OFFSHORE TECHNOLOGY
REPORT - OTO 97 009

DESIGN, CONSTRUCTION,
COMMISSIONING AND TESTING OF THE
SEASCAPE SYSTEMS LTD.
EMERGENCY EVACUATION SYSTEM

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1.0 SUMMARY

The prototype system's successful trials showed that the SEASCAPE concept has important safety and operational advantages, including possible savings in maintenance levels, when compared to other alternative TEMPS C launching systems.

It is concluded that the system has proved that it offers offshore operators a safer and more reliable option to conventional davit launched systems and that it fulfills the recommendations of the Cullen report as regards to improving the performance of evacuation systems.

However this report is not concerned with promoting the system for offshore use but rather with recording and commenting on this specific project.

1.1 Scope of Report
This report covers the activities carried out during the design, construction, commissioning, testing and demonstration of the prototype Seascape TEMPS C launching system. These activities include the design and construction of the arm, tower and TEMPS C lifting yoke, the design and construction of the winch and the development of the initial commissioning and testing procedures. This report does not cover work previously carried out by Seascape in St. John's, Newfoundland involving scale model testing which is addressed in earlier reports (see Page 33 Ref. 7).

1.2 Objectives
The objective of the project was to produce a full size, fully functional launching arm, winch and lifting yoke built to offshore standards and under Lloyds Register survey. It was intended to use a fully fitted and functional TEMPS C provided by HOTA. In order to demonstrate the operational viability of the system it was designed and constructed to be fit for purpose on the British Gas Rough 'B' platform but it from a permanent training aid at the HOTA base.

1.3 Contributors
The project was jointly funded by the following organisations:

Atlantic Canada Opportunities

British Gas plc.

British Petroleum Operating Co.

Health and Safety Executive.

National Energy Board of Canada

National Research Council of Canada

Seascape Systems Limited
2.0 INTRODUCTION

2.1 Design
The detailed design of the system including the winch specification was carried out by Andrew Palmer and Associates of London. The design brief (See REFERENCES) formed the basis for the contract. Work started on 20th November 1992 and was completed on 1st June 1993. The design calculation reports for the various components making up the system are listed under References on Page 33.

The hinge arrangement of the deployment arm was redesigned in a more simple form. The final arrangement performed in a satisfactory manner and provided some cost savings (see FIGURE 5).

2.2 Construction
A contract for the construction and installation of the tower, arm and TEMPSC yoke was placed on Qualter Hall and Co. Ltd of Barnsley UK on 12th. December 1993, followed by a contract to design and build the winch placed on Lanteo Industries Inc. of Langley in British Columbia, Canada.

The construction programme was completed on 14th. May 1994, approximately 6 weeks behind schedule, although further minor works were undertaken by the contractor over the following 6 weeks to improve the system.

Various problems caused delays during the construction phase, the most significant being the lack of suitable material under the concrete foundation block, resulting in the need to install piles on the back edge of the foundation block.

Design defects were found during construction of the tower which were rectified at additional cost.

2.3 Commissioning, Testing & Demonstrations
The winch was finally installed on top of the tower, connected to the lifting rope and power supply and operated for the first time on 14th. May 1994. It was operated under the weight of the deployment arm only and, initially, only for a few meters of movement at a very slow speed. Subsequent runs were extended in both distance run and speed. On 6th. June the TEMPSC was fitted to the arm and a number of runs were carried out at increasing speeds up to the full working speed.

Minor problems were experienced docking the TEMPSC on the first runs due to clashes with hand-railing and other minor obstructions, but in general the system worked perfectly from the first day.

Members of the original research team from National Research Council, St. Johns, Newfoundland, attended the site during week commencing Monday 15th. June and carried out a series of tests to calibrate the data obtained during the initial model testing programme. These results are reproduced in the appendix document see Ref. 9 Page 33.

Following the successful commissioning and testing programme a series of demonstration runs were carried out.
3.0 DESCRIPTION OF PROJECT

3.1 General
The Seascape System would normally consist of the deployment arm with a pivot foundation at or near the sea level, the fall arrestor/recovery winch (complete with rope and bridle) and the TEMPSC fitted with the lifting yoke. In the case of this project, i.e. HOTA Base, Albert Dock, in Hull, a support tower equating to an offshore production platform was also required. The tower had to be designed and constructed to resist the dead loads and overturning moments developed by the system both at rest and whilst in operation. A general arrangement is shown in FIGURE.1 below.

