Malcolm Sharples, Vice President, Offshore Project Developement, ABS

Understanding FPSO's

An eagerly awaited Record of Decision from the Minerals Management Service (MMS) to permit floating production/storage offloading (FPSO) vessels for U.S. Gulf of Mexico (GOM) installation will redefine the oil patch as we know it. With a go-ahead for FPSO's, the industry can move toward efficient production from smaller fields in deep water while also making possible production in areas remote from pipeline infrastructure.

The high hydrocarbon flow rates often associated with the use of FPSO's in remote locations will further spur a change of business traditions within the region to reflect an integration of marine and offshore cultures, and perhaps a melding of global expectations and technology for increased frontier development.

Floating production has come a long way since the first ABS-classed unit was installed offshore U.K. in 1975. For the Argyll field, Hamilton Bros. converted the *Transworld 58*—an early semisubmersible—for use as a floating production system (FPS). While the initial concept was to place a process plant "on top of" a floating facility, enhancements of ship-shaped vessels, increased volume, and expanded topside facilities over the years have added to the complexity. Classification societies, and their certification businesses, as a result, have become an integral part of the development process.

Of late, Kellogg Brown & Root has awarded ABS the classification contract for the Petrobras *Barracuda* and *Caratinga* FPSO's offshore Brazil. The sheer breadth of this project calls for a globally integrated logistical effort among manufacturers, designers, and fabricators to ensure quality work and timely completion. With staff located around the world, ABS is providing on-site facilitation and inspection to accommodate the global scope and time-critical effort. Conversions for both vessels have commenced.

Class society roles in this process can be confusing, making in-depth understanding of how they fit into both the marine and offshore worlds necessary as FPSO's come forward for being permitted in the U.S. GOM.

Both the maritime and offshore cultures need to work together for a successful project. Embracing some of the maritime traditions may be a lesson learned by the offshore community; however, the offshore community cannot rely completely on the maritime world paradigms. Issues impacting the use of FPSO's include design and construction problems, cost overruns, cracks, and motion problems.

For the most part, we have the technology to avoid these nightmares. Traditional ships do not have flat bows; instead they have pointed ends to better handle the seas. Ships, other than special-purpose vessels, are not triangular, so predictably high motions experienced with some FPSO designs are not a surprise to most naval architects.

The maritime world builds vessels to standards and tolerances and with technology designed to dovetail with the regulatory regime. Vessels are traditionally dry-docked periodically, occasional and minor vessel cracks are tolerated for lighter scantlings, and nominal service life in a North Atlantic wave spectrum is adopted as the uniform standard of acceptability. Not so for FPSO's.

FPSO's are different. *Unlike ships—*

For a permanently moored FPSO, there is nowhere to run and nowhere to hide. Operators have to plan for a full range of weather conditions. For instance, the *Modec Nan Hai Sheng Li* in the South China Sea sustained a supertyphoon in September 1996. Wave heights exceeded 89 ft while the maximum vessel design was 79 ft, and wind speeds topped the 100-year return.

FPSO's cannot detach and go to drydock when modifications are necessary. ExxonMobil's *Zafiro Producer* originally went on location for a 5-year field life at 80,000 BOPD. But when field production expectations revised to 30 years with 120,000 B/D, the operator stipulated that modification be performed on location. Oceaneering did an amazing job of completing this conversion on location, including bottom-plate replacement while operating.

Vessels stationed in benign locations do not need to meet full North Atlantic ship-bending movement requirements, as required for trading tankers; steel requirement can be purpose-fit to the project and location. ABS is involved with Woodside's *Cossack Pioneer* and Petrobras' *P-35* developing risk-based approaches to inspection, maintenance, and classification for these site-specific production programs.

The technical basis for evaluating FPSO designs is site-specific, and very rigorous methodologies are required. Accurate fatigue life of the vessel over 30 years is required, and the expectation is that service matches reality. This demand requires appropriate corrosion margins, yet industry lacks accurate predictors for this in terms of location, cargo temperature, cargo type, and the many other variables. ABS, working with a number of oil companies, plans to launch a joint industry project to better pool ABS' and other industry data toward understanding these issues.

Minimum downtime is a more important driver than minimum capital cost. For example, the *Kakap Natuna* has been in operation for 14 years with no downtime.

FPSO's need to observe maritime traditions. *Unlike fixed platforms—*

Ships flex under loads, and the tie-down of production to the decks must allow for this flexion. Topside design must be capable of the appropriate motions both in the delivery voyage and during operations to ensure effective and safe operation of processing equipment.

Piping must be compliant with ship bending, and extensive pipe-stress analysis is required. Expansion loops and expansion joints need to be carefully placed.

