No: 11/92 **Ref: EW/G92/09/13** **Category: 1c**

Aircraft Type and Registration:	Steen Skybolt, G-BRIS	
No & Type of Engines:	1 Lycoming IO-360-A1A piston engine	
Year of Manufacture:	1988	
Date & Time (UTC):	12 September 1992 at 1600 hrs	
Location:	Netherthorpe Airfield, Yorkshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Landing gear collapsed and engine shock loaded	
Commander's Licence:	Private Pilot's Licence with Instrument Rating	
Commander's Age:	40 years	
Commander's Flying Experience:	779 hours (of which 4 were on type) Last 90 days - 63 hours Last 28 days - 25 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

While landing into a light wind, the aircraft ballooned following the flare and landed heavily. The landing gear collapsed and the aircraft came to a halt on the runway after a ground slide of about 50 yards. The pilot attributed the cause of the accident to his over rotation in the landing flare.

The crew indicated to the Helicopter Landing Officer (HLO) that it was safe to approach by switching off the anti-collision beacon, and giving the 'thumbs up' signal. He approached from the right hand side of the helicopter, accompanied by the Helideck Assistant (HDA). Because of the restricted clearance between the edge of the rotor disc and the helideck perimeter, transition to the left hand side was made by moving close in around the nose of the helicopter. The HDA delivered a package of crew catering through the left side crew door, and proceeded to the baggage bay to handle the passenger baggage changeover. Meanwhile, the HLO exchanged load manifest paperwork with the first officer also on the left side. The left hand side of the helicopter was used for passenger boarding to facilitate use of the hinged doors on that side. On the right side was a door of the "move out and slide rearwards" type, which was generally regarded as being more difficult to operate than the hinged type door. The offgoing passenger was thus disembarked from the left side, and moved around the nose of 'ND' to clear the helideck area, and was given advice on the safe route by the HLO. The boarding passenger was then signalled to approach 'ND' by the HLO. His route also took him into the right side and close in around the nose of 'ND', and he boarded via the left side passenger door. With boarding and baggage loading complete, the HLO moved to take up a position at the nose of 'ND', head slightly bowed and facing towards the helicopter crew, awaiting the HDA who was also in the process of moving forward.

The witnesses on the vessel's bridge stated that, at this point, the ship was hit from astern by a large wave, which caused the ship to shudder. The helicopter crew described the ensuing motion of the ship as initially a roll right and pitch down, followed by a very rapid roll reversal to the left and pitch up, referenced to the ship's axes. The ship's Captain, who was observing from the bridge at the time, described the extremity of the motion as being a list of between 5 and 8° to port. As this movement was occurring on the vessel, the helicopter began to move backwards on the helideck. Witnesses could not be positive whether the movement was a roll back or a slide across the deck, but were in general agreement that rearwards displacement of the helicopter was of the order of one metre. One observer from the bridge thought that the right rear wheel of 'ND' may have lifted briefly, but that was not corroborated by other witnesses. The rearwards movement of 'ND' resulted in the HLO being left in a position more forward of the helicopter than was planned. At the same time, the plane of the rotor disc dipped to the front of the helicopter, resulting in the HLO receiving a fatal strike on the head by a rotor blade. Witnesses on the ship's bridge indicated that the HLO staggered briefly before falling backwards onto the helideck.

The commander decided that it was unsafe to shut down the helicopter on the vessel in such conditions of wind and sea state. He therefore elected to lift off and make the short transit flight to the Heather 'A' platform, some 2 nm distant. He indicated his intention by RTF to the vessel, while the first officer indicated to the HDA that he should clear the helideck immediately. The HDA crawled clear of

Prior to departure, the weather report for the Heather 'A' gave the surface wind as 270°/30 kt, visibility 10 miles, cloud 4/8 cover at 1500 feet, temperature +6°C, QFE 998 mb, and wave height of 4.5 metres. The corresponding weather for the 'Mayo' at 0700 hrs, gave the surface wind as 270°/35 kt, visibility 12 nm, present weather rough, temperature +7°C, with the ship's Pitch ±3°, Roll ±2°, and a heave of 4 to 5 metres. The operator's limitations for the S76 on moving decks were ±4° (4° either side of the vertical) for each of Pitch and Roll, with the amount of heave left to the pilot's discretion.