![Diagram of the tower arrangement](image)

FIGURE 1 Test Tower General Arrangement.

3.2 Tower
The tower was constructed as part of the main contract using conventional construction materials and techniques. In general it was constructed with standard steel sections with bolted or welded connections.

The tower was founded on a mass concrete gravity base weighing approximately 250 Tonnes. This mass was required to resist the high value overturning moments generated by the controlled descent of the deployment arm supporting a fully loaded TEMPSC, and also to cater for possible additional dynamic loadings caused by a winch malfunction or emergency stop of the launch.

During the course of construction it became evident that the material under the base slab did not have sufficient strength to support the structure and it therefore proved necessary to provide a piled foundation to the back edge of the slab and additional steel reinforcement to the concrete base.
A number of design defects were found during construction of the tower and these were rectified as construction proceeded.

A front elevation and plan of the winch deck are shown on FIGURES 2 and 3 respectively.

![Front Elevation Diagram](image)

**FIGURE 2** Front Elevation.

3.3 **Deployment Arm**

This item, which was built under Lloyds Register survey, was constructed using conventional offshore materials and techniques, to meet typical offshore environmental conditions. It was sized for installation on the British Gas Rough Bravo platform and was built in accordance with the design produced by Andrew Palmer and Associates with the exception of the hinge detail which was changed to simplify construction and installation.

Details of the deployment arm are shown on FIGURE 4, with details of the revised hinge arrangement shown on FIGURE 5.
3.4 Winch

The design and construction of the winch is without doubt the most crucial item in the success of the project being unique in its performance and a vast improvement over existing devices. In addition it exhibits a high level of reliability coupled with a minimum maintenance requirement. Whilst it was not a requirement in the original specification for the winch to recover a fully loaded TEMPSC, it was found during the trials, that no problems were experienced carrying out such an operation. It is therefore quite acceptable for the system to operate in this mode.

The winch is required to carry out 4 main functions during one launch cycle as follows:

- Maintain the TEMPSC in its stored position in a state of instant readiness.
- When activated to control the decent of the deployment arm and TEMPSC to the required speed.
- Bring the deployment arm to rest at a pre-set point below the surface of the sea.
- Recover the TEMPSC and restore it to its ready position.

The first three items being carried out without recourse to platform power. The winch provided by the contractor met the requirements and no modifications were required.

3.5 TEMPSC.

The original proposal was based on the use of one of the existing HOTA vessels as the test TEMPSC. This proposal was abandoned in favour of providing a dedicated vessel, mainly because of insurance considerations. The deployment arm and lifting yoke were designed around the original HOTA vessel and modifications to the lifting yoke design were required to fit the new vessel. Whilst not entirely satisfactory in terms of visual impact the completed system worked extremely well and no problems were encountered.
3.6 Test Site

The test site chosen for the project was in the Hull Offshore Training Association Ltd. site on the Albert Dock in Hull. The dock side is between 3 to 4 meters above water level, and the dock wall is constructed in masonry blocks and founded on a layer of firm sand approximately 10 meters below ground level. This dock wall provided adequate support for the front edge of the foundation block although the material behind the wall (described as soft silt) was incapable of supporting the weight of the foundation block and tower and piling to the rear edge of the foundation block was required. The power requirements were met by running a new supply from a sub-station approximately 100 meters to the east of the site in existing ducting.
4.0 DESIGN DETAILS

The detailed structural design of the tower and deployment arm was based on the Structural Design Premise document produced by Andrew Palmer and Associates issued on 29th January 1993. The document contained all relevant Bathymetric, Meteorological, Loadings, Materials Specifications and Standards information necessary for the design and specification of the various components for Seascape Systems Limited, the final revision of which is referred to on Page 33 Ref. 1.

4.1 Tower
The tower was designed under a contract placed on Cold Oceans Design Associates Ltd. of St. John's, Newfoundland. The design work was completed and presented in a report see Page 33 Reference 5.

