Offshore crew supply - Modern marine options challenge helicopters

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Abstract

The helicopter has long been regarded as the default choice for crew supply due to its speed, flexibility and passenger comfort. Marine crew transportation has until recently being regarded as slow and more hazardous. Three specific technological advancements, high speed hull design, DP2 automatic vessel station keeping and advances in transfer capsule design, now offers high speed marine crew supply, with levels of passenger safety and comfort that exceed helicopter transfers. Utilizing the 'state of the art' CrewZer Class vessel, this new crew supply solution is leading many operators to re-evaluate their crew supply options.

A good crew supply solution should provide high levels of safety, speed and reliability, as well as operational flexibility. As offshore development cost rise and other assets mature, there is increased pressure to reduce operating costs, whilst attending to crew welfare and morale. The CrewZer access solution can deliver up to 30% savings on logistical costs, whilst enhancing safety or passenger welfare.

The first CrewZer Class vessel, the Seacor Cheetah (the fastest offshore support vessel ever built) was introduced to the market in February 2008. Voted 'American Ship of the Year', it has an aluminum catamaran hull, capacity for 149 passengers and a cruising speed in excess of 40 knots. It's DP2 station-keeping and wide stable hull provide an ideal platform for personnel transfer operations. The vessel also utilizes a custom designed 9-passenger advanced transfer capsule. The entire system is expected to provide one of the safest crew transfer solutions in the industry. This integrated solution provides the following additional benefits:-

- An ideal emergency evacuation tool (e.g. hurricanes), capable of the rapid evacuation of large crews. This allows operators to delay evacuation decisions, possibly avoiding unnecessary shut downs, without compromise to safety.
- A high speed vessel suitable for making early response to an offshore fire, equipped with two large fire monitors.
- 150 ton of deck load optimized for fast track logistic support.
- Enhanced vessel stability which increases the operational weather window for transit and loading operations.

Following a year in operation and tens of thousands of successful transfers, the system has been thoroughly field proven. This paper describes the system in full, the experiences of the first year in operation and goes on to explore likely future developments in crew supply operations.

Introduction

The offshore oil and gas industry has from its outset used both air and sea transportation to move its workforce. Both transport alternatives carry risks, whilst sharing the same purpose - to transport personnel offshore in a safe and efficient manner. The aviation industry, exposed to the potential of catastrophic failure and multiple fatalities has

Figure 1. Seacor Cheetah - Advanced crew supply with a top speed over 40 knots

Figure 2. Frog 9 High Capacity Transfer Capsule

invested heavily to try to minimize the risks and consequences of airborne failures. Helicopters are fast, relatively comfortable and are therefore widely favored despite the inherently high costs associated with aviation services.

Until recently, moving personnel by sea would involve the use of vessels, principally designed for heavy logistics support, and the use of personnel baskets (based on a design established over 50 years ago). The marine option was unlikely to employ the sort of routine procedures associated with air travel, such as heliport check ins, boarding procedures, passenger safety training, pre-flight briefings and incident reporting, to name a few. The marine alternative by contrast appeared casual and did not present itself as a 'credible alternative' to air travel.

In 2006, Seacor Marine and Reflex Marine set out to work together to develop a truly competitive alternative to helicopter transfer. The new CrewZer Class of vessel, complemented by a purposed designed transfer solution (utilizing the 9-passenger Frog-9 transfer capsules), with the objective of providing a superior service, in terms of speed, passenger comfort and the safest crew supply option available to the industry.

One year of incident free operation in West Africa, and around 30 000 passenger transfers, has now confirmed the performance expectations.

Concept Definition

For the first time a major vessel operator and a transfer specialist collaborated to develop an optimized transfer solution with both companies sharing expertise in their respective fields to develop a state-of-the-art crew supply system.

Figure 3. Schematic of the CrewZer concept vessel with a Frog capsule

High speed catamaran passenger ferries are well established competitors for local air carriers. Such vessels would typically have capacity for 400 passengers, with cruising at speeds of 40+ knots. Adapting this vessel type for offshore crew and materials supply was the basis of the CrewZer Class concept. However, unlike a passenger ferry, this service would not have the luxury of a quayside mooring at the point of destination. A key feature would therefore be the ability to hold station and conduct personnel transfers safely and quickly, thereby minimising the risk exposure of passengers, installations and vessel.

