Logistical Challenges for Crew Transportation in Brazilian Pre-Salt Province

E.M. Vilameá  
*Petróleo Brasileiro S.A. – PETROBRAS, Rio de Janeiro, Brazil*

M.B.A. Moreira  
*Petróleo Brasileiro S.A. – PETROBRAS, Rio de Janeiro, Brazil*

R.R. Loureiro  
*Petróleo Brasileiro S.A. – PETROBRAS, Rio de Janeiro, Brazil*

**ABSTRACT:** With the development of the Pre-salt province, in Brazilian coast, Petrobras requires a new logistical model for crew transportation and transhipment to the drilling and oil rigs, due to the intrinsic characteristics of this new basin (great distance from the coast, harsh environment, great number of workers to be transported, etc.) and the expected reduction in overall cost compared to the actual model adopted (only made by helicopters).

The adoption of a logistic model with maritime transportation in this scenarios can present advantages, in various aspects, but the number of attended rigs per trip and the transhipment between ship-shaped vessels can be represent a great limitation in terms of operational window.

An overview of the proposed logistic model, a mix of maritime and aerial transportation, with an installation of an intermediate logistical passenger base (called HUB), will be presented and the requirements for the maritime transportation and transhipment discussed.
1 INTRODUCTION

In 2008, with the announcement of Lula Field (called Tupi before the economical statement) discovery, a new exploration frontier was created for oil companies in Brazilian Coast.

With proven reserves estimated in 6.5 billions bbl, one of the majors discoveries in the last decades (see figure 1), the first field discovered in the Pre-Salt province of Santos Basin demands the most recent technologies for exploration and production, due to the high depths (up to 3,000 meters) and the distance from the coast (approx. 160 nautical miles).

This scenario also demands a new logistic model to optimize the supplies fleet and reduce overall costs involved in the support operations for exploration and production.

One of these operations is the crew transportation, who actually is performed exclusively by helicopters, transporting up to 300 passengers per day only in Santos Basin. Despite the agility of the operation, in the present scenario the costs involved increase substantially, fact that demands an alternative solution not only to reduce costs but also to reduce the aerial dependence.

The proposed logistic scenario, who will discussed during this paper, involve an installation of one or more logistic units (called HUB) to support the helicopter operations and provide medical assistance in emergency cases.

Considering the current development stage, the appraisal phase in the project development walkthrough (see figure 2), where the technical and economical issues are discussed, the intend of this paper is present the main results of the technical analysis and compare to the aerial transportation, the current model adopted.

2 SCENARIO DESCRIPTION

2.1 Current Scenario

Due to the risks involved in the basket lift operation, the rash environmental condition and the reduced demand for crew transportation (approximately 300 PAX per day) the adopted model for the initial production phase is to use helicopters departing from one operational base directly to the production or drilling units (as illustrated in figure 3).

Although it is a model adopted worldwide when we compare the cost per PAX in Santos with the other Brazilian Basins the total cost is the double, basically due to the great distance (approx. 300 kilometres to shore), who obligate the maximum capacity of the helicopters to be 2/3 of the maximum
capacity, to carry more fuel, or the adoption of bigger models.

Other aspect that is being considered is the operational safety, in terms of medical emergency response, which it is necessary to trigger a helicopter to move the victim to the hospital.

2.2 Future Scenario

With a future demand of 1.100 PAX per day, up to 2020, the current modal represents a great percentage of the Basin’s operational cost.

In order to reduced the transportation cost, increase the modal flexibility and the operational safety a new model is being studied, a mixed of maritime and aerial transportation, as showed in figure 4, with an installation of one or more HUB units, capable to accommodate up to 400 persons and provide all infra-structure necessary for helicopters operation and medical emergency response.

3 TECHNICAL APPRAISAL

The first step of a project development is the appraisal phase, where all technical and economical aspects are evaluated and the results will feed the conceptual study.

The focus of the technical appraisal is to verify the feasibility of the solution, in this case the maritime transportation and transhipment in Santos Basin.

When compared with a typical application for passenger’s transportation (from shore to shore) the proposed model add an important characteristic: the offshore transhipment.

This characteristic imposes motion restrictions at zero speed, to increase the operational window for crew transhipment, and high speeds, to reduce crew exposure time. In the next topics the main vessel’s characteristics will be presented and discussed.

3.1 Environmental Conditions

The definition of the HSV main characteristics is extremely dependent of the environmental conditions for operation, in this case during the transportation and transhipment, specially the wave height.