The report outlines the work completed by Cold Ocean Design Associates (CODA) Limited on the structural design of the test tower for the Seascape Evacuation System. The design was based on the Structural Design Premise report prepared by Andrew Palmer and Associates Limited (APAL) for Seascape Systems Limited.

4.2 Deployment Arm
4.2.1 General
The design of the deployment arm and supporting structure was based on the data and other technical information contained in the report produced by Andrew Palmer and Associates Limited. No corrosion allowance was made on the deployment arm structure as satisfactory 20 year protection can be provided by using a suitable protective coating system.

Design details are set out in the AP&A Ltd. report, see Ref. 2 on Page 33:

The deployment arm was built under Lloyds Register survey, a copy of the certificate is reproduced in the appendix document, see Ref. 9 on Page 33.

A sketch of the deployment arm is provided FIGURE 4 overleaf.
FIGURE 4 Deployment Arm General Arrangement.
The overall effective dimensions of the deployment arm are as follows:

- Length, from centre of lower hinge pins to centre of the TEMPSC lifting yoke main tubular. 23.786 m
- Width between centres of hinge pins. 12.838 m
- Width between centres of main chords at TEMPSC supports 3.540 m
- Outside diameter of main chords of various wall thicknesses. 457 mm
- Outside diameter of cross members of various wall thicknesses 219 mm

Material used:

DIN 17121 ST52 - 3
8 API 5L X52

Materials have Charpy values of 27 J at -20 Degrees C.

Copies of the weld procedures and heat treatments (where relevant) are reproduced in the appendix document see Ref 8 Page 33.

4.2.2 Design Changes

The deployment arm was built in accordance with the above design with the exception of the lower pivots and the addition of security retaining padeyes at the upper floor level. The additional padeyes were installed as a safety feature for the HOTA site only and would normally not be required for offshore operations.

The redesign of the lower hinge detail was carried out as it was felt that the originally proposed design was overly complicated resulting in unnecessary expense. Details of the new arrangement can be seen on Figure 5 below and are based on the use of a 200 mm stainless steel pin and a lining of an industrial lining material known under the trade name of Orcot. An information sheet, and wear and swell test details on this material are reproduced in the appendix document see Ref. 9 Page 33.

4.3 Winch

4.3.1 General Details

This section of the report describes the Lanec Industries Inc. Model 1100SS winch as used for the deployment and recovery of the TEMPSC during the project. The winch, which is a prototype and test bed for a next generation lifeboat deployment winch, is not suitable for man riding purposes as it was not built under survey. The design was however examined by Lloyd's Register who accepted the general concept.

Full design and manufacturing details would be required to be submitted to a warrantee surveyor prior to the fabrication of a production system for offshore use.
Because of the specialist nature of the winch and the winch making industry it was considered advantageous to limit details of the winch contract to a performance specification and leave it up to the winch manufacturers to produce a design which would meet or exceed the performance requirements for the system. These performance requirements are set out in two reports produced by Andrew Palmer and Associates Limited. See References 3 & 4 on Page 33.

Following proposals and discussions with various winch manufacturers the sponsors agreed that a design contract should be placed on Lantec Industries Inc. of Langley, British Columbia, Canada, to produce a design for the winch to meet the required specification. The design work was satisfactory and the order was then extended to cover the construction of the winch.

Following detailed discussions held with the winch manufacturers design team it was decided to change the basic design from a two line system to a single line system. This had the effect of doubling the line pull and halving the line speed.

It was originally intended that the winch would be built under Lloyds Register survey and would be suitable for manned use on the HOTA site during testing and subsequent demonstrations. However, the costs and delays emanating from this procedure were found to be unacceptable and the winch was therefore built for demonstration purposes only. Lloyds Register were given the opportunity to review the design and confirmed in writing that it would meet their requirements subject to acceptable materials and manufacturing methods being employed.

Full details of the final winch design and operating procedures can be found in the report Reference 6 on Page 33.

