, or must be secured off at the tanker rail.
- Greater possibility of tangling of the floating hose ends from wave action during non-loading operations due to the increased number of hoses. Also, during storm conditions, the equipment at the ends of the floating hoses move freely and independently which increases the possibility of impact between this equipment resulting in damage.
- Increased berthing and unberthing time due to the increased number of hose connections and handling required. It has been shown that an operator could load/unload a tanker faster with a two tail hose configuration in comparison to a four tail hose configuration. Even though the overall flow rate was slightly reduced due to an increased pressure drop of having only two tail hoses, this was offset by the time saved by the reduced number of hose connections and handling required.

Operator Preferences

3. Type Of Mooring Hawser

- Single or grommet hawser.
  - A single hawser has a single rope with spliced eyes at each end.
  - A grommet hawser is a continuous loop utilizing two ropes for strength.
- When these two types of hawsers of equal strength are compared, a grommet hawser is smaller which reduces the size of the various connecting hardware resulting in reduced weight and easier handling by the operator.



Operator Preferences

4. Emergency Shut-Down (ESD) Valves Versus Double Acting Actuated

An ESD valve actuator uses a spring to close the valve automatically when directed. The valve is held open usually by constant hydraulic pressure via an umbilical to the CALM Buoy.

Most operators are now replacing ESD valves with double acting actuators (Fail Last Position) for the following reasons:

- Loss of hydraulic pressure at valve results in a closed valve. If this is a subsea valve, then it takes considerable time for an operator to organize a diving spread to manually open the valve.
- Demerge costs during the time to re-open the valve.

Operator Preferences

4. Hose Flushing Valves & Crossover Piping

Every operator has a preferred method to flush the submarine and floating hoses for inspection or replacement based on their available equipment.

The addition of a few small valves and/or crossover piping on the PLEM or CALM Buoy piping can greatly reduce the flushing time and pollution risk.

Experience from the operator can help decide the strategic placement, number, size and location of flushing valves depending upon the preferred method and equipment.

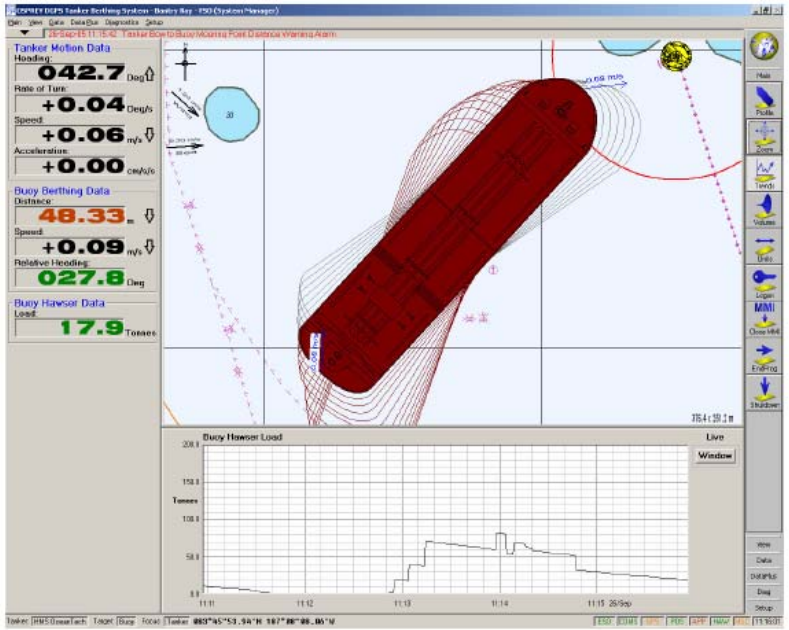
Operator Preferences

5. Telemetry Display / Control Data

Most CALM Buoy systems transmit/receive data from an onshore control room.

The type of data that is transferred to/from the CALM Buoy and displayed in the control room can greatly benefit from an operator's input. Below are only a few of the typical choices:

- Control of hydraulically actuated valves and indication of open/close position status
- Monitoring of product parameters such as pressure, temperature & flow rate.
- Mooring Hawser Tension
- Batter voltage and charging current
- Navigational Aids status
- Meteorological Conditions at the CALM Buoy (wind wave & current)
- Tanker Berthing Data
- Interconnection with DCS computer



Operator Preferences

6. Hand Held Portable Unit Type & Functionality

The mooring master typically takes a portable hand held unit to the tanker. This device can display information or provide control similar to the computer in the onshore control room.

There are several types of these portable units and the choice as to which is appropriate should be with the operator's marine group.

The three typical types are:

- Tablet PC – Mainly used with a tanker berthing system and provides full system functionality.
- Multi-line LCD – Displays data on several lines of LCD display requiring menu navigation to retrieve data.
- Enhanced Motorola Type Voice Radio – Besides voice communication, only real function is to initiate an ESD signal to control room.

Thank You