Marine crew supply utilising crane transfer is well established, however, there had been very limited development in this area during the last 50 years. The traditional collapsible 4 person basket provides an inexpensive and some would say 'proven' method of crane transfer. However, although the number of fatalities associated with such transfers has been relatively small, injuries are much more common place and as a result created the perception that marine transfer was a risky method of crew supply. Operators are now taking a more careful look at the data, which indicates that marine transfers carry a lower risk of fatal incident than helicopters, although using established methods there is greater risk of sustaining injury. Analysis of industry safety data shows that the traditional basket transfer incur high rates of injury, either from side impact or vessel deck impact. Such injury is in large part a result of the minimal protection afforded by the traditional basket. The external riding position, lack of restraint and collapsible nature of a rope basket creates a very high exposure to falls and impact injuries. Furthermore, there has been little industry focus on raising the level of risk awareness, improving operational controls and establishing best practice.

Traditional baskets and early capsule designs were sized for transferring 3 to 4 persons simultaneously. This lower capacity was suitable for non-routine operations and small crew transfers. However, when managing large transfers of up to 50-60 personnel per installation, the number of crane lifts becomes an important factor in determining the time the vessel must hold station at each installation. Minimising this loading period is important to avoid; tiring of the vessel captain, unproductive use of the vessel, unproductive use of the workforce and tying up the installations cranes.

To provide a competitive and flexible crew supply service for up to 150 people, with the highest safety standards, it was recognised that a radically different crane transfer solution was required. The aim was also to allow operators with multiple offshore installations, or logistics club members, to save 40% on current air transportation costs whilst improving the overall safety performance.

Enhanced crew supply concept

An objective was established to develop a transportation system capable of carrying up to 150 passengers, 150 tons of deck cargo plus fluids, with emergency response capabilities (which included rapid evacuation and fire fighting). The service was aimed at the following market applications:

- **Routine crew support operations.** - A service offering speed, comfort and high levels of safety, which also provides significant operating cost saving over aviation alternatives. The option would be particularly attractive for routine crew changes across a number of field assets.

- **Balanced logistical support** - As part of a mixed marine logistics support strategy, the CrewZer provides 150 tons of deck capacity and this could be a vital component in the overall logistics support strategy.

- **Emergency evacuation and fire fighting** - Hurricane threats put tremendous short term pressure on available helicopter services and inevitably leads to defensive and early decisions to evacuate installations. Such decisions have major commercial implications and are therefore best delayed

Figure 4. Normal deck load on passenger run

Figure 5. With 150 ton deck load capacity, providing substantial logistical flexibility

as far as the practicality of safe evaluation logistics permit. CrewZer provides a powerful tool for rapid large scale evacuation, potentially allowing the final decision to evacuate to be deferred or avoided altogether, should the threat abate.

● **Remote Logistical support** - Offshore oil and gas activities are now taking place in remote waters outside the range of normal helicopter support. The ability to have fast a reliable crew transfer by marine vessel is the only option.

Managing risks and transfer efficiency

In 2006, to support the development of an enhanced crew supply solution, a detailed risk assessment was performed to assess the requirements to support safe and efficient operations. The scope of the evaluation included:

- The safety track record of crane transfer operations and analysis of incidents.
- Identification of areas with scope for improvement.
- The assessment of new, and emerging, crane transfer technologies (the project team recognised crane transfer as the 'Achilles Heel' of existing marine crew supply).
- Vessel specification to provide a safer platform for crane transfer operations.
- Improved operational controls and training provisions to further reduce the risks.

The review initially focused on identifying the root causes of recorded incidents, which indicated that the vast majority of transfer incidents fell into clear categories. This was followed by a detailed evaluation that indicated that a new generation of rigid transfer devices (in operation for over a decade) had out-performed all other systems on the market, in terms of passenger protection and performance (in particular weather capability). The study concluded that the risks could be managed in three ways:

1. Vessel specification - An improved transfer platform could be created by focusing on the vessel's stability, station-keeping and landing area. The aim was to ensure that the vessel had the necessary mobility, control, all weather capability and safety systems to provide a safe platform for personnel transfers.