4.3.2 Performance Specification

The final as built performance specification of the as built winch is as follows:

- Number of wires 1
- Number of falls 1
- Wire Diameter 44 mm
- Deployment arm fall angles: Stowed 75 Degrees
- TEMPSC Release 5 to 0 Degrees
- Arm immersed at between 5 to -5 Degrees
- Arm halted at -15 Degrees

4.3.3 Characteristics in Fall Arrestor Mode

- Maximum TEMPSC velocity at 0 degrees 2.50 m/s
- Maximum winch wire payout velocity 1.67 m/s
- Maximum dynamic holdback load at 0 degrees 225 kn.
4.3.4. Characteristics in Hoisting and Stowing Mode

Maximum wire load 202 kn.
TEMPSC Retrieval velocity 0.30 m/s
Wire payin velocity 0.19 m/s

4.3.5 System Description.
The major components that make up the Model 1100SS consist of the following:

- A right-angle brake/motor drive with a backstop and manual crank which drives the planetary gear reduction group.

- A planetary gear reduction group which drives the drum while hoisting and is driven by the drum while deploying.

- A cable drum which holds 30.6m a 44mm of active cable plus the required number of dead wraps (in this case 3.5 wraps).

- A band brake which can be both manually energised or released as well as automatically energised. Its main function is for it to be manually released for lifeboat deployment and automatically energised when the lifeboat is in the water and free of the deployment arm.

- A hydraulic fall arrestor will be used to control the descent of the lifeboat deployment arm.

4.3.6 Brake/Motor
The right-angle brake/motor drive is designed to be used for hoisting and retrieval of the TEMPSC only. The output shaft of the brake/motor drive is coupled to a sprag-type clutch or backstop. This mechanism ensures that the cable drum cannot drive the brake/motor drive in reverse, nor is the brake/motor drive able to drive the cable drum in reverse. The brake/motor drive is also equipped with a hand crank that can be used for small movements of the deployment arm (e.g. final positioning the TEMPSC in its stored position) and could possibly be used to hoist or retrieve the TEMPSC in the event of electrical failure. However this would take many hours.

4.3.7 Gear Reduction Group
The gear reduction group consists of 4 planetary stages (see FIGURE 6):

- The first stage sun gear is connected to the brake/motor’s output shaft with the internal(ring) gear linked to the second stage sun gear and the planet hub linked to the fall arrestor cross shaft.

- The second stage sun gear is linked to the first stage internal gear with the planet hub linked to the third stage sun gear and the internal gear attached to the fourth stage planet hub/winch housing.

- The third stage sun gear is linked to the second stage planet hub with the planet hub linked to the fourth stage sun gear and the internal gear attached to the fourth stage planet hub/winch housing.

- The fourth stage sun gear is linked to the third stage planet hub with the planet hub linked to the winch housing and the internal gear attached to the cable drum.
The gear reduction group operates slightly differently when hoisting or retrieving as opposed to deploying.

- While hoisting or retrieving the TEMPSC, the fall arrestor cross shaft is held by the band brake which in turn holds the first internal gear stationary. This enables the brake/motor to drive through the four planetary stages and thus drive the drum.

- When deploying the TEMPSC, the brake/motor drive output shaft is held by the backstop which in turn holds the first sun gear stationary. This enables the cable drum to drive through the four planetary stages to the fall arrestor cross shaft.

4.3.8 Cable Drum
The cable drum is designed to store and spool off the cable attached to the deployment arm. It is spooled in by the brake/motor drive and despooling is controlled by the fall arrestor. Grooving is used to facilitate clean and neat spooling. Extra capacity cylindrical roller bearings are used to carry the load transmitted by the deployment arm.
A total active length or wire rope of 30.6 meters was fitted to the drum plus the additional required minimum of 3.5 dead wraps remaining on the winch at the end of the run.

4.3.9 **Band Brake**

The band brake is used in two ways:

- With the brake engaged, the first planet hub is held stationary and therefore allows the brake/motor drive to hoist or retrieve the TEMPSC. Also, the brake must be engaged to hold the deployment arm in its stored position and must be activated to bring the deployment arm to rest after launching the TEMPSC.

- With the brake disengaged the first planet hub is released, allowing the cable drum to despool.

The band brake is designed so that it is normally engaged. This is accomplished by using a weighted torque arm that applies, via linkage, a constant tension on the band brake live end. The brake is disengaged when the torque arm is raised and the tension on the live end is released.