Emergency generators and firefighting pumps, which are integrated into the ship, must be capable of pumping at large angles in case of a damaged tank concurrent with a fire.

Vendors supplying equipment may not be familiar with the certification requirements for offshore service, or they may not know how to obtain information about motion tolerances for optimum equipment design. Vendor coordination of equipment through the certification body helps ensure proper design to specification according to on-site motions, together with a safe transit voyage and punctual delivery.

FPSO's and floating storage units (FSU's) are subject to a myriad of regulatory requirements, including requirements by the International Maritime Organization (IMO) and the coastal state regime (e.g., MMS/U.S. Coast Guard), stability requirements dictated by the flag state of the vessel and/or the coastal state, separate manning requirements, and potentially customs regulation.

Floaters have some risk of sinking in the event of a casualty, making damage-stability requirements necessary. Prior to the vessel going into service, an operator needs to ensure that vessel equipment will not shift and that the cargo will not increase the propensity of the vessel to capsize.

Because oil is stored in the structural facility, which also supports the production deck, oil-storage tanks cannot be replaced as they corrode over time. As a result, in the early design phase, operators need to address issues of thermally accelerated tank-bottom corrosion, which is particularly prevalent in double-hulled vessels. Special precautions to inspect concurrently with filling and emptying tanks also are necessary as vessel inspections are carried out during operations.

FPSO design issues cannot be certified only to American Petroleum Institute (API) standards. Instead, FPSO issues are probably best solved with the assistance of classification societies, which understand the offshore arena.

ABS has been involved in the classification and/or certification of 73 floating production systems (FPS's), which includes tension leg platforms, spars, semisubmersibles, and FPSO's in every type of sea environment. This includes roughly 50% of the floating-production fleet offshore Brazil.

Role of a Classification Society and its Affiliates

Classification is the self-regulatory process that the maritime world has adopted to ensure safety of life, property, and the environment. Class societies see that this process is followed.

- Class societies write down their standards, or rules.
- They ensure that the design of a vessel meets those standards.
- They ensure that the vessel is built to those standards.
- They ensure that the vessel remains in compliance with its rules for the life of the asset.

This process is widely used by the offshore industry under the name of asset integrity management, and it has been operating under the name of classification for about 150 years.

Class societies additionally perform "statutory functions." In many cases, class societies are delegated authority from flag states (the country where the vessel is registered) and from coastal states (where the vessel is operating). These functions are delegated in varying amounts to the different societies.

ABS, with its U.S. origin, is granted a number of statutory delegations from U.S. government entities. Several of these agencies, including the USCG, impact the offshore business. For instance, ABS has been delegated authority to act on behalf of the USCG under the Navigation and Vessel Inspection Circulars. In a consulting role, ABS also carries out risk analyses and commercial studies. On behalf of the MMS recently, ABS/EQE carried out a comparative risk study of FPSO's and shuttle tankers. The study confirmed that FPSO's do not present any significant additional risks as compared with any other floater or fixed-design concept or infrastructure currently applied in the GOM.

Class societies and their affiliated companies also have an important niche in the offshore arena because of the number of research scientists and engineers they have studying a range of critical issues, including structural hot spots aboard FPSO conversions and mooring techniques to facilitate deepwater production. For example, in response to industry's growing need for mooring in deep water, ABS recently issued Guidance Notes on the use of synthetic ropes.

In preparation for FPSO's and shuttle tankers that will be site-specific for the GOM, ABS has modified its SafeHull technology used in the design of ships to make it applicable for FPSO's. The availability of this new program will make the preliminary design of an FPSO or shuttle tanker possible within a few days instead of months.

With class already playing a key role in the asset integrity of ship-shaped vessels, the extension of asset management integrity of offshore vessels, floating facilities, and even platforms is easily executed. Using an information technology network that encompasses electronic information on surveys due and any outstanding recommendations of nearly 10,000 vessels worldwide, ABS has extended this "central library" system to owners for effective vessel management.

The blending of marine and offshore concepts presents a new breed of industry vessels. While these vessels have achieved independent status within some of the marine world provisions, they need champions, such as leading classification societies, to ensure an appropriate and fair balance between offshore and marine standards to design the best vessel with minimum regulatory encumbrances. JPT

Malcolm Sharples, vice president of Offshore Project Development for ABS Group, is responsible for ABS' worldwide services for managing risk in the offshore environment. He is a registered professional engineer in Louisiana, Texas, and Ontario, Canada, a European Engineer, and a chartered engineer in the U.K. Sharples holds a bachelor's degree in engineering science from the U. of Western Ontario, Canada, and a doctorate in structural engineering from the U. of Cambridge in England.