2. Engineered passenger transfer protection - Just as a modern car provides a secure environment protecting passengers from impacts (frequently caused by driver errors), a well engineered transfer device should protect passengers from the human factors that appear to contribute to the most transfer incidents. A new generation of rigid transfer capsules offering comprehensive passenger protection has established an excellent track record in the industry. They provide passengers with four main categories of protection:

a. An rigid external shell protects the passengers from any side impact
b. A central suspension feature protects the passengers from landing shocks and whiplash injuries.
c. A seat harness restrains passengers preventing falls.
d. Buoyancy and self righting features protect passengers in the event of immersion.

Figure 6. The first production model Frog 9 - clearly showing seat restraint

The unit has a low centre of gravity providing a stable platform on a heaving vessel deck with an angle of stability of 35°.

However, the requirement to transfer up to 150 personnel suggested higher transfer rates were required so a transfer specialist was commissioned to develop a new high capacity unit. Having evaluated a range of concepts, the project selected a 9 passenger unit with an enhanced suspension system. This has allowed significant increases in transfer

rates, whilst providing operational integrity, manageable deck operations and retaining an excellent weather envelope.

3. Improved operational control - Procedures, pre-lift planning, communications and training can all play a significant role in reducing risk and improving transfer rates. New procedures and training provisions were developed to increase risk awareness, operational control and the overall efficiency of transfer operations.

CrewZer Class Vessel Description

The new CrewZer Class vessel was designed by Incat Crowther of Newport, New South Wales, Australia and constructed at the Gulf Craft shipyard in Louisiana, US. The vessel is 50m long and has a very wide beam of 11.6m due to its catamaran design. Its spacious main deck (27.8m by 9.14m) provides an excellent area for landing and loading the transfer capsules, with landing areas provided at amidships or toward the aft, providing flexibility to manage location specific variables, such as weather direction, crane reach, vessel motions etc.

Figure 7. Seacor Cheetah is equipped with state-of-the-art navigation equipment and steered with joystick control

Each of the two hulls is powered by 2 MTU 16V 4000 engines, developing 3,305 HP to each of the Hamiltons HM811 waterjets and the vessel achieved an impressive 42 knots during trials. The CrewZer is the fast workboat ever build and even at economy speed is some 10-15 knots faster than most crew supply vessels - at economy speed of 31 knots its fuel consumption is 265 gph. The vessel is highly manoeuvrable with its 4 main water jets and each hull is fitted with a 200HP azimuthing bow thruster.

With a 149 passenger capacity and under 100 tons gross weight, the CrewZer Class meets the US coastguard subchapter T/L requirements and ABS has certified the vessel as +A1 HSC Crewboat, +AMS and DP-2. It is one of very few crew/supply boats with a DP-2 rating. On arrival at the installation, the Kongsberg SDP21 dynamic positioning system takes over the navigation of the ship. This system includes a pair of windbirds, two gyrocompasses, two position reference systems, two Garmin 2106 GPSs and two motion sensors. This allows CrewZer to provide close position holding support for even deepwater floating rigs where movement of up to 100ft can be expected. Keeping manual control to hold station during crew transfer activities would be very tiring, but with full DP-2 rating the vessel is ideal for safe and efficient transfer operations. The ship is equipped with state-of-the-art electronics, communications and navigation systems. Image intensified night vision and day color camera equipment helps the vessel move around the rigs and platforms at night where unlit buoys are not detected on radar.

The 10 person crew is accommodated on the mid deck level and on the upper deck is a large fully equipped wheelhouse offering full 360 degree vision, with excellent visibility onto the aft deck. The vessel can carry 150 tonnes of cargo on a 2,700 sq ft deck, as well as 13,150 gallons of cargo fuel. By combining a powerful crew supply capability with flexible and rapid cargo transit, provides operators with a very attractive economic package. In the event of a fire on the host installation, the vessels speed allows rapid deployment for emergency support. It made sense that the vessel specification included a pair of remote-controlled fire monitors with a capacity of 5,300 gallons per minute.

Figure 8. Fast response to offshore emergencies, the Cheetah is equipped with fire fighting capability

Passenger Comfort

Passenger comfort was viewed as a top priority, to gain increased industry acceptance for marine crew supply solutions. The passenger lounge on the main deck is laid out and equipped similarly to a wide bodied airliner, with a 3-6-3 format. The lounge features a pair of 42-inch LCD televisions, wireless internet and a beverage and snack area, helping to

Figure 9. The passenger lounge has reclining seats, satellite TV and internet access. Aircraft level comfort

ensure that passengers are fresh and ready to work on arrival at the offshore platform. For travelling at speed, the vessel is fitted with a wave dampening system by VT Maritime Dynamics. The vessel automatically smoothes out the effect of any wave action and minimizes the likelihood of travel sickness.

