Aircraft Type and Registration:	Sikorsky S61N Sea King, G-AYOM
No & Type of Engines:	2 General Electric CT58-140-1 turboshaft engines
Year of Manufacture:	1962
Date & Time (UTC):	18 August 1995 at 1056 hrs
Location:	Claymore Accommodation Platform, 94 nm northeast of Aberdeen
Type of Flight:	Public Transport (non-scheduled)
Persons on Board:	Crew - 2 Passengers - 14
Injuries:	Crew - None Passengers - None
Nature of Damage:	Substantial to main rotor blades and tail rotor driveshaft assembly
Commander's Licence:	Airline Transport Pilot's Licence (Helicopters)
Commander's Age:	58 years
Commander's Flying Experience:	19,010 hours (of which 12,055 were on type) Last 90 days - 149 hours Last 28 days - 50 hours
First Officer's Flying Experience:	2,370 hours (of which 2,148 were on type) Last 90 days - 99 hours Last 28 days - 33 hours
Information Source:	AAIB Field Investigation

The commander and first officer reported for duty at 0800 hrs and 0745 hrs respectively to operate a non-scheduled public transport flight that was due to depart Aberdeen at 0900 hrs. Both crew members were well rested, each having had in excess of 12 hours free from duty. The flight, planned with the first officer as the handling pilot, was to route via the 'Piper B' platform and the 'Saltire A' platform before transiting to the Claymore 'A' Accommodation Platform (CAP). Fog offshore, however, delayed the flight which eventually departed Aberdeen at 0955 hrs.

Whilst the helicopter was en route the crew were retasked, due to improving weather conditions, to land on the CAP first. Updates on weather conditions for their arrival were transmitted to the crew, whilst they were en route, by the Flight Information Liaison Officer (FILO) on the Piper 'B'. The crew recorded these weather updates as; wind 090°(T)/05 kt, visibility 2 nm, cloud overcast at 400 feet, temperature +15°C and a QNH of 1023 mb.

The approach to the CAP helideck and the local environment dictated that the commander, seated on the right, was best positioned to carry out the landing so control was transferred to the commander prior to the approach to the platform.

The CAP helideck had only been in operation a few days prior to the accident and at that time an information chart depicting the layout of the installation and containing details of dimensions, contact frequencies and hazards etc, was not available. The commander, however, had landed on the helideck a few days earlier, on a company line check flight, and was familiar with its layout.

Before their arrival at the CAP the commander briefed the first officer on the approach and go-around. The commander was aware that the northern flare stack boom, on the adjacent production platform, was active and the crew discussed the go-around options in the light of this.

Approximately three minutes before landing the commander reduced the helicopter's speed to 70 kt and 15 seconds later the crew identified the CAP on radar. With the surface in sight the crew descended below 600 feet and adjusted their height to keep the aircraft below the 'ragged' cloud base. Twenty seconds later at a range of about 2 nm the crew became visual with the CAP with the helicopter at 400 feet amsl. The first officer then transmitted to the CAP Helicopter Liaison Officer (HLO) requesting clearance to land on the deck. The HLO confirmed the "Claymore's deck all clear". At 40 seconds to run the commander confirmed the go-around direction and that "all torques over 60%". The commander reported that as the helicopter crossed the deck edge the addition of normal amounts of power did not check the rate of descent and the aircraft arrived over the landing circle with a substantial sink rate. The first officer reported that just prior to touchdown he had become aware, by visual cues and smell, that the helicopter was being engulfed by the downwind emissions from the flare on the production platform. The commander tried further to check the sink rate by selecting maximum gearbox torque (115%). When this high torque setting was seen to have no effect and at a height of one to three feet above the deck, the commander 'pulled' all the remaining torque. The first officer called "over torque" and both crew members were aware, through noise and visual impressions, that there was considerable 'rotor droop'.

As the helicopter landed straight ahead the commander heard a 'thud' and was aware that there had been a main rotor blade strike and 'mechanical damage somewhere in the transmission train'. Moments later the HLO transmitted to the crew that "the tail rotor shaft was out!". There was no fire warning and the shutdown checks were completed normally. The rotor brake was applied 5 seconds after the engines were stop cocked and the passengers disembarked normally once the rotors had stopped. The commander pulled the CVFDR circuit breakers within a minute of shutdown.

