COMAH - Amplus philosophy for facility selection and safety considerations in design, operations and maintenance of the VPU™

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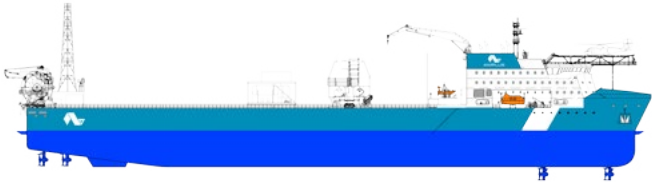
ISSUED FOR INFORMATION

Prepared by: Stewart Risk

Checked and Approved by: Ian Herd

Ian Herd

Amplus Energy Services Ltd
119 Grandholm Drive
Aberdeen AB22 8AE
United Kingdom



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Introduction

In 2008 Amplus Energy Services Ltd identified that much of the UK's remaining oil reserves were in small reservoirs with around 30 million barrels of recoverable oil, which were stranded from major infrastructure. Amplus commissioned Senergy to undertake a review of the remaining reserves, which confirmed the Amplus assumption.

In the late 80's the Amplus operational directors were involved through their employment with the development of the BP dynamically positioned FPSO the Seillean and which was constructed in the Harland and Wolf shipyard. This provided a radical departure from conventional production facilities and successfully and safely operated on the Cyrus Oilfield block16/28 and then on the Donan field in the North Sea. At the time, this was a major technical achievement for BP considering the maturity of DP referencing systems and the bespoke disconnectable rigid riser system that BP had developed. Since dynamically positioned shuttle tankers did not exist, the Seillean disconnected from the subsea production facility and transported its cargo directly to onshore offloading facilities, which in turn demonstrated the disconnection/reconnection system being well proven.

Petrobras saw the potential of the Seillean for production operations in Brazil and after BP sold the vessel to Reading and Bates. Petrobras contracted the vessel for work on Roncador, initially. Other developments were to follow.

Amplus considered the Seillean ahead of its time and the vessel was viewed as a safe and efficient production solution for marginal fields, particularly in light of the advances made in technology that could be incorporated into the design.

Amplus have therefore spent several years refining the design of a modern day dynamically positioned VPU (versatile production unit). Originally, the VPU was designed to utilise a rigid production riser with a high angle disconnect – similar to the BP Seillean vessel – but Amplus identified that in reality the remaining fields were more difficult to produce; these often needed addition flow paths to produce oil. In response, Amplus identified a field proven standard disconnectable turret, which completes the redefined design.

The physical integrity of the plant and equipment has also been considered and has been incorporated into the shipyard specification – which the shipyard will use to construct the vessel.

Design Justification

The HSE published a review entitled Topic Strategy 2008 – 2013. Maritime Integrity and Mobile Installations. (Division, Health & Safety Executive Offshore, n.d.)

This document has the following background for Monohull Installations:

'The UKCS fleet of some 20 monohulls include FPSO and FSU installations. Some of these were specifically designed and built for the purpose, whilst others were converted from trading tankers - it is not unusual for the original marine systems and the new process systems to "Clash" within the latter converted vessels.

In many cases the vessels are 30 years of age and as such require a higher frequency of inspection, tank inspections being of particular relevance. The duty holders tend to be averse to dry docking the vessels, which would be the norm for trading tankers, largely due to the difficulty of demobilising and remobilising the installation, the time off location and the consequent loss in revenue at the current high oil price. The need for increasing maintenance leads to an increase in the numbers of personnel required on board while placing greater pressure on existing accommodation. It is not unusual to find that Safety Critical maintenance has to be deferred due to lack of available bed space.

A frequent concern with all floating installations relates to the lack of maritime competence and the difficulty of recruiting personnel from a suitable background. The relative importance that is placed upon the need for competent maritime personnel varies considerably between duty holders, although all units are subject to maritime risk. The choice by some FPSO operators to deselect Class, (as a Fixed Installation the ship shaped FPSO does not require to be Classed), increases the concern yet further. '

Design Justification Continued

'There has been an increase in the number of mooring failures of FPSO and FSU installations recently, thought to be for a number of reasons including age, link bending / fatigue and bad weather. Additionally a number of installations are dependent upon thrusters for heading control and as these are difficult to maintain it is not unusual to find one or more thrusters out of action.' (Division, Health & Safety Executive Offshore, n.d.)

Amplus took into account all of these findings when selecting the VPU for the production of marginal fields.