Vessel Features for Performing Safe Transfers

Although the Frog-9 provides a high degree of passenger protection, the role of the vessel as a safe landing platform is also a key consideration for the overall transfer safety. The aspects of vessel design that affect the safe operating limits and operator procedures of transfer activities are as follows:

● **Deck Stability** - The transfer capsule's low centre of gravity and high angle of stability circa 35° minimises the risk of toppling the capsule on a pitching and rolling deck. However, a more stable deck will make transfer operations easier for the crane operator and provides assurance for the passengers. The vessel´s wide beam, twin hulls and DP-2 station keeping equipment provides an ideal platform for safe transfer operations.

Figure 10. View from the wheelhouse providing excellent visibility for deck operations and station keeping

● **Deck Visibility** - Whilst holding station and performing transfer activities the vessel master should enjoy clear visibility. The vessel has excellent, 360° visibility, from the wheelhouse, with a closed-circuit television system covering the rear of the main deck, the engine room and thruster room. There are 10 deck lights, totalling 6,500 watts, plus two forward searchlights and one 12-inch searchlight aft, with a remote control.

● **Free Deck Size** - The transfer specialist recommended a minimum clear landing area of 7.0m by 7.0m based on the station keeping tolerances, the size of the capsule (+/- 1m for the landing inaccuracy) and clearance for passenger access (+/- 1m). This specified landing area is suitable for operations up to 4.0m significant wave height, but this area may be reduced for set weather criteria, subject to a case specific risk assessment. As the CrewZer class provides ample deck area, with over 9.0m of working width and even with a half deck full of cargo, a safe landing zone is assured.

● **Deck Condition** - The CrewZer deck has no obstructions that pose either trip hazards or causes of potential impact with the transfer capsule. The deck has a non slip finish and is clearly marked with a landing zone to aid the crane driver in aligning the lift. A review of collision hazards was performed with no major hazards identified in the vicinity of the deck.

High Capacity Capsule Development

To fulfil the need for increased transfer rates, the project team assessed a range of capsule designs and configurations. Eventually a 9-passenger version of the well established 3-passenger Frog capsule was selected.

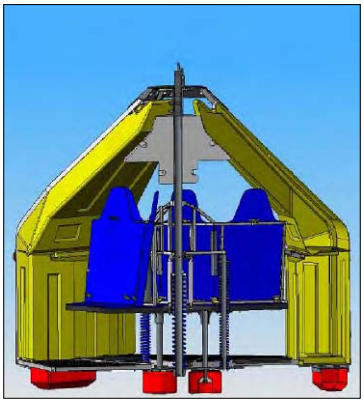

Figure 11. Frog 9 Suspension Design

The principle design challenges were to:-

● Maintain a compact footprint to ease handling

● Limit the unit weight (thereby reducing the energy dissipated in the event of a collision)

● Develop a configuration that supported rapid passenger flow

● Develop a suspension system for an increased passenger mass that maintained acceptable decelerations on passengers for the defined weather operating envelope.

Figure 12. Frog 9 undergoing drop testing

With safety as a top priority new capsules were designed with ABS type approval. Full details of the design specification are provided in Appendix A. Like all transfer devices in the same product family the new unit was subjected to a rigorous test regime, to verify the defined safe operating envelope for the device. These testing and verification programme are unique in the industry and setting the Frog completely apart from any other transfer devices.

Figure 13. Frog 9 undergoing immersion testing

The capsule was designed and tested to withstand very high impact loads:-

● Vertical impact speed:	10.5 ft/sec	(3.25m/sec).
● Lateral impact speed:	6.5 ft/sec	(2m/sec).
● Max. significant wave height:	16 ft	(5m).
● Angle of stability (loaded)	35°	