The band brake is also designed to automatically re-engage when the TEMPSC has been lowered and released and the deployment arm has cleared the TEMPSC (at HOTA an angle of 15 degrees was selected but on production models the angle would depend on the depth required to clear the TEMPSC in worst conditions). This is achieved with the use of a shuttle which travels on a lead screw to re-engage the band brake. When the deployment arm is in its topmost position (cable drum is completely reeled in), the shuttle is in its furthest position away from the thrust transfer assembly. As the cable drum is despooled, the fall arrestor cross shaft turns the band brake transmission gears. The transmission gears turn the bevel gear set which then turns the lead screw. When the lead screw turns, the shuttle travels toward the thrust transfer assembly until it contacts. At this point the shuttle will move the thrust transfer assembly and in turn re-applies tension to the live end of the band brake and therefore re-engages the band brake.

Details of the arrangement are shown on FIGURE 8.
4.3.10 Fall Arrestor

The fall arrestor is designed to control the descent of the deployment arm so that the required descent velocity does not exceed allowable limits. This is achieved with the use of four hydraulic pumps coupled together via their output shafts which are driven by a bull gear on the fall arrestor cross shaft. As the motor shafts are turned, they draw hydraulic fluid from the enclosing reservoir and pump the fluid through a bank of flow restrictors. By restricting the fluid flow, the hydraulic motor shaft speed and in turn the cable drum speed is restricted. The hydraulic fluid which exits from the flow restrictors is diverted through the band brake and its components and then makes its way back to main reservoir for recirculation.

Details can be seen on FIGURE 9.
4.3.11 Wire Rope System
Because the original winch design was modified to eliminate the requirement for the two fall wire system the wire used was increased from the original 35 mm to 44 mm diameter, with the link bridle wire rope remaining the same at 42 mm. The factor of safety remained at 6. (i.e. tensile breaking load divided by 6 is greater or equal to maximum working load. The total active length of the wire rope (i.e. 75 degrees to -15 degrees) is 28.6 m.

4.4 TEMPSC
4.4.1 General Details
The original design for the system was based on the use of a HOTA owned vessel currently in use by HOTA in their day to day operations. This vessel is briefly described as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Watercraft Mk 2, 50 Person, with 4 No. side door openings.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>8.00 meters</td>
</tr>
<tr>
<td>Beam</td>
<td>2.70 meters</td>
</tr>
<tr>
<td>Draft (loaded)</td>
<td>1.18 meters</td>
</tr>
</tbody>
</table>

In the event, due to circumstances unrelated to engineering considerations, a bare TEMPSC hull was purchased and fitted out with propulsion and ballast for the testing programme and demonstrations. This vessel was slightly smaller than that previously mentioned and is briefly described as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Watercraft, 35 Person, with 2 No. side and stern door openings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>7.00 meters</td>
</tr>
<tr>
<td>Beam</td>
<td>2.30 meters</td>
</tr>
<tr>
<td>Draft (loaded)</td>
<td>1.18 meters</td>
</tr>
</tbody>
</table>
4.4.2 Attachment Yoke

The attachment yoke was modified to take account of the change in dimensions of the vessel and the different loading hatch layout. The final design of the lifting yoke are shown in Figures 11 and 12. However the general arrangement and scantlings of the revised attachment structure remained the same as the original design with the exception of the yoke to hull attachment. This detail was changed to a pair of stainless steel hangers. Calculations in support of the original yoke design are contained in the Miscellaneous Calculations file produced by Andrew Palmer and Associates Ltd. and the revised design is based on these calculations.

FIGURE 10 TEMPSC/Lifting Yoke Side View

Materials used for the construction of this item as follows:

Aluminium Parts (crossheads, tubular) B.S. 1470 1987
5083 'O' (MP 80)

Stainless Steel Parts (straps hangers spacers etc.) B.S. 970 Part 1
1983
Grade 316 S 61
4.4.3 TEMPS/Propulsion

In order to simulate offshore operations during a TEMPS launch it was decided that a propulsion system was required to drive the TEMPS away from the arm. This was achieved by installing a 40 HP outboard motor on an internal transom cut into the stern of the TEMPS.

Because of the restriction not allowing anyone on board the TEMPS during operations involving use of the winch the motor was started and set to the required speed in the stored position just prior to the launch from a control panel fitted to the stern of the TEMPS. Engine STOP controls were fitted to each side of the vessel to enable the support vessel to stop the motor and reposition the vessel in the lifting arm for recovery.