Nothing in the weather reports was considered unusual by the crew, and the helicopter departed from Aberdeen at 0805 hrs. The flight to the 'Ailsa Craig' was uneventful, the weather being in accordance with that expected from the forecast. The Heather 'A' weather was updated prior to landing on the 'Ailsa Craig', and was little changed from the earlier report, with the exception of an increased amount of cloud at 1000 feet, and a change in the QFE to 996 mb. The weather at the 'Ailsa Craig' was also similar, the ship giving a Pitch of ±1°, Roll ±3°, and a heave of 10 feet (3.3 metres).

G-BOND ('ND') landed on the 'Ailsa Craig' at 0940 hrs, and the passenger exchange progressed normally. The flight was airborne again at 0945 hrs en route for the 'Mayo'. The normal checks were carried out after departure, the commander releasing the parking brake, and resetting it ON in accordance with the initial approach checklist.

Confirmation was obtained by RTF from the 'Mayo', which was sharing a common frequency with the Heather 'A', that the helideck was clear for landing. The updated weather report from the vessel was not requested by, or passed to, the helicopter crew. The report had been prepared in anticipation of the landing, and quoted the surface wind as 270°/45 kt, visibility 12 nm, cloud and temperature as previously reported, and the Pitch as ±4°, Roll as ±2 to 3°, and heave as 2 to 3 metres. The Pitch figure was just on the limit for operation to the vessel. The 'Mayo' was approximately 2 nm east of the Heather 'A' platform, and had been turned onto a heading of due east, at a speed of approximately 1-2 kt. The heading was taken up by the vessel's Chief Officer in order to facilitate the helicopter landing, in accordance with normal practice. Two other ships of similar profile and colouring were also in the area. The crew therefore requested that the 'Mayo' switch on its NDB radio beacon, to enable positive identification. This was readily achieved, and 'ND' made a short right hand circuit around the vessel, before coming to the hover just ahead of the bow, awaiting a null in the motion of the ship. A suitable reduction in motion occurred within approximately one minute, and the aircraft landed on the helideck at 0955 hrs, in a position described as approximately 40° to the centreline of the vessel (Figure 1), to maintain maximum visibility of the landing area from the commander's (right hand) seat of the helicopter. Positioning in the aiming circle was towards the bow of the vessel. Mainwheel chocks were not used during the turnround.

was initially positioned on the helideck slightly towards the bow rather than on the central position of the aiming circle, one or both of the main wheels would have been very close to the bow edge of the deck netting as the movement occurred.

Personnel & Training

The HLO, a Dutch national, was the vessel's third officer, and specialised as the dynamic positioning officer for diving operations. He was 29 years old, and was assessed medically fit after a routine medical examination in February 1992. He had been working on the vessel since 1990, and had attended a one day HLO training course at the KLM Helikopters Safety Training Department, Schipol, Amsterdam, in March 1992. The course comprised a large amount of material, relating to international regulations and requirements for North Sea operations, helicopter operations including dispatch and turn around procedures, emergency procedures, helideck regulations and requirements, communications, and helicopter loading. A comprehensive handbook was issued with the course, and a copy was available on the vessel at the time of the accident.

The handbook contained details of the "safe" areas of approach to the S76, and indicated that it was acceptable to move from one side of the S76 to the other by passing close into the nose of the helicopter. The section detailing helicopter operations contained a diagram of the S76 (but not labelled as such), showing the low forward rotor blade position, with a cautionary note *"remember, rotor blades may at any time sweep down to below shoulder height"*, and *"caution, very low rotor"*

During the course of the investigation, two additional UK training manuals were inspected with regard to the advice given for S76 operations. In both cases, no specific warnings of the low rotor disc profile were published in the sections detailing the S76 type specification and operations. However, in an appendix, one of the manuals contained a copy of a letter to operators from the Department of Energy, dated 14 November 1980, specifying the need to make HLOs aware of the low rotor disc profile on the S76 and Boeing Chinook helicopters. There was also some variance in the definitions of "safe" areas of approach to the S76. Differences in the standard boarding procedures used by various operators were also apparent. Three basic door configurations exist, namely two hinged doors on the left side combined with either hinged doors, or a move out and slide back rear door, or a straight backward sliding rear door on the right side. The operators surveyed seemed to have a mixture of aircraft standards in each fleet.