The actual weather conditions, logged at 1100 hrs by the CAP's radio operator were; wind 090°(T)/3 to 5 kt temp +15°C.

Claymore Accommodation Platform

The CAP, a new permanent installation located approximately 95 nm on the 060° radial from Aberdeen, is positioned to the west alongside the Claymore Production Platform (CPP) and joined to it by a walkway 95 metres in length (Figure 3). The dual installation complex supports two helidecks. The CPP helideck was to be used for emergency landings only due to the proximity of the new walkway. The newly commissioned helideck on the CAP, however, had no such restrictions or limitations except that its 210° obstacle free sector had been reduced by 9° to 201°, again due to the presence of the adjoining walkway. This infringement of the 210° sector by the walkway, had been notified to the Civil Aviation Authority and was listed as a non-compliant item in the crew briefing material (Installation/Vessel Limitation List (IVLL)). The CPP, as well as being equipped with gas turbine engines to provide production power supplies, was fitted with two horizontally mounted flare stacks used for the 'burning off' of surplus gas products. These flare stacks, referred to as the 'northern' and 'southern' stacks, are approximately 50 metres in length and extend to the east and south from the production platform structure.

Information charts

The company provide the crews with information charts for each installation in their area of operation. These charts, which show the installation in plan and profile, depict the structure of the installation, its orientation, position of the helideck and the position of the obstacle free sector. Other information includes the helideck height, NDB and RT contact frequencies. The charts, which show structures associated with the flare stacks, do not show the position of turbine exhausts outlets. Furthermore each installation is depicted in isolation. Installation complexes of two or more structures are not shown on a chart as a combined feature.

Flight Recorders

The helicopter was fitted with a Penny and Giles D51508 combined Voice and Flight Data Recorder (CVFDR). The 8 hour data recording and the ninety minute voice recording contained all the flight data but ended immediately on landing. This was due to the main rotor striking the tail boom and causing the operation of the inertia switch which cut electrical power to the CVFDR. This switch was designed to prevent the voice recording on the CVFDR from being overwritten, post impact, if power supplies to the recorder are maintained. Recorded data is shown in Figures 1 and 2.

The AAIB intend to submit a Safety Recommendation concerning the specification for an inertia switch in helicopter CVFDR systems. This will be in conjunction with the report on AS332L, G-TIGK, which suffered a lightning strike on 19 January 1995 and subsequently ditched.

The helicopter descended with the collective pitch at approximately the rigged position and the engine torques between 35% and 45%. This gave a rate of descent of approximately 320 feet per minute. Four minutes prior to touchdown and at an altitude of 550 feet, more collective was applied and the helicopter climbed to 630 feet over a period of one minute. At a distance of two miles from the rig and with just over two minutes to run, the collective was then lowered to just below the rigged position and, with the engine torques at approximately 40%, the helicopter descended at 350 feet per minute to an altitude of 250 feet. One hundred seconds prior to touchdown the collective was again raised and the helicopter climbed to an altitude of 360 feet.

Fifty seconds before the landing the data showed a large reduction in the collective pitch to 8% below the rigged position and the engine torques reduced to approximately 30%. The recorded rotor speed (NR) indicated variations between 102% and 104% and the indicated airspeed steadily decreased from 80 kt to less than 20 kt (indicated airspeed below approximately 40 kt are unreliable due to inaccuracies in the transducer system). As the helicopter commenced its final descent towards the rig the radio altimeter indicated a rate of descent of 200 feet per minute. Ten seconds before the landing the commander asked the first officer to call the engine torques. At the same time the descent rate suddenly increased to 440 feet per minute with no change in the controlling inputs. As the first officer was calling the torques the commander smoothly increased the collective pitch to the maximum extent over the next 7 seconds with the torques on both engines following the required demand. The radio altimeter indicated no reduction in the rate of descent as the edge of the helideck was crossed. The first recorded radio altitude over the helideck was 6.7 feet with 3 seconds to go before the end of the recording. At 2 seconds before the end the Engine No 1 and Engine No 2 torques were recorded as 106% and 112% and the first officer called "Overtorque". The rotor speed at that time was 97% and the radio altimeter was recorded as zero feet indicating that the main wheels were very close to or just touching the deck. The collective was then lowered rapidly and the aircraft yawed 5˚ the right. As the collective was lowered the rotor speed increased to its last recorded value of 103%.

Although the recorded weight-on-wheels signal did not register the final settling on the gear by changing state, the one second sampling period of this data means that the landing gear switch may have been made at any point on from the start of the last second of the recording. The time taken from the known airborne state (radio altitude 6.7 feet) to the when weight-on-wheels was likely to have occurred, makes it apparent that the rapid descent was arrested at around the point that the helicopter came into contact with the deck. The absence of any 'holding up' of the power supply within the CVFDR meant that the recording of data and voice terminated immediately upon the operation of the tail boom mounted inertia switch.

The helicopter also carried a Health and Usage Monitoring System (HUMS) which recorded engine and power train exceedance information. The HUMS information was analysed and no exceedance information for the accident flight was recorded.

Examination of aircraft

The S61N has a tail rotor driveshaft split into four sections between the main rotor gearbox and the intermediate gearbox at the base of the pylon. A fifth section is located on the pylon between the intermediate gearbox and the tail rotor gearbox. Examination of the helicopter showed that the number four section shaft had been severed immediately ahead of the intermediate gearbox due to main rotor blade contact. Fragments of the glass fibre transmission tunnel in the area of the strike were recovered from the landing platform.

The driveshaft damage had been caused by successive contacts from the main rotor blades. The damage to the blades was relatively minor, and took the form of creases at the tips. The driveshaft had broken as a result of the downward deflection caused by the blade contact. The deflection in the shaft, which continued to be driven by the main rotor gearbox, resulted in a whirling action in the upstream section. This had caused the progressive failure of three out of the four bearing hangers that supported this section. The shaft had been retained on the helicopter only by the front bearing, close to the union with the number three section shaft. There was evidence of distress both on this bearing hanger, and on the rearmost one of the number three shaft.

The severed ends of the driveshaft had penetrated the airframe structure immediately beneath. It was also evident that the whirling action of the driveshaft had caused the dislodged bearing hangers to penetrate the transmission fairing from within.

The helicopter, built in 1962, had a current Certificate of Airworthiness and had flown 25,926 hours and completed 70,497 cycles.

Performance

The company operations manual includes a section covering the maximum landing weights to be used for landing on offshore platforms. It states that platforms which are certificated for S61N operations are classified as 'Unrestricted' or 'Restricted'.

On 'Unrestricted ' offshore platforms the maximum weight for landing is 20,500 lb (adjusted for the effects of temperature, pressure and wind) and is applicable only to those landings which are significantly free from the effects of turbulence and/or down draughts; contamination of the landing space by gases from flares or turbine exhausts; pitching, rolling or heaving helidecks; obstructions in the vicinity of the approach or overshoot paths; or insufficient manoeuvring space on or close to the helideck.

Platforms significantly affected by the items mentioned above are categorised as 'Restricted' and as such the maximum weight for landing is then calculated from a graph which caters for the effects of; ambient temperature; pressure altitude; windspeed and whether engine anti-icing is selected on or off.

The company operating the platform had supplied plan drawings of the proposed installation complex, prior to commissioning, to the British Helicopter Advisory Board (BHAB) Helideck Group. This group works on the basis of applying past experience to anticipate problems or to resolve experienced problems. As there was no past history or operational experience to suggest, from the drawing, that a problem might exist the CAP helideck was categorised as 'Unrestricted'.

The estimated AUW of the helicopter at landing was 19,200 lb. The maximum weight authorised for landing on this 'Unrestricted' deck was 19,800 lb. If the helideck had been 'Restricted' the maximum weight authorised would have been reduced, in the prevailing conditions, to 18,900 lb.

Offshore helicopter landing areas

The CAA publish Civil Aviation Publication (CAP) 437 (Dec 1993), a guide to criteria, recommended minimum standards and best practice for offshore helicopter landing areas. Relevant portions of Chapter 3 paragraph 3 are reproduced below:

'3. AIR TURBULENCE AND TEMPERATURE GRADIENT

3.1 Turbulent airflows across the landing area can be caused by wind flow around adjacent structures and by prime mover exhausts (in particular gas turbines), which can also cause temperature gradients. These effects can seriously influence helicopter handling or performance characteristics.

3.2 Landing areas situated directly on top of deep slab-sided structures such as accommodation modules, have been known to suffer from excess vertical airflow components unless there is sufficient separation to allow airflow beneath the helideck.

3.3 For this reason the combined effects of airflow direction and turbulence, prevailing wind and installation prime mover exhaust emissions, should be determined for each installation.....Suitable wind tunnel model tests should be carried out to confirm the suitability of the arrangements. The resulting information should be made available to the helicopter operator and the Civil Aviation Authority......

3.4 Ideally, where gas turbines are installed and the exhaust gases may affect helicopter operations, some form of exhaust plume indication should be provided for use during helicopter operations, for example, by the production of coloured smoke. Unless it is obvious that the air temperature in the vicinity of the flight paths to and from the helideck will not be affected by the exhaust plume, a survey of ambient temperatures should be conducted during periods when the wind is blowing directly past the turbine exhaust duct towards the landing area. Where ambient temperature, in the vicinity of the flight paths and over the landing area, is increased by more than 2°C the helicopter operator and the Civil Aviation Authority should be informed. If required further advice on these aspects may be obtained from the Civil Aviation Authority (Aerodrome Standards Department)'

The Health and Safety Executive (HSE) reiterate these procedures in their Fourth Edition Guidance Notes (55.3) publication entitled: 'Offshore Installations: Guidance on design, construction and certification'.

The United Kingdom Offshore Operators Association (UKOOA) publication entitled 'Industry Guidelines on the Management of Offshore Helideck Operations' also discusses the problems associated with conditions surrounding adjacent platform/mobile unit operations. Paragraph 2.9.5 of that document is reproduced below:

> Where a platform is operating with a mobile facility (ie accommodation unit) alongside and both helidecks are to remain in use, it is essential to evaluate the effects of the adjacent structures on helicopter operations. This applies equally to long term and temporary operations.
>
> Application must be made to the CAA as described in 2.9.4 and preferably a composite set of drawings (general arrangements) should be produced showing the platform/vessel relationships in the 'bridged' condition and when the mobile facility is 'standing off'. Checks must be made to establish that the 210° arcs of both helidecks continue to meet CAP 437.

If they do not, an operating restriction must be established. The effect of mobile facilities on 5:1 falling gradient should be considered.

Additionally, it is essential when establishing the location of the mobile facility, to optimise the orientation of the helideck(s) to achieve maximum advantage from prevailing wind conditions and to minimise the turbulent airflows from one structure impinging on the other. Furthermore the impact of flare booms in terms of discharge/heat/light and water spray and any other liquid discharges blown down wind must be considered.

Regulatory Responsibilities

The (HSE) have a statutory responsibility for the health and safety of offshore helideck operations. As a result of a recommendation made in the AAIB report into the Brent Spar helicopter accident (AAIB Report No 2/91) that occurred in July 1990, the HSE contracted with the CAA to undertake a survey of all installation helidecks. The HSE never intended that this programme of surveys would become the normal route for HSE to ensure compliance with legal requirements. Working closely with the CAA during the period of the contract provided HSE Inspectors with a better understanding of good helideck practice, which has been fed into future installation inspections. The survey also proved to be a catalyst in encouraging the offshore industry to consider and improve as necessary its day to day management arrangements for helideck operations. The publication of 'Industry Guidelines on the Management of Offshore Helideck Operations' was a result. Although the CAA contract finished in March 1995 the HSE continue to call upon the CAA's aviation expertise when necessary and has contracted with the CAA to provide such advise on a call out basis.

Inspection work associated with helidecks forms part of the HSE's planned inspection programme for each offshore installation. Inspections normally consider all aspects of helideck safety, including fire-fighting equipment and arrangements, the competence of the helideck crew and the physical characteristics (taking account of the CAA guidance material) as necessary. Visits to installations specifically to inspect helidecks are not normally carried out but helideck issues are identified during planned installation inspections and areas needing attention are subject to revisits involving the CAA if necessary.

With regard to considerations given to helideck operations from the effects of installations being stationed adjacent to each other the HSE expect the installation operator to inform the Certifying Authority (responsible for the installation's Certificate of Fitness) of any change in circumstances which could affect the validity of the Certificate of Fitness (ie this would include situations where a platform is operating with an accommodation platform alongside). It is essential in these cases to evaluate the effects of the adjacent structures on helicopter operations. The HSE states that it is normal, therefore for the installation operator to inform the CAA at the same time as the Certifying Authority. The procedure is set out in Section 55 of HSE's Fourth Edition Guidance Notes (55.3), and is also referred to in the Industry Guidelines on the Management of Offshore Helideck Operations at paragraph 2.9.4 and 2.9.5. In April 1995 the CAA informed the offshore industry that it would no longer be issuing separate approvals for combinations of installations, and that it was satisfied that the British Helicopter Advisory Board (BHAB) Helideck sub-committee was adequately managing the compensating measures required when planning flights to combinations of installations.

Helideck Surveys conducted by the Civil Aviation Authority

Routine helideck surveys carried out by the CAA ceased in March 1995. The CAA did however survey the helideck of the CAP at the request of the platform manufacturing company. At the time of the inspection the platform was on a barge awaiting shipping from its manufacturing site at Lowestoft and the final location of the platform was not known. The findings of the survey were discussed only with the engineering company at the time of the visit.

Follow-up action

1. As a result of this accident the BHAB revised the entry regarding the CAP, in the Installation/Vessel Limitation List (IVLL), stating that, when the wind direction is from 110° to 145° and the wind speed is less than 15 kt, operators of the S61N helicopter should use the 'Restricted' graph for performance calculations.

2. In addition the HSE will be issuing a Safety Notice to installation operators drawing their attention to this incident and emphasise the importance of the Section 55 Guidance and the need to inform the CAA/BHAB of any changes that could affect on helideck operations. The HSE also sees merit in including extra information on turbine exhaust locations and installation combinations on Approach Chart available to crews. Furthermore the HSE also understands that flare stack emissions and exhaust flow effects have been discussed by the Helicopter Research Management Committee (which consists of representatives from the CAA, HSE and the oil companies, with the CAA taking the lead) and would support further research into gas plume behaviour together with assessment of helicopter susceptibility to effects by type.

Summary and recommendations

During the approach to land on the Claymore Accommodation Platform the performance of the helicopter was most likely affected by a combination of flare stack and turbine exhaust emissions to the extent that insufficient power was available to the crew to prevent a higher than normal descent rate prior to touchdown. The BHAB have already recognised the results these effects and have amended the performance criteria related to the Claymore platform combination by re-categorising the CAP helideck as 'Restricted' for S61N operations during certain wind conditions. This change is based on the accident event and not on any factual analysis or research carried out. Wind tunnel tests which have been carried out to assess the effects of strong wind flows and exhaust emissions on platform helidecks have been carried out on platforms in isolation and not on combined installations.

It is therefore recommended that:

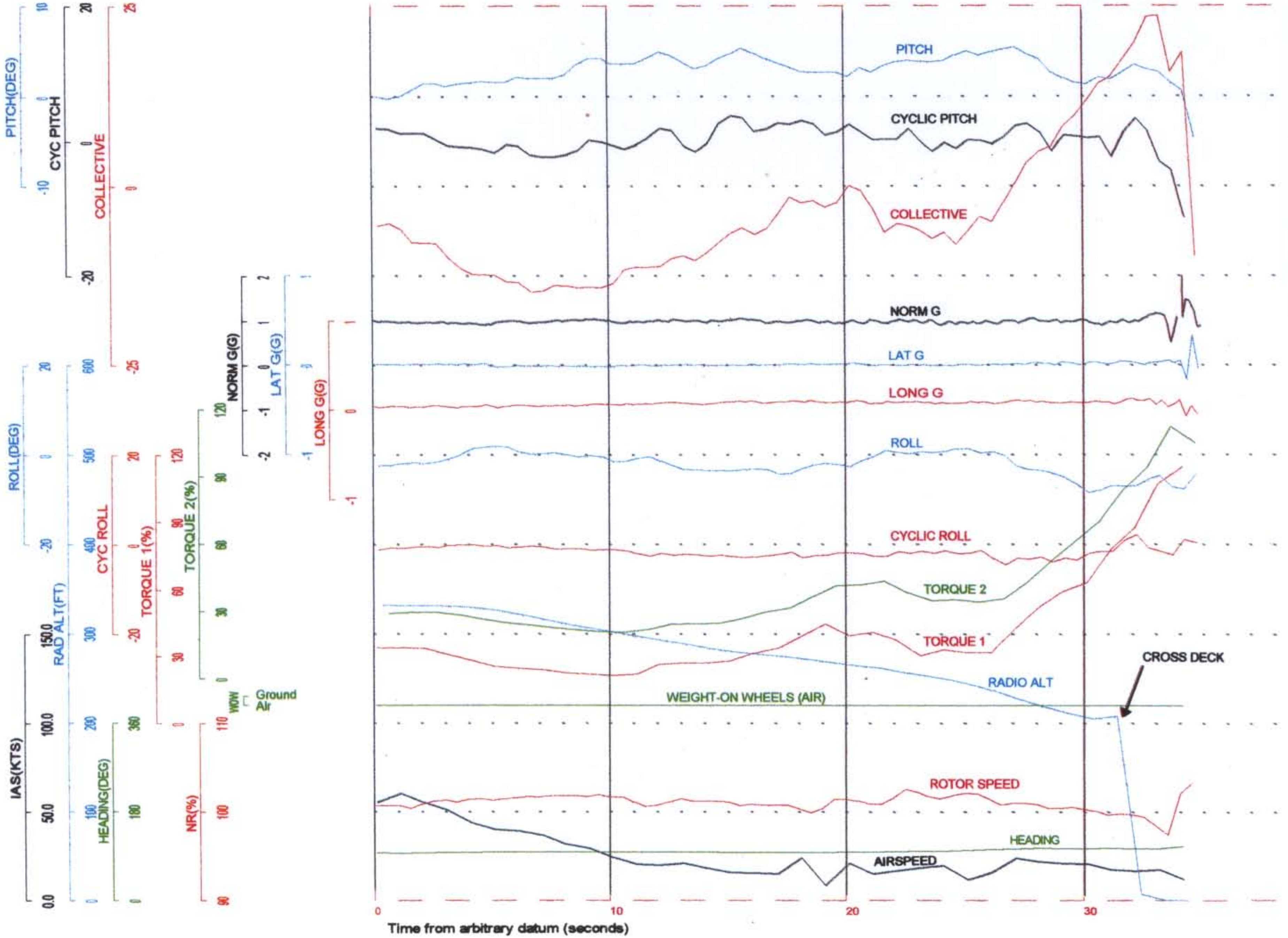
The CAA jointly with the Health and Safety Executive (Offshore Safety Division) and representatives of the oil industry, should together consider the need to commission research, into the effects that wind flow, turbine exhaust and flare exhaust emissions have on the helidecks of installations that are positioned adjacent and in close proximity to one another. This research should concentrate initially on the CAP/CPP installation and should be applied to other combined installations already commissioned or about to enter service. [Recommendation 96-1].

The crew were advised about and, in the later stages of their approach, able to see and smell the emissions from the flare. They could not see the exhaust from the turbines. The commander was familiar with the helideck, having visited it some days earlier but an approach chart was not available to the crew. Even if one had been produced it would not have highlighted the location of the turbine exhaust outlet and it would not have shown the platform combination as a complete entity on one chart.

The BHAB, acting on behalf of the Helicopter Operators, should examine, in co-operation with Aerad (the chart production company), the possibility of publishing approach charts that provide information to crews on the location of turbine exhausts and flare stack emissions in order that commanders are made fully aware of all potential hazards that might affect the performance of their aircraft during approaches, landings and go-arounds to helidecks.

Consideration should also be given, where platforms are located in close proximity to one another, to depicting on one chart the combined installations so that the effects that one platform may have on the adjacent helideck can be more readily assessed by crews. [Recommendation 96-2].

FIGURE 1. Selected Aircraft Parameters: Last 30 seconds of flight



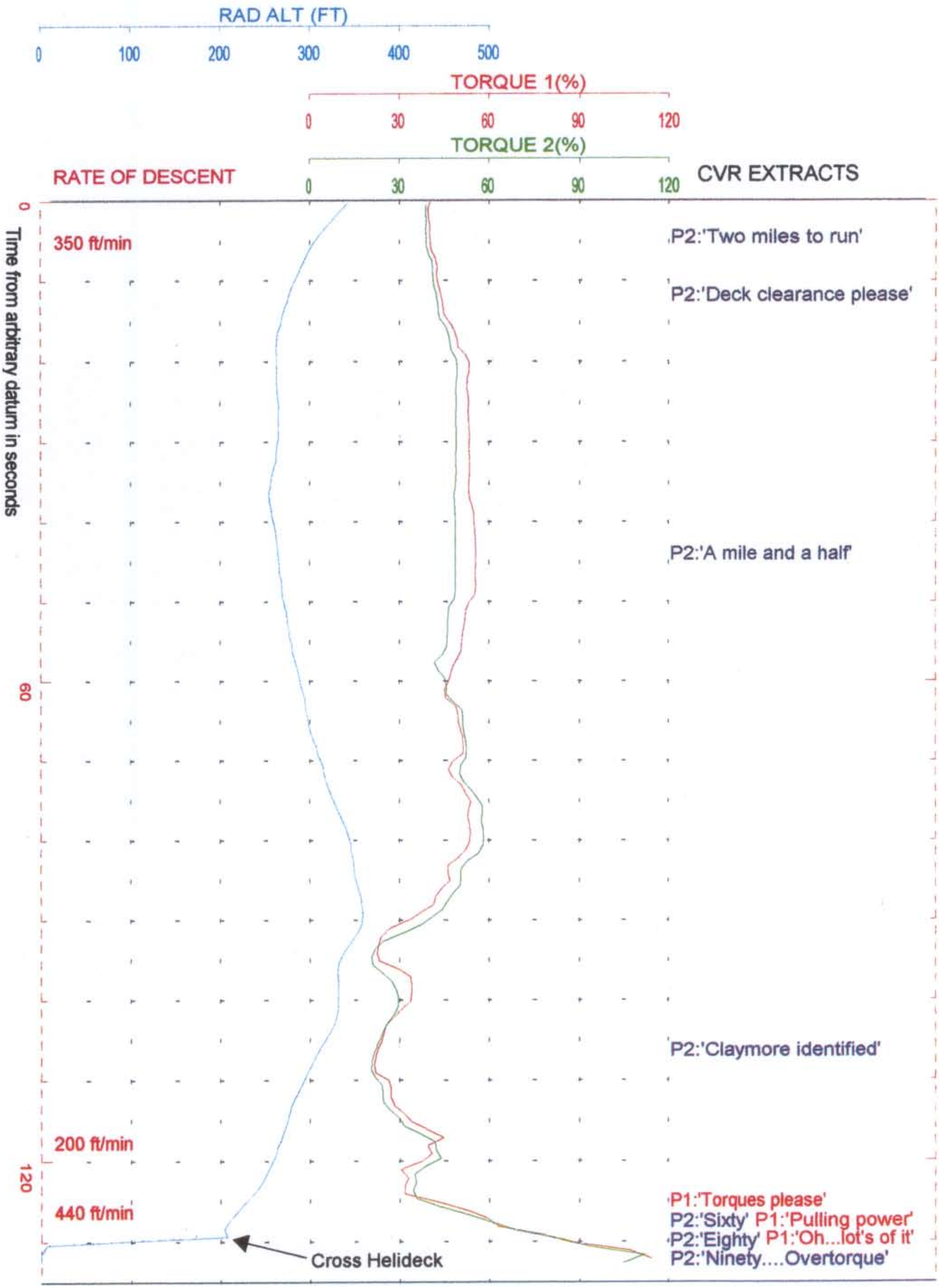