In the interests of safety the outboard motor fuel supply was mounted on the outside of the stern of the TEMPS adjacent to the engine control panel. Cooling water for the outboard was provided from a 40 gallon container mounted inside the vessel.
5.0 COMMISSIONING AND TESTING

5.1 Commissioning
The system was ready for winch commissioning purposes without the TEMPS, on Thursday 17th. May 1994 and with the assistance of a representative from the winch manufacturers it was put into operation. Because the winch was an entirely new concept the arm was only allowed to move a few meters in the first runs and the braking system was checked for action and adjusted. As confidence grew the runs were extended in both distance and speed. On the second day (Wednesday 18th. May). The auto braking shuttle was adjusted to bring the arm to rest at the required immersion depth at approximately minus 15 degrees. All subsequent drops were made in accordance with the agreed procedure generated by HOTA specifically for use on the Seascaper system under the direction of HOTA personnel given in the appendix document see Ref. 9 Page 33.

On the following day (Thursday 19th. May) a total of 20 runs were made and the speed gradually increased until the required maximum descent time of 26 seconds had been achieved. A total of 10 runs were made at this speed during which time the hydraulic oil temperature was monitored. The increase was found to be insignificant.

The TEMPS was finally ready for use on Tuesday 7th. June and it was fitted to the deployment arm and hoisted into its stowed position. Several small problems were encountered during this activity which necessitated adjustments to be made to hand railing and security padeyes at the upper deck level. Two drops were made at a reduced speed and the TEMPS was removed for ballasting.

A total of 8 drops were made during Friday 10th. June gradually increasing the speed up to the full service speed with a total ballast of 2 Tons (i.e. the maximum service weight of the TEMPS).

5.2 Testing
The research team from National Research Council of Canada (St. John's Newfoundland) arrived on site on Monday 13th. June and commenced setting up their equipment in the TEMPS. Between the 13th. and 17th of June a total of 44 runs were made. The results of these runs are provided in the appendix document see Ref. 9 Page 33.

Pressure and temperature gauges were fitted to the pressure side of the speed arrestor and 10 runs were made during 25rd. June. The results of these runs are provided in the appendix document see Ref. 9 Page 33.

A further 9 runs were made on behalf of the NRC team on the 16th. August to verify the TEMPS impact speed. The results of these runs are provided in the appendix document see Ref. 9 Page 33.

A total of approximately 160 runs have now been carried out with the system of which approximately 25 were manned. This far exceeds the total number that a normal production system could expect to make. No significant problems were encountered at any time and both the winch and deployment arm performed faultlessly. Many of these runs were made for public demonstration purposes attended by leading figures in the oil industry and interested public bodies. The observers included Lord Cullen leader of the enquiry into Piper Alpha disaster.
6.0 SCHEDULED MAINTENANCE REQUIREMENT

6.1 General
The maintenance requirements of the Seascape compare very favourably with those of existing systems mainly because of the relative simplicity of Seascape. It is recommended that the maintenance of the deployment system is limited to visual inspection and oil sampling (apart from the regular change out of the main wire rope as required).

The main components of the system are as follows:

- Retard/recovery winch
- Wire rope and bridie
- Deployment arm, Lower hinge and Upper pivot

Details of the recommended maintenance schedule are discussed below.

6.2 Maintenance Requirements
The total life operational time of the components of the winch and deployment arm are extremely short compared with what would be considered normal under normal operating conditions. For example, the hydraulic motors/pumps of the winch operate for a total of 6 minutes/year carrying out one complete cycle every month, whereas the maintenance schedule recommended by the manufacturers is based on approximately 5000 hrs./year.

6.2.1 Retard/Recovery Winch
The proposed maintenance frequencies are based on either the recommendations of the component manufacturer or an assessment by the winch manufacturer (Lantec Industries Ltd.).

From section 6.2 above it is clear that wear is not a consideration when assessing maintenance intervals. Indeed, the number of deployments of the prototype carried out so far exceed the total number to be expected over the life of a production system. On inspection of the maintenance requirements, the need for the dismantling of the pumps, for example, is to measure the wear on the various components within the pump and the only reason for replacing the 'O' rings and seals etc. is to eliminate the possibility of replacing damaged items (i.e. damaged during the dismantling process).