It was also apparent that the training of HLOs is conducted either by the various oil companies themselves, or by the aircraft operators. Therefore, there is little standardisation in the content and

the helideck, and after waiting a short time for the next null in the ship's movement, the commander lifted 'ND' off and departed at 1000 hrs. During the short transit flight, Viking Control were informed of the accident, and the helicopter landed uneventfully on the Heather 'A' at 1005 hrs. Shutdown and disembarkation of the passengers was then completed. The commander went to the telephone to report details of the accident, while the first officer secured two of the rotor blades. Some time later, as wind conditions were worsening, the crew returned to the helicopter to tie down the remaining blades, and noticed that cracking was present on one blade, in the vicinity of the blade trim tab. The operator's engineers were then informed, and arrangements made to deliver and fit a replacement blade once the weather had improved, during the following day.

An aftercast for the area indicated that at the time of the accident, a deep depression was centred about 150 nm north of the vessel's position, maintaining a gale force westerly airstream over the area, with winds of 35-40 kt, gusting 50-55 kt. It was remarked that the sea state had increased fairly rapidly from 2 metres to 6-8 metres by late morning, as the effect of the long fetch generated by the gale force west to northwest winds reached the area.

At the time of the accident, the helicopter was not required to be fitted with a Flight Data Recorder, but an installation work package was planned in order to comply with a forthcoming change in the regulations. The 'Mayo' had a sensing and computer storage facility to record the vessel's movements over the previous 30 minute period. Information recorded prior to this time is overwritten. The ship's crew did not preserve the data recorded at the time of the accident. There was no indication as to whether the data had been observed over a particular time period prior to it being noted on the report.

Helideck Details

The 'Mayo' was equipped with an 18.95 metre diameter helideck, and was approved by both the Netherlands Department of Civil Aviation and UK CAA for operations by helicopters up to the size of the Bell 214ST and AS332L Super Puma, both of which are longer than the S76A. The surface of the helideck was finished with an anti-slip coating. The deck markings were in accordance with the guidance given in CAP 437 for Offshore helicopter landing areas. The aiming circle was of 10 metre outside diameter, with the 'H' centrally positioned in the circle aligned across the helideck. Over the aiming circle was positioned a medium sized (12 metre square) deck net, secured at appropriate intervals around the periphery, and tensioned in accordance with the recommendations. The deck net was made up of a mesh of 20 mm diameter sisal rope, knotted at each corner of the mesh. Because of limited deck space, the net was not centrally positioned over the aiming circle, the forward edge of the deck net being almost tangential to the outer edge of the aiming circle at the bow end (Figure 2). The wheelbase of the S76A from the nosewheel to the main wheel axis is 5.0 metres. As the helicopter

rotor disc may typically tilt forward to give a ground clearance of 54 inches (1.37 metres) at the tip. Based on this figure, the rotor blade height at the location of the metallic impact damage would have been 68 inches (1.73 metres). The HLO was 1.92 metres tall.

The commander could not recall making a forward cyclic stick input in response to the rearward motion of 'ND', but stated that he may have done so instinctively in an attempt to prevent further rearward travel towards the edge of the helideck. He did state positively that the collective pitch control remained in the fully down position throughout the time on the helideck.

The helicopter was fitted with a dual channel Automatic Flight Control System (AFCS), which is intended to provide stability about the pitch, roll and yaw axes. The authority of this system is limited to 10% of the manual control authority, and the operator's standard procedure is for it to remain engaged, at the discretion of the aircraft commander, from after engine start until just prior to shutdown. Once again, because of the lack of recorded data regarding rate and amount of movement experienced at the time of the accident, it was not possible to determine precisely the amount of rotor disc deflection due to the AFCS, but this is thought to be less than 2 feet (0.61 metres)

Other UK operators of the S76 follow a standard practice of disengaging the AFCS after landing. A variation in the operating limits applied by different operators to landings on moving decks was also apparent. These ranged from an individual vessel-specific pitch and roll limit of ±2° by day (±1° by night), to an overall ±5° limit by day (±4° by night) with restrictions on the maximum deck angle from the horizontal.

A Pitch Bias Actuator system was also fitted, but the operation of this is inhibited below 45 knots by an airspeed switch, and inputs progressively increase as speed is increased above this value. The system is also powered through a weight-on-wheels microswitch, thus disabling the system while the helicopter is on the surface. This system was checked for serviceability at the operator's maintenance facility, and was found to operate normally.

Wheel Brake Investigation

The S76A is fitted with an independent disc brake on each of the two mainwheels, activated by hydraulic pressure from master cylinders operated by either pilot's toe pedals. Application of the parking brake requires that both toe pedals be pressed simultaneously and held while the parking brake 'T' handle in the centre of the cockpit is pulled up. The pressure held in the system is thus proportional to the amount of pressure applied to the toe pedals prior to the pulling up of the parking

layout of the training manuals, each being tailored to the particular operator's standard practices, and being compiled from whatever data may be readily available at the time of compliation.