Amplus have reviewed the performance and safety of the Seillean and another DP production FPSO, the Helix Producer 1, and concluded the concept of a DP FPSO is an inherently safe option because of the disconnectable turret. This enables rapid emergency disconnection from the major fuel source (reservoir) thereby protecting the vessel and crew.

Amplus operational directors were involved in the emergency response operations from the MV Tharos, which they were crewing during the Piper Alpha disaster and subsequent body recovery and well kill operations. Aware of the challenges of being unable to isolate the fuel source when on a fixed installation or moored FPSO, Amplus consider the VPU's ability to disconnect from the fuel source a fundamental advantage, when compared to conventional technologies.

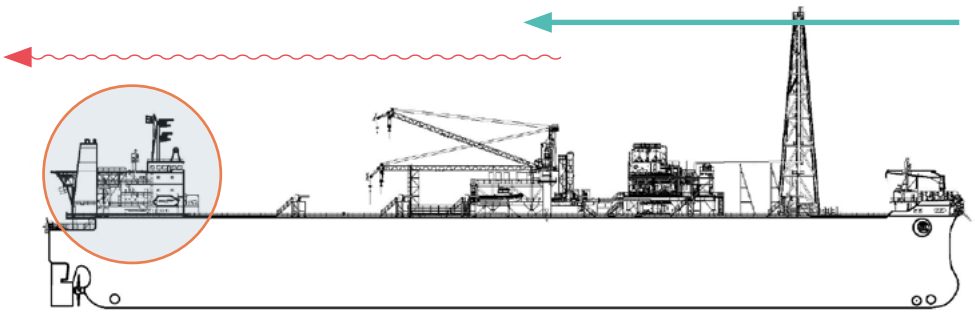
Recent incidents involving a moored FPSO's loss of position, due to mooring failures, have put their crews at high risk and, because there was no disconnection capability the subsea infrastructure in both cases were extensively damaged. This could have resulted in production riser damage and loss of containment. The ability to undertake a planned or emergency disconnect mitigates this risk.

Design Justification Continued

On a conventional FPSO the large quantity of deck mounted equipment requires a large vessel to mount the equipment on with storage of dead crude ranging from 300,000 barrels to 1,000,000 barrels. The VPU does not require to carry such an inventory and has a 200,000 barrel storage capacity. Double skinned vessels are a mitigation method for loss of containment and Amplus opted to double skin all of the hull areas around the tanks as part of its design.

Amplus also opted for a top of the range IMO DP3 standard for station keeping and power generation integrity, with the 3 engine rooms having complete redundancy in the event of fire or flood in any engine room. This exceeds the standard of all existing dynamically positioned production facilities.

In reviewing existing conventional moored FPSO design it became apparent that with tanker conversions the accommodation block and bridge control room are conventionally positioned astern. Amplus opted for a new build design where the accommodation could be placed forward and upstream of the fuel source as the VPU will be operated head to weather, so any gas clouds or pool fires and smoke and flame are directed awav from the safe haven and helideck.

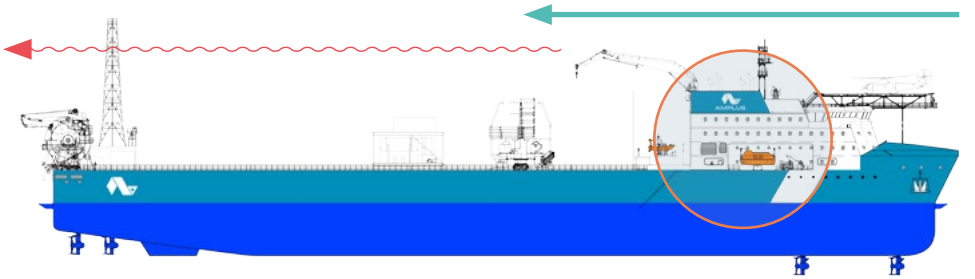


COVENTIONAL FPSO

Weather

Hydrocarbon Release

Accommodation
Life Boats
Helideck
Power Generators



AMPLUSVPU™

The ability to maintain a heading is also a benefit during shuttle tanker offloading operations and mitigate against the risk of fish tailing.

Amplus considered major modifications to the process system as a result of changing reservoir conditions and identified the challenges of undertaking modifications on fixed production platforms and moored FPSO's; this was another factor in selecting a disconnectable turret, which enables the vessel to transit to port and thus taking advantage of shore side support for major modifications/replacement of the VPU's topside processing modules.