With the amount of usage envisaged during the lifetime of a system it is clear that the only consideration in deciding the replacement or servicing interval of the winch or its components, in this specific service, is deterioration of these components, i.e. corrosion or decay, or degradation of the oils.

Maintenance should therefore be limited to checking the quantity and quality of the oil in each of the 3 main components receivers (i.e. main gearbox, the recovery motor gearbox and the hydraulic motors receiver). This is most easily accomplished by taking oil samples for analysis at regular intervals, e.g. on a 6 monthly basis for the first year and annually thereafter. In addition, a magnetic probe should be fitted in the main gearbox to detect any wear.

In addition the function of the retrieval motor heater system must be checked at monthly intervals.
6.2.2 Wire Rope and Bridle.
This item will be treated in the same way as other system wire ropes and require replacement in accordance with normal company requirements.

6.2.3 Deployment Arm and Lower Hinge
This item again has no maintenance requirement apart from periodic inspection.

With regard to the lower hinge, the material Orcot, used as the bearing surface against the stainless steel pin is detailed in the appendix document see Ref. Page 33 Construction Details. Wear tests indicate zero wear over an 85hr. running period when water lubricated running against stainless steel.

The quoted working compression strength of Orcot provides a factor of safety of 10:1 against a bearing compression failure.

6.2.4 Upper Pivot
This item requires no maintenance. During the early part of the testing programme the PTFE linings on the pivot support worked free and were removed. After the subsequent deployments no wear was noted on either the aluminium pivot or its steel support.

6.3 Recommended Service Intervals.
As stated above the system can be regarded as maintenance free with the exception of the wire rope and the TEMPSC which is common to all evacuation systems. However some periodic inspection should be carried out as follows:

- A visual inspection of the winch for mechanical damage and oil leaks, and a function check on the retrieval motor heating system is recommended on a monthly basis.

- Oil samples should be recovered every 12 months for analysis and condensation check, and the magnetic probe examined at the same time.

- The lower hinge should be checked every 24 months or additionally as required for mechanical damage.
7.0 RISK AND RELIABILITY

In 1983 (Reference 8) the Department of Energy concluded that the performance of
davit launching systems " in anything other than calm conditions, is less than
would be expected from emergency life saving systems ". It also concluded that
there were measures which could be taken to improve their performance, but that
alternative systems " with a higher expectation of success " were needed.

The department of Energy (Reference 8) reported the following results from
offshore installations:

<table>
<thead>
<tr>
<th>Sea Conditions</th>
<th>Historic Results</th>
<th>Risk Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calm</td>
<td>95%</td>
<td>61 - 96%</td>
</tr>
<tr>
<td>Moderate</td>
<td>-</td>
<td>22 - 82%</td>
</tr>
<tr>
<td>Severe</td>
<td>45%</td>
<td>7 - 65%</td>
</tr>
<tr>
<td>Average all</td>
<td>70%</td>
<td>31 - 83%</td>
</tr>
</tbody>
</table>

DNV Technica conducted a study on a typical southern North Sea platform for one
of the Project sponsor companies in 1992. Using their ESCAPE model they
predicted the following results from 2 fall conventional boats:

<p>| | |</p>
<table>
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<tbody>
<tr>
<td>Calm</td>
<td>92%</td>
</tr>
<tr>
<td>Moderate</td>
<td>65%</td>
</tr>
<tr>
<td>Severe</td>
<td>14%</td>
</tr>
<tr>
<td>Average all</td>
<td>70%</td>
</tr>
</tbody>
</table>

By implementing some technical improvements, in particular the replacement of
off-load release gear with on-load release gear an overall improved success rate of
11% was predicted i.e. improved from 70% to 81%

DNV Technica have also recommended that an overall success criteria of >91%
should be applied when assessing TEMPS systems. Hoever this level of success
criteria has not been incorporated into any regulation or accepted industry standard
to date.

Using the same model, DNV conclude that a skidfall lifeboat is mechanically more
complex than a conventional 2 fall boat but less affected by weather. The effect is
to level the predicted performance over the weather categories making it much
better than the conventional lifeboat in severe weather but less successful in calm
weather. In effect, they concluded that for this particular installation, modified
conventional 2 fall systems were preferable to skidfall systems.