The helicopter crew remarked that the HLO had followed the normal operating procedures satisfactorily, and gave them no cause for concern about the management of the turnround on the helideck prior to the accident.

Engineering Aspects

The rotor diameter of the S76A is 44 feet (13.41 metres).

The main rotor blade from 'ND' was returned to the operator's maintenance facility at Aberdeen, where inspection revealed two areas of damage. On the leading edge of the blade, some 1.5 metres inboard from the tip, there was evidence of metallic impact damage, thought to have been caused by components of the HLO's radio headset. There was also evidence of a 0.3 metre wide trail of soft tissue debris on the underside of the blade, from the leading edge, moving slightly outboard across the width of the blade. A crack was noted on both upper and lower surfaces of the blade, originating from a "stress relief" drilled hole at the inboard end of the blade trim tab. This crack appeared to have progressed 0.17 metre forward into the blade, before turning diagonally inboard for another 0.1 metre towards the blade spar.

A report is awaited from United Technologies Sikorsky Aircraft Division regarding the nature of the observed cracking. It is not possible, at present, to determine whether the crack was initiated by the impact or subsequent short flight, or by the very strong winds encountered overnight on the Heather 'A' after the accident.

Rotor Disc Deflection

Because of the lack of any recorded data from either the helicopter or the vessel, regarding the amount and rate of movement attained, it was not possible to quantify the amount of rotor disc deflection at the time of the accident. However, in order to observe the amount of possible deflection downwards ahead of the S76A in a dynamic condition, an aircraft of the same type was positioned outside the operator's hangar at Aberdeen, with a video camera aligned to view the forward tip of the rotor disc. The helicopter was run at flight idle (107% NR), with the collective pitch lever fully down, and a progressive forward input was made on the cyclic pitch control until the rotors just reached the droop stop position. This stick position was noted, and the cyclic control re-centred. A rapid forward input was then made to the same position as had previously been achieved. The results showed that the

helicopter, with a view to minimising the requirement for any personnel to transit from one side to the other by routing close in around the nose of the helicopter.

92-96 The CAA should require all UK operators of the S76 in the offshore role to review the current operating limitations on pitch and roll for operations to and from moving decks, and issue advice to crews on the possible reduction of the limits on decks of restricted size in adverse weather and sea conditions.

92-97 All operators of the S76 should ensure that crews are aware of the hazards associated with the AFCS remaining engaged while alighted on moving decks in adverse weather conditions.

92-98

The Health & Safety Executive should circulate information about this accident to all organisations in the United Kingdom who carry out helideck crew training. They should endeavour to circulate the information to other countries with regulatory agencies having responsibility for oil industry safety and who may be able to influence training organisations in those countries.

Training organisations should be advised to include, in their training materials, clear and unambiguous reference to the specific hazards associated with this type of helicopter, with regard to the method of approach and boarding and the relatively low rotor disc position forward of the nose. The possibility of an increased rotor disc hazard as a result of the dynamic effects encountered on moving decks should also be emphasised. Wherever possible, trainees should be given the opportunity to visit operators and to view the helicopter types covered in the training prior to their first operational encounter.

brake handle. There is currently no pressure gauge to indicate to the pilots that the parking brake pressure has reached or maintained an adequate level.

The technical log for 'ND' revealed that on 17 occasions, between October 1991 and the 3rd April 1992, entries had been made indicating that the braking performance on this machine was unsatisfactory, mostly relating to a soft or spongy feel to the pedal inputs, or ineffective braking. On the 3rd April 1992, the parking brake valve was changed, and no further problems were reported prior to the accident.

As a general check of brake effectiveness, a tow bar with load cell was fitted to 'ND' at the operator's maintenance facility. The parking brake was applied normally, and attempts made to tow the helicopter against the brakes, until the wheels began to turn. The load value required to maintain wheel rotation was noted, rather than the initial break-out value, in order to remove the effect of surface friction. The test was repeated several times to assess consistency, and load values of between 600 and 800 kg were found to be required to overcome the parking brake pressure.