To define the maximum operational environmental condition the monthly non-exceedance wave contours were plotted and compared with the HUB’s minimum operational window (minimum of 90% per month), as illustrated in figure 5.

Figure 5. Maximum wave height envelope for Santos Basin
The other environmental conditions necessary for the HSV design (wind and current) was defined by Petrobras guidelines for offshore operations. In resume the following conditions shall be considered:

- $H_s$ (significant wave height) = 3.5 m;
- Wind Speed = 30 knots;
- Current Speed = 1.39 m/s;

Compared with other passengers transportation the environmental conditions is not so harsh, but as mentioned in before, the HSV will be designed to guarantee, at zero speed, small motions to make feasible the crew transhipment.

Other characteristic that differs this modal from the conventional passenger transportations vessels is the motion controller system (foils and/or fins), who will improve the seakeeping behaviour during the transportation but not in the transhipment phase.

3.2 Speed Requirements x Exposure Time

Others characteristics that impact the HSV design are the speed requirement and the human comfort, in terms of sea sickness.

Due to the great distance between the operational base and the HUB (160 nautical miles) and the requirement to perform all the operation in less than 6 hours the minimum service speed, considering the environmental conditions defined above, the minimum service speed was defined in 40 knots.

This minimum requirements for speed and exposure impose the same acceleration level usually considered for cruise liners vessels design (0.2m/s²), more than the double of the adopted in fast small crafts (0.5m/s²). Figure 6 presents the ISO vertical acceleration boundaries considering vomiting probabilities varying from 1% to 10% (the adopted criteria).

Other characteristic that differ this project than the usual designs is the requirements for zero speed, who is considering the same as the forward speed, in order to guarantee the maximum operational window for crew transhipment.

3.3 HSV Concepts

As presented before the behaviour of the HSV will influence directly the windows operating system and the human comfort.

Conventional displacement vessels can not meet the requirements for human comfort and speed for the crew transportation in the scenario.

Considering the criteria defined for this project it was necessary a validation study to verify which HSV concepts (see figure 7) are capable to reach the requirements exposed and the best solutions.

Among the types of hull presented above we can highlight five concepts as the most promising from the viewpoint of hydrodynamic behavior:

- Semi-displacement hull;
- SWATH;
- Wave-piercing (catamaran);
- Trimaran;
- Hydrofoil;

Figure 6. ISO Discomfort Boundaries (see reference)

Figure 7. Advanced marine vessel concepts
(Source: Insel, M. et al. 2000)
3.4 Transhipment

The solution proposed for the crew transhipment is the installation of a hinged gangway with a heave compensator system in the HSV deck, as illustrated in figures 8 and 9.

![Figure 8. OAS System connected to a fixed unit](Source: Offshore Solutions Website)

Initially these systems were developed to operate only with fixed production units, but studies were carried out to extend the concept to operate with floating units.

Other characteristic that is being improved is the transfer rate capacity, in order to reduce the connection time and, consequently, the total exposure time.

![Figure 9. Ampelmann System operating in North Sea](Source: Ampelmann Operations B.V. Website)

Although these systems make feasible the crew transhipment the installation represents a great impact in the HSV design, due to the motion equipment’s requirements, in terms of available deck space and cargo capacity to accommodate the main and auxiliary systems (the intend of these systems are to operate with supply vessels).

4 ECONOMICAL APPRAISAL

After the technical evaluation, showing the maritime transportation feasibility, the next step is the preliminary economical evaluation, where the NPV (net present value) of the proposed model is compared with the aerial transportation.

Due to the complexity of the proposed logistic the economical study is not finished at the present moment, but preliminary results shows a NPV reduction up to 25% (may vary with HUB’s location) when compared with the aerial transportation.

5 CONCLUSIONS

The present study summarise the technical investigation about the feasibility of the maritime transportation and transhipment from shore to a floating logistic unit, called HUB, with the objective to reduce the operational cost and increase the operational safety in Brazilian Pre-salt province.

When considering commercial concepts the study shows the need for a specific HSV project to reach this specific scenario, especially in terms of:

- Speed requirements at rough waves;
- Reduced accelerations at forward speed to increase human comfort;
- Reduced motions at zero speed to increase the transhipment operational window;
- Cargo capacity for PAX (200 passengers) and transhipment equipment (gangway + auxiliary systems).

Considering this conclusion the next step for the technical appraisal is the development of a conceptual design (or more than one) with commercial designers and research institutes to consolidate the previous results and foment the research for new technologies that can comply with this scenario.

In the point of view of the economical approach the preliminary results shows a reduction in the cost per PAX in 25% approximately.