Because the prototype Seascape system was not engineered to full certification and
QA/QC standards, no publishable Risk Analysis has been completed. However, the
available model tests, risk assessment and partial risk analysis, completed by the
sponsors, indicate that an all weather success criteria of >91% is achievable. This
predicted success rate matches the recommended DNV Technica Success Criteries
and out performs the other systems reported.

The basis of the Seascape Systems high success rate is that it avoids the high
failure items such as release gear and includes the Dept. of Energy and Cullen
recommendations such as boat orientation and launch distance away from the
platform. In addition, high performance, low wear systems particularly in the
winch reduced predicted failures.
8.0 OBSERVATIONS AND RECOMMENDATIONS

8.1 General
The successful operation of the system proved its validity as a viable option to existing launching systems, and it can also show important advantages over these alternative systems including savings in maintenance costs. However this report is not concerned with promoting the system for offshore use but rather with recording and commenting on this specific project.

In most research and development projects it becomes clear with the benefit of hindsight that certain things could have been done better, and this project is no different. Decisions are made using the best available information at the time which may subsequently turn out to be inaccurate or inadequate.

Various improvements are recommended as follows:

8.2 Deployment Arm
The deployment arm worked in a satisfactory manner although at no time was it subject to the maximum working or design loads. Several minor points were noted for rectification and/or improvements as follows:

8.2.1 General Layout.
The general layout of the arm was dictated by the requirement to fit the British Gas Rough Bravo Platform and the HOTA TEMPSC. The change in direction at the upper end of the main chords of the arm, required to improve access to the side doors of the TEMPSC, and the spread of the main chords at the lower hinge points resulted in substantial increased in costs and should be avoided wherever possible. Future designs will be standardised where possible.

8.2.2 Lower Hinge Detail.
The original design was unnecessarily complicated and costly which is why it was changed. The revised design was shown to be satisfactory, but in addition to the obvious change to the stainless steel pins the tolerance of construction was also significantly changed, i.e. the specified allowable misalignment of the hinge centre line of less than 0.5 degrees in any plane. In practice, if both hinges carried the maximum tolerances large forces would have been generated in the hinge bearing possibly resulting in hinge failure.

Future hinges should be designed to be self aligning or fabricated to a tighter tolerance.

8.2.3 Upper Pivot Support.
These supports, which carried each end of the TEMPSC lifting yoke tubular, were lined with PTFE in accordance with the specification, after only a small number of runs the linings were observed to distort and were eventually removed altogether. No damage to either the yoke tubular or steel support brackets was observed and no detrimental effects were noted during the launch.

This item should be eliminated from future designs.
8.3 Winch
Generally the winch performed in a very satisfactory manner and no problems were noted, apart from a few peripheral details. In all probability the overall size of the winch could be reduced.

To facilitate oil sampling and condensation checks on the oil reservoirs it is recommended that sampling points are fitted to allow draining at the lowest point on each reservoir and a magnetic probe is fitted to the gear planetary gearbox.

8.3.1 Winch Rope Bridle
If possible the winch wire should be attached directly to the deployment arm, this would probably require some stiffening to the attachment point tubulars but would eliminate the requirement for a bridle and the attendant rigging problems.

8.3.2 Rope Termination
The retention socket in the winch drum was unsatisfactory and caused the termination socket to foul on the winch framework. Modifications were carried out which resolved the problem.

Modifications to the drum could eliminate this problem.

8.4 TEMPSC/Lifting Yoke
The design of the lifting yoke finally adopted on the project was an adaptation of the original Andrew Palmer and Associates Ltd. design. Because the TEMPSC used on the project was smaller and lighter than the design premise vessel, the lifting yoke tubular extended excessively over each side of the TEMPSC giving it a top heavy appearance, which was not improved by the excessive depth of the crossheads (which, in any event, were only required because of the side entry hatches). In addition, due to doubts concerning the structural integrity of the TEMPSC, the stainless steel straps were added. None of the above features would necessarily be required on a production system, particularly on a new build system, where a purpose made TEMPSC complete with a built in lifting yoke would be supplied. There are already some TEMPSC available on the market which incorporate an internal yoke.
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