Model		FROG-9			
Sig. wave height. (m/ft)	Max. wave height. (m/ft)	Fixed platform to Vessel	Semi-sub to Vessel	FPSO to Vessel	Vessel to Vessel
≤ 1.0m/3'	≤ 1.9m/ 6'	●	●	●	●
≤ 1.5m/5'	≤ 2.8m/ 9'	●	●	●	✦
≤ 2.0m/7'	≤ 3.7m/12'	●	●	✦	■
≤ 2.5m/8'	≤ 4.6m/15'	●	●	✦	■
≤ 3.0m/10'	≤ 5.6m/18'	●	✦	■	■
≤ 3.5m/11'	≤ 6.5m/21'	✦	✦	■	■
≤ 4.0m/13'	≤ 7.5m/24'	✦	■	■	■
≤ 4.5m/15'	≤ 8.4m/28'	■	■	■	■
≤ 5.0m/16'	≤ 9.3m/30'	■	■	■	■
≤ 5.5m/18'	≤ 10.2m/33'	■	■	■	■

Key

●	Low risk of high landing or take-off velocity, and exceeding Frog-9 personnel damping.
✦	Increasing risk of high landing or take-off velocity. Consideration of hook speed and consideration of all other factors is recommended to ensure controlled landing and take-off. Dry run to assess risk (without personnel) also recommended.
■	High risk of high landing or take-off velocity. Not recommended for routine operations unless a specific hazard analysis can demonstrate otherwise.

Figure 14. Recommended Operating Envelope for Frog 9

Operating Procedures and Control

Safely achieving high rates of transfer safely requires more than just well designed vessels and transfer equipment. There are many opportunities to further enhance the safety and transfer rates by increasing risk awareness, development high quality procedures, communications tools and training routines. Pre-transfer planning and preparation are also essential.

Training - When new routines or equipment are introduced, it is essential to ensure that an appropriate training is performed. Passenger need to be instructed on how to approach, strap themselves in and disembark from the transfer capsule. Operators of the equipment, vessel captains, deck crews, crane operators and platform crews, need to be clear about best practices including risk awareness, knowledge of procedures and the safe operation the equipment and its operating limits. They also need to establish clear protocols for communication.

High quality user manuals were developed which detail all aspects of the transfer equipment operation, inspection and maintenance. Maintaining the integrity of personnel lifting equipment requires the implementation of rigorous inspection, certification and maintenance regimes.

A key aspect of the operation was to organise the efficient flow of passenger's board and disembark, to prevent confusion and delays during transfer activity. Transfer briefing videos were developed, similar to those used for helicopter operations. These are shown to crews prior to commencing operations. The video explains the passenger boarding process and this information is also repeated in seat back safety cards.

Passenger Boarding Procedure - When using a 9-passenger transfer device, there are potentially up to 20 persons on deck at any one time, including 9 departures, 9 arrivals and 2 deck crew. This level of traffic requires close management, to both minimise the safety risks and optimise

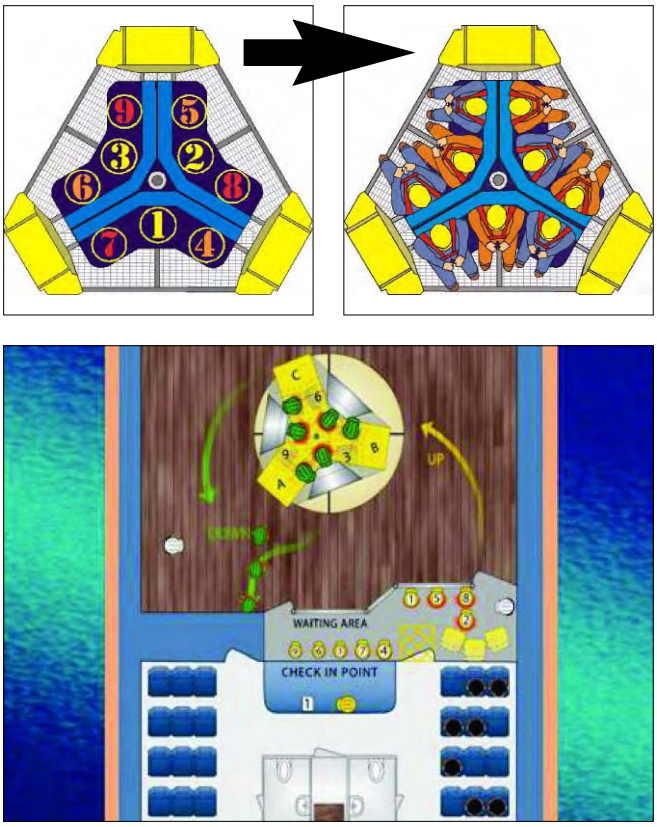

Figure 15. Frog 9 Loading Pattern and Passenger Flow Control Design

the transfer rates. The greatest potential time saving (or loss) is aligned to the experience and drill of the crews embarking and disembarking.