The systems incorporated in the design of the Amplus VPU have been extensively field proven and are generally standard oilfield products.

Containment of Dangerous Substances.

Conventional moored FPSO's in the UK North Sea can be considered as Installations and can be designed without the benefit of design and build under class rules. Amplus will design and build the VPU under Lloyds Register class rules and benefit from compliance with the recently introduced FPSO rules.

Lloyd's Register's Rules and Regulations set appropriate standards for the design, construction and lifetime maintenance of ships, offshore units and land-based installations - providing all the information required for classification purposes. To keep pace with changes in technology, market trends and new legislation, Lloyd's Register is dedicated to an on-going programme of research and development to enhance existing technical standards and publish new Rules.

Lloyd's rules cover the containment of dangerous substances and the need for structural integrity, suitable materials and measures to protect against overpressure and fire and explosion.

Amplus engaged early in our design programme with Lloyd's Register who will also provide supervision and compliance services during the construction programme.

Design Standards and Failure Modes

The Lloyd's rules cross-reference all of the specific standards that must be complied with.

The HSE sponsored Research Report 195 'reviewed the current approach to demonstrating redundancy on offshore vessels with dynamic positioning (DP) systems, in order to establish whether it meets the requirements for suitable and sufficient risk assessment. The review covers the relevant formal requirements and guidelines, recent incident experience, failure modes and effects analyses (FMEAs) and trials reports, consultations with stakeholders in the industry, and a review of approaches used in other industries. It concludes that the current approach is appropriate in principle, although there are several areas of weakness in the way it is applied in practice. In order to make more effective use of FMEAs, the report recommends that management guidance should be developed, to provide an industry standard for how FMEAs of DP systems should be specified, managed, performed, verified and updated.'

The International Marine Contractors association (IMCA) produced the FMEA guidance and Amplus has specified this process as a core assurance process for all vessel systems from design through to construction and operation.

The Research Report identifies the benefit of using the FMEA output as a training aid for vessel operatives to better understand the operation of vessel systems and Amplus have mandated that the FMEA will be a living document on the VPU and familiarity with the FMEA part of the competence assessment process.

Plant Operation to Specification.

The OIM/Master Chief Engineer and Electronics Technician will be involved in the detailed design process of the VPU from the outset and involved in the development of operating procedures in the design phase for display to operatives. This will be in the form of user-friendly process flow charts that will assure that equipment is operated in accordance with specifications.

Amplus have also identified that there have been shortcomings in the design processes for offshore PLC controlled systems. In response, a detailed specification has been written to assure the vessel control system is designed and built to a high standard of integrity.

Maintenance and Safety Critical Equipment

After a review of maintenance systems in the market and from extensive experience in managing DP vessel systems, Amplus have nominated the software system TM Master as a maintenance system preferred by our offshore crews.

The intention is to have the OIM/Master and Chief Engineer to populate the software in conjunction with the shipyard during the detailed design and build phase.

Safety critical items reviewed as part of the FMEA process will be identified and highlighted in the software.

Amplus has already nominated condition monitoring on some major safety critical equipment; this requirement may be increased by the OIM/Master and Chief Engineer as a result of the output from the FMEA process to assure a high level of Reliability Availability and Maintainability of equipment

Amplus has worked with sub system manufacturers to reduce the risk from crane operations during maintenance and has required that components can be skidded and lifted on custom-built devices.

Where lifting operations cannot be engineered out and are essential, Amplus has specified knuckle boom cranes instead of the convention fixed boom cranes – which are conventional on production platforms but are not the best solution for control of loads on production facilities.

Examination and Testing

Examination and Testing will be carried out in accordance with the manufacturers requirements. In addition, tests will be performed as a result of the output from the holistic FMEA output. This will confirm that failure modes and mitigation measures perform as predicted in design.

Competence

The OIM/Master and Chief Engineer will develop a detailed competence matrix; this will be produced for all vessel/production crew during the detailed design and build phase. Specialist engineering services may be requested during operation for the maintenance of safety critical equipment.

A robust Permit to Work system and Management of Change system will be implemented.

The FMEA system will be a living document and if system change is authorised, the FMEA document will be updated.

Our philosophy conforms with the principles of COMAH 2015 regulations which implement the majority of the Seveso 111 Directive 2012/18/EU - Section 8 The physical integrity of plant and equipment.

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