A standard maintenance check was then carried out on the braking system. This showed that the fluid levels in the master cylinders were satisfactory, and that the brakes functioned satisfactorily during the check. An in-situ check of the gap dimension showed this to be within tolerance by 0.002 inches (0.051 mm). To investigate further, the brake assemblies were dismantled. The discs, backing plates and pressure plates were then checked individually. Both discs were found to be within the required tolerance. However, the left and right backing plates were found to be below limits, by 0.021 inches (0.533 mm) and 0.018 inches (0.457 mm) respectively. The pressure plate from the left hand brake was found to be below the specified minimum thickness by 0.003 inches (0.076 mm), and that from the right brake was within limits.

Safety Recommendations

In order to prevent the possibility of a recurrence of this type of accident, the following safety recommendations are made:

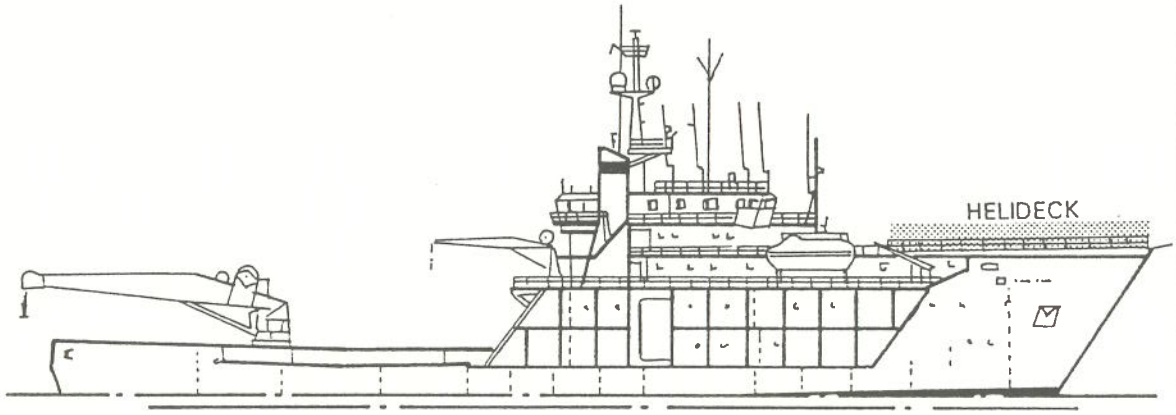
92-94 The CAA should re-assess the certification criteria for landing gear/braking system capability in the context of the particular conditions experienced during operations onto moving decks.

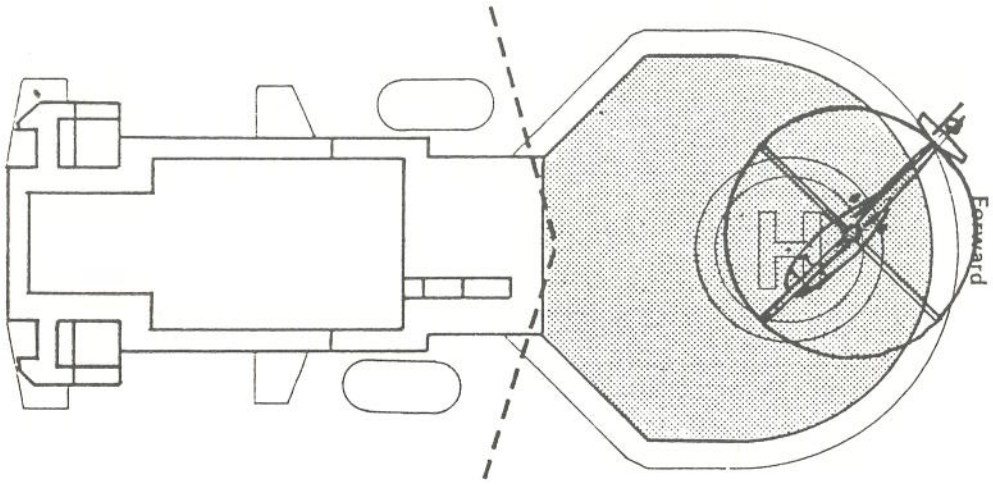
92-95 The CAA should ensure that all UK operators of the S76 standardise the various current practices with regard to the method of approach and the "safe" areas designated for this type of

HELIDECK ELEV 41	Var CHECK	Position CHECK

MAYO DSV

	VHF	NDB	D2 / 2.D
HEIGHT OF INSTALLATION: 108 HIGHEST OBSTACLE WITHIN 5NM: See below FUELLING INSTALLATION: No STARTING EQUIPMENT: No HELIDECK APPROVED FOR: See below	As advised	As advised	22 JUL 91
	OPERATING COMPANY		APPROVAL AGENCY CAA





Helideck 18.95m diameter

1. Check higest obstruction within 5nm if rig operating adjacent to other rigs or fixed platforms.
2. Helideck approved by UK CAA for operations restricted to AS332L B214ST

Rev. Helideck approval

FIGURE 1 - LAYOUT OF HELIDECK AND HELICOPTER POSITION

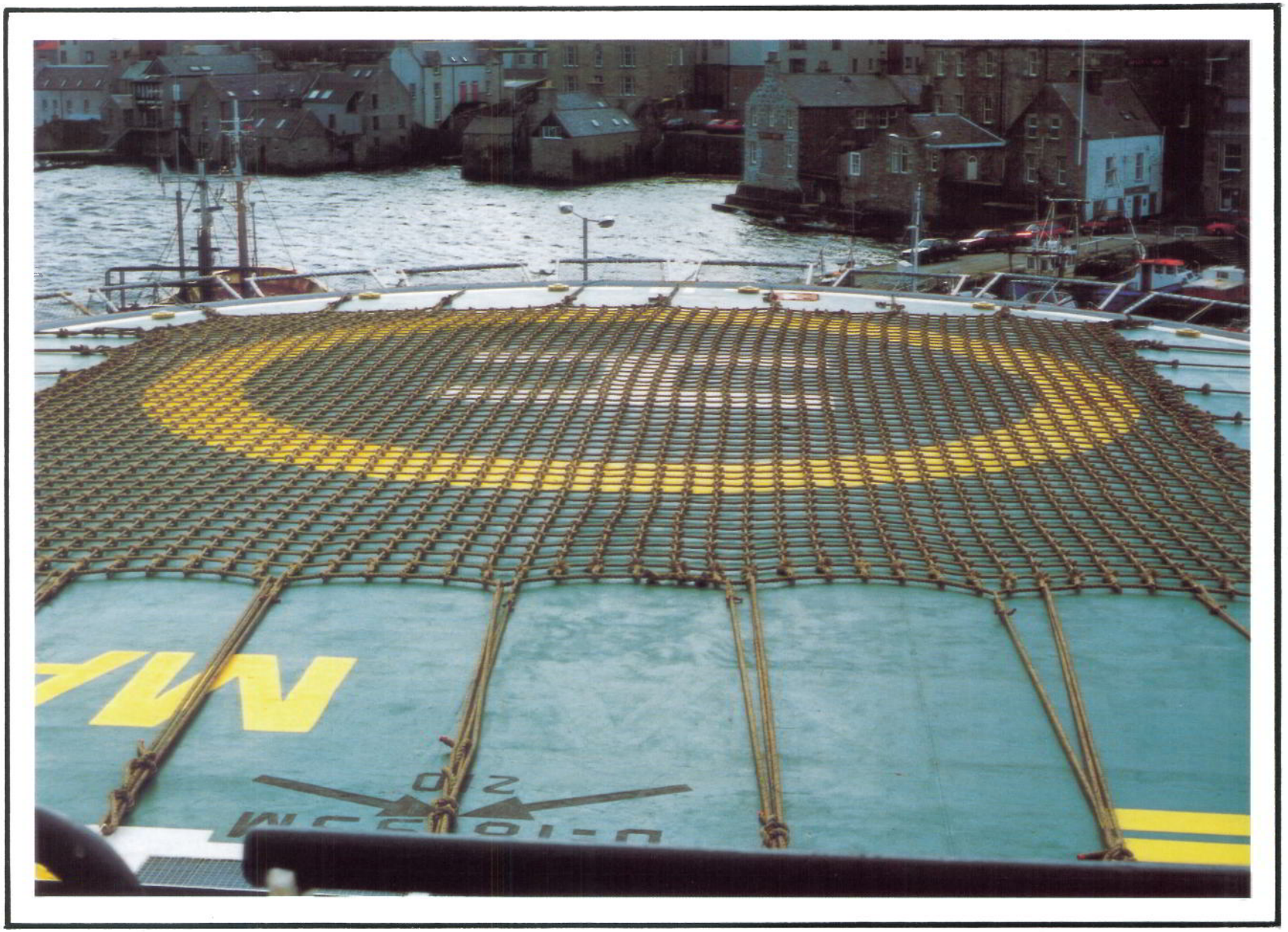


FIGURE 2 - VIEW OF DSV 'MAYO' HELIDECK FROM THE SHIP'S BRIDGE, FACING FORWARD