Launch and Early Service

Two years after the developing the initial concept, the Seacor Cheetah, complete with enhanced transfer system was officially launched in February 2008. The vessel was demonstrated in Gulf of Mexico, Trinidad, Mexico, Brazil, before setting sail for Angola to begin its first long term contract. On 17th May 2008, the vessel began a 3 year contract providing marine and crew transfer services to Sonangol, the National oil Company of Angola.

Passengers are processed on the departure lounge on Sonils jetty close to where the vessel berths. Procedures are very similar to those found at an airport. The passengers are checked-in against a booking list and issued with a boarding card. Next the passengers are security screened and then wait in a secure area until boarding starts. Luggage is X-rayed and stowed in a sealed luggage bag; the passenger is re-united with his baggage when he reaches his destination.

15 minutes before the vessel is due to depart the passengers are escorted to the vessel, their boarding cards are collected at the bottom of the gangway as a further security check. Onboard the passengers are lead to the passenger cabin where they will stay for the duration of the transfer.

Service Description

The Seacor Cheetah supports all the installations in Block 3 for 5 days of the week with passenger runs to the accommodation Barge Kissama on Monday, Tuesday

Figure 16. Frog 9 Transfers underway at the FPSO Gimboa

Figure 17. Accommodation barge Kissama

Figure 18. The Cheetah on crew change duties at semi Sub Aleutian Key

Wednesday and Friday and a food run to all Sonangol installations in Block 2, 3 &4 on Friday evening/Saturday morning. Thursday is a mixed passenger/ cargo run to the FPSO Gimboa in Block 4 (see Figure 16). Sunday is set aside for maintenance. The main port facility is in Luanda to the North of Angola, with the oil installations laying some 180 kms offshore. Typical wind and weather conditions for offshore Angola are; winds are generally light to moderate typically 10-15 knots the predominant swell has a long period and is from the Southwest at 2 metres, currents are generally strong, the Benguala current follows the coast from the south, during the rainy season there is a strong out flow from the Congo River to the Northeast of the field which affect operations.

All passengers for block 3 are disembarked on the Barge Kissama which is moored by 8 anchors (see Figure 17). The barge is moored head to swell and has only one crane on the starboard quarter. With this configuration the Cheetah has very few options to set up for the passenger transfer, the vessels high engine and thruster power together with the DP2 installation allows the Captain to find a balance between the swell and current to produce a stable platform for passenger transfers.

Service Performance Record

So far the Cheetah has performed 364 service days, with utilization level of 40%. The vessel is proving a robust and reliable workhorse.

The Seacor Cheetah has transferred approximately 21,000 personnel in the first year of service with zero incidents. The average number of passengers per week is 400; however a typical crew change day will transport 42 persons from Luanda.

Personnel transfers are conducted at an impressive rate of 108 passengers per hour (both up and down transfers). This rate of transfer has been achieved by adopting good procedural control and establishing experienced crews.

Transfer Rate Performance

It is desirable to try to maximize the transfer rate, without jeopardizing the safety or control of the activity, for the following reasons:

- The exposure of vessels operating in close proximity to the installation is reduced.
- Vessel utilization is increased, enabling more transfers and extending routing options.
- Passenger transit time is reduced, benefiting productivity and morale.
- The risk of fatigue for vessel captains and crane operators is reduced.

