LNG FSRU PROJECT

CABRILLO PORT

TECHNICAL REPORT

OFFSHORE PIPELINE SYSTEM DESCRIPTION

PEGASUS International

A	Issue for Review	11/13/03	B. Jarrell	J. Riley			
Rev	**Description**	**Date**	**Originator**	**Checker**	**Project Approval**	**Pegasus Approval**	**Client Approval**

DOCUMENT NO.: 308-5751-TR-320

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1.0 INTRODUCTION

BHP Billiton (CLIENT) is planning to install a new LNG Floating Storage and Re-Gasification Unit (FSRU), *Cabrillo Port*, to be moored off the coast of southern California near Ventura. The regasified LNG will be transported to shore via two new gas transmission pipelines, with landfall close to Ventura/Oxnard, California. Once onshore, the transmission pipeline will tie into an existing Southern California Gas (SoCal) system.

1.1 Scope of Document

The intent of this document is to summarize the description of the proposed offshore gas pipeline system as part of the *Cabrillo Port* FSRU project. The description covers components downstream of the PLEM. The risers and the PLEM are not included in Pegasus's scope of work.

2.0 SYSTEM SUMMARY

The proposed offshore gas pipeline system for *Cabrillo Port* consists of several components. The offshore gas pipeline system connects to the FSRU and serves as a gas supply link to shore near Ventura, California. Custody transfer takes place at a receiving station onshore near an existing power producing facility, but the gas is then transported an additional 12 miles to the Center Road Station. The components associated with the offshore gas pipeline system are listed below:

- Jumpers
- Pipeline End Termination (PLET),
- Offshore Pipelines (2- 24")
- Shore Approach Tie-In (pipeline/HDD tie-in)
- Shore Approach (HDD beach crossing)
- Above Ground Installation (AGI).

The risers departing the FSRU connect to the riser Pipeline End Manifold (PLEM). This PLEM is located on the seabed in approximately 2,850 feet of sea water. The Riser PLEM is connected to the two offshore gas pipelines via two jumpers. One jumper for each pipeline departs the Riser PLEM and connects to a PLET at the end of each offshore gas pipeline. The PLET is used to connect the jumper to the appropriate offshore gas pipeline. Both offshore gas pipelines depart the respective PLETs and run to a subsea tie-in to the shore approach in approximately 40 feet of sea water. The subsea tie-in spool connects the offshore gas pipelines to a Horizontal Directional Drill (HDD) shore approach for each pipeline. Once onshore, the HDDs will penetrate the surface and tie-in to an existing SoCal gas transmission system at an Above Ground Installation (AGI). The following sections describe each component in greater detail.

3.0 RISER PLEM

The proposed offshore gas pipeline system will connect to the FSRU system at the bottom of the risers on the seabed via a PLEM. The riser PLEM is under the scope of work of FMC Energy Systems. As such, it is referred to but not defined in this report.

4.0 JUMPERS

For installation and future expansion and/or maintenance considerations, the proposed offshore gas pipelines will terminate in separate, simple PLETs. The PLETs will be connected to the riser PLEM via steel pipe "jumpers". These jumpers will be connected to the riser PLEM and the PLETs via ROV operable subsea connections. The exact geometry of the jumpers will be defined based on metrology taken after the installation of the riser PLEM and the PLETs. This will allow for the jumpers to be fit-for-purpose and will decrease the chance of alignment problems during installation.

A typical jumper configuration consists of a vertical ROV operable subsea connector with an upside-down "U" pipe configuration on top of the connector. At the other end of the jumper, a second vertical ROV operable subsea connector is usually placed. This design allows for a simple vertical installation and easy removal should any problem occur in the future.

5.0 PIPELINE PLETS

A separate PLET will be attached to each offshore gas pipeline. The PLETs will be simple PLETS that consist of a pull head, mudmat, pipeline connection, vertical jumper connection, and a manual valve. The pull head will be used to assist in the installation/laydown of the pipeline and PLET. The mudmat will be used to distribute the weight of the PLET over a larger area to prevent subsidence of the PLET. The pipeline connection will likely be a weld-on connection so that the PLET may be used as a laydown head during installation. The vertical jumper connection will likely be the same type of subsea ROV operable vertical connection as was used on the Riser PLEM. An ROV operable manual shut-in valve will be placed on the PLET so that the pipeline can be isolated for various reasons such as testing and/or removal of the jumpers in the case of possible riser replacement. The design of the PLET will dictate the method used during installation to terminate the pipeline. As such, the PLET will most likely be designed after the selection of an installation contractor so that the PLET can accommodate the installation equipment available.

6.0 OFFSHORE PIPELINES

Two offshore gas pipelines will be used to deliver the natural gas from the FSRU to the AGI. Each pipeline will be installed separately and is expected to have approximately 100 feet of separation from the other offshore gas pipeline. The offshore gas pipelines have been designed to the appropriate codes and regulations. Concrete Weight Coating (CWC) is expected to be used in shallow water depths to ensure on-bottom stability and to provide protection for the pipeline from external impacts. The proposed route for the offshore gas pipelines is approximately 20 to 21 miles in length. The proposed route transverses from the flat expanse of the Hueneme Fan in approximately 2,850 feet of sea water up a slope, where they parallels the Navy FOCUS cable, onto the shallow shelf where it approaches Ormond Beach near Oxnard, California. The offshore gas pipelines will terminate into separate tie-in spools that will connect the offshore gas pipelines to the respective HDD shore approach. The offshore gas pipelines will contain a manual shut-in valve next to the tie-in spool at the shore approach. The manual shut-in valves will be used for pipeline isolation during testing, maintenance, or upset condition repairs.

7.0 SHORE APPROACH TIE-IN

The shore approach tie-in spools will be used to connect the offshore gas pipelines to the HDD shore approaches in approximately 40 feet water depth. Each tie-in spool will consist of an induction bend to adjust the appropriate offshore gas pipeline heading to match that of the respective HDD shore approach. Connections for the tie-in spools to both the offshore gas pipelines and the HDD shore approaches will be either flanged or welded connections. Exact spool geometry will be designed and fabricated based upon metrology taken after the pipeline and HDD installations. This should provide for an accurate and precise alignment and installation of the tie-in spools.

8.0 SHORE APPROACH

HDD will be the method used for the shore approaches. Each offshore gas pipeline will have a separate shore approach. The shore approaches will traverse from approximately 40 feet water depth to approximately half a mile inland to an entry point near a power plant. Each shore approach will consist of a manually operated shut-in valve next to the tie-in spool for HDD isolation for testing, maintenance, or upset condition repair. The HDDs will exit into the ocean at a small angle relative to the seabed to avoid the pipeline protruding from the seabed any more than necessary. This is to ensure the safety of vessels in the area and the safety of the pipeline. The HDDs will enter the ground from the AGI at a small angle relative to horizontal in order to provide ease of installation and additional safety at the AGI.

9.0 ABOVE GROUND INSTALLATION

The AGI will be placed at the entry point of the HDD shore approaches near the power plant onshore. Manifolding and a metering station will make up the AGI. The manifolding will allow for isolation of each of the gas pipelines, metering of the gas supplied by each pipeline, the operation of a gas supply line to the power plant, and tie the dual gas pipelines into the existing SoCal onshore gas system.