Figure 19. Using dual Frog 9's achieved a maximum transfer rate of 125 pax/hr

		FROG-3	Rope Basket	FROG-9 (Benchmark)	FROG-9 (Dual)
	Transfer times (seconds)	**3 Person**	**4 Person**	**9 Person**	**9 Person**
Up Lift	Passengers board	50	20	120	120
	Prepare for Lifting	30	30	30	30
	Lift Vertical	30	40	30	30
	Slew Sideways	30	40	30	30
	Lift Vertical	120	150	120	120
	Slew Sideways	30	40	30	30
	Lower onto Deck	50	70	50	50
	Passengers exit	30	20	60	60
Down Lift	Passengers board	50	20	120	120
	Prepare for Lifting	30	30	30	30
	Lift Vertical	30	40	30	30
	Slew Sideways	30	40	30	30
	Lift Vertical	120	150	120	120
	Slew Sideways	30	40	30	30
	Lower onto Deck	50	70	50	50
	Passengers exit	30	20	60	60
	Total (secs)	**740**	**820**	**940**	**580**
	Total Cycle Time (min)	**12.3**	**13.7**	**15.7**	**9.7**
	(Up and Down) Transfers / hour	9.7	8.8	7.7	12.4
	Pax / transfer	3	4	9	9
	Passenger transferred / hr	**29**	**35**	**69**	**112**
	Variation	-17%	0%	96%	218%
					Activity off critical path

Figure 20. Table of Transfer Time Comparison

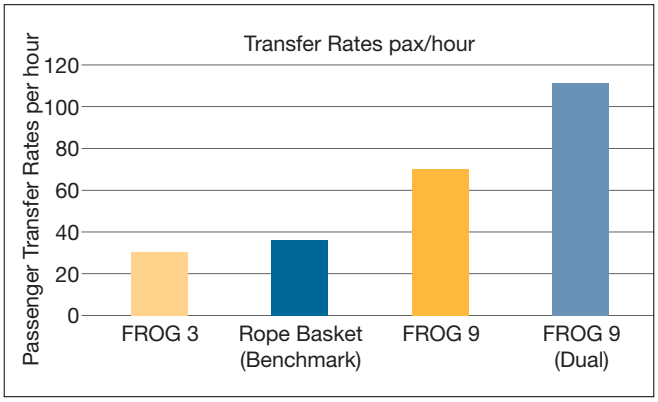

Figure 21. Chart of Passenger Transfer Rate Comparison

A traditional collapsible basket provides a benchmark transfer rate of approximately 35 passengers per hour.

In good weather this rate may be marginally better than the Frog-3 device, due to its larger passenger capacity and also the time taken to fasten harnesses. The Frog-9, when used by crews familiar with loading and unloading procedure can achieve in excess of 69 passengers per hour.

In Sonangol's operations, where passenger lists of 120 were routine, the transfer activity was further optimized by using two Frog-9 capsules in tandem. One capsule was positioned on the installation, whilst the other capsule is landed on the vessel. The vessel crew would then unhook the capsule on the vessel, allowing the crane to pick up the unit on the installation. Meanwhile, the capsule on the vessel would be unloaded and another batch of passengers loaded, ready for transfer to the installation. This cycle of tandem lifts would continue until all passengers' transfers were complete. In effect, this approach removes all loading and unloading activity from the critical path, which allowed the operator, Sonangol, to routinely achieve transfer rates of 108 pax/hr.

The highest transfer rate achieved to date is 125 pax/hr when a total of 253 people movements took place in two hours.

Service & Safety Performance

With over, 60,000 miles travelled and 21,000 transfers now completed in Angola, the new transfer solution has delivered an impressive safety performance with zero incidents. The vessel has also demonstrated its capability for station keeping in adverse sea conditions and is routinely required to maintain station some 5 meters from the installations.

Passengers find the journey comfortable and often sleep during the transit.

Figure 22. Passengers relaxed during transit

Lessons Learnt

- After a period of building familiarity and refining the new arrangements, the vessel crew and passengers now perform these operations with ease and comfort.

- Detailed supervision and planning of the passenger flow (loading / unloading operations) is essential achieving high transfer rates.

- Having a plan for the handover of the work vests and maintaining control of deck access paid dividends in enhanced transfer time.

Conclusions

1. After a year of excellent service, the Seacor Cheetah, has met the key performance objectives of speed, comfort and safety. The potential value of the CrewZer Class concept for the offshore industry has been clearly demonstrated.

2. Over 21,000 passengers have been transferred to and from installations at an average rate of 108 passengers per hour.

3. The vessel has been utilised 40% of the time and has operated at an average transit speed of 33 knots. Transfer time for passengers has been an average of 4 hours from check in to arrival at rig site.

4. The system has been shown to offer a highly competitive alternative to helicopter crew supply, including achieving an estimated cost saving of around 30%.

5. In addition to providing the crew supply service, the CrewZer solution has also provided high quality and flexible logistical support to the operations. The service also provides important contingencies for fire fighting, emergency evacuations and medevac.

6. As well as the proven capability of the equipment, the hearts and minds of the passengers and operators have also shifted. All have embraced this mode of transportation.

7. The collaboration of a vessel operator and transfer specialist has proven to be highly beneficial to all parties and it is envisaged that this collaboration will continue in order to enhance the capability, safety and transfer rate of vessels yet to be commissioned.

Authors

Seacor Marine: Steve Douglas General Manager, Seabulk de Angola LDA

Reflex Marine: David Brittan, Bus Dev. Director.

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Appendix A
Seacor Cheetah Outline Vessel Specifications

Length overall	50.29 m
Length waterline	43.89 m
Beam	11.58 m
Draft hull	2.13 m
Fuel capacity	53,314 Litres
Fresh water capacity	14,000 Litres
Service speed	41.5 knots
Deadweight	50.0 tonnes (max 152 t)
Installed power	4 x 3300 BHP
Main engines	4 x 16V4000 M71
Propulsion system	4 x Hamilton HM811's
Passenger capacity	149
Survey	USCG Sub ChapterT / ABS +A1 HSC Crewboat + AMS + DPS-2
Construction material	Aluminium

Appendix B
Frog 9 Specification

Specification Summary	
Model	**FROG-9**
Payload	900kg (9 x 100kg)
Dimensions	
Width 1	2794mm
Width 2	3219mm
Height	2877mm
Weight	
Max Gross Weight	2000kg
Tare Weight	1100kg
Manufacture	To ISO 9001:2000 standard
Materials	
Frame	316 SS
Central Column/Lift Eye	UNS S32205
Lift Eye Connection Bolts	17-4PH H1075
Other Steel Components	316 and 304 SS
Buoyancy	Rotationally Moulded MDPE shell with PU foam fill in lower unit
Seat Base	40mm Nidaplast 8 + Trespa Meteon 6mm
Seat Back	Trespa Meteon 6mm
Shock Absorption	
Springs	1 x Central and 3 x Peripheral Springs 3 x Dampers

Design Information	
Model	**FROG-9**
Verification	ABS Type Approved Product Manufactured to ISO 9001:2000.
National Technical Standards	UK, BS449: Part2:1969: The use of Structural Steel in Building
	UK, BS2830:1994: Suspended Chairs and Cradles for the use in the Construction Industry
Industry European Standards	EC Machinery Directive EN 1050, EN292 Parts 1 & 2 Load Test - ILO152/ LOLER
National Regulations	UK, PUWER/ LOLER
Impact Behaviour	The Seating assembly is suspended on a quadruple spring assembly designed to protect passengers from impacts up to 3.25 m/s. Spring recoil is handled by triple hydraulic dampers.
	The capsule is designed to withstand a 2 m/s lateral impact.
Other Features	Full height seating
	Quick release seat harness buckle
	Full harness ensures passengers are secure.
	Secondary Back-up sling
	Handling Eye
	6 x Tie-Down Points
	Angle of Stability - 35 degrees

Operating Envelope - Other Operating Parameters	
Model	**FROG-9**
Wind Speed	30 knots (equivalent to 15 m/s). Frog-9 is very stable in high wind. Limiting factor is usually crane operability or control of load.
Visibility	Crane operator should have clear view of the pick up and set down areas.
Vessel motion/ Frog-6 Stability	Pitch 10°, Roll 10°. (FROG-9 stable up to 35° for a load of 1-9 Passengers. In static test).
Vessel station-keeping	Able to maintain position within a 5m (15ft) radius. If a high risk of the vessel losing position exists, recommend disconnecting Frog-9 for passenger embarkation.
Landing area	Clear of obstructions, protrusions, trip and fall hazards.
Minimum recommended landing area on a vessel	7m x 7m clear space (23ft x 23ft) based on 1+m entry and exit path all round the Frog.
Landing area - ice/ spills	Ice and spills must be cleaned from landing area prior to transfer.
Crane operator experience	Briefing video within 1 month. Local authority requirements for personnel transfer must be adhered to.
Deck crew experience	Briefing video within 1 month.
Passenger training	Briefing video within 1 month.
Communications	Radio communication must be established between the crane operator and the vessel deck crew and master.
Crane construction	Crane must be certified for use for lifting personnel and properly maintained.
Temperature	+50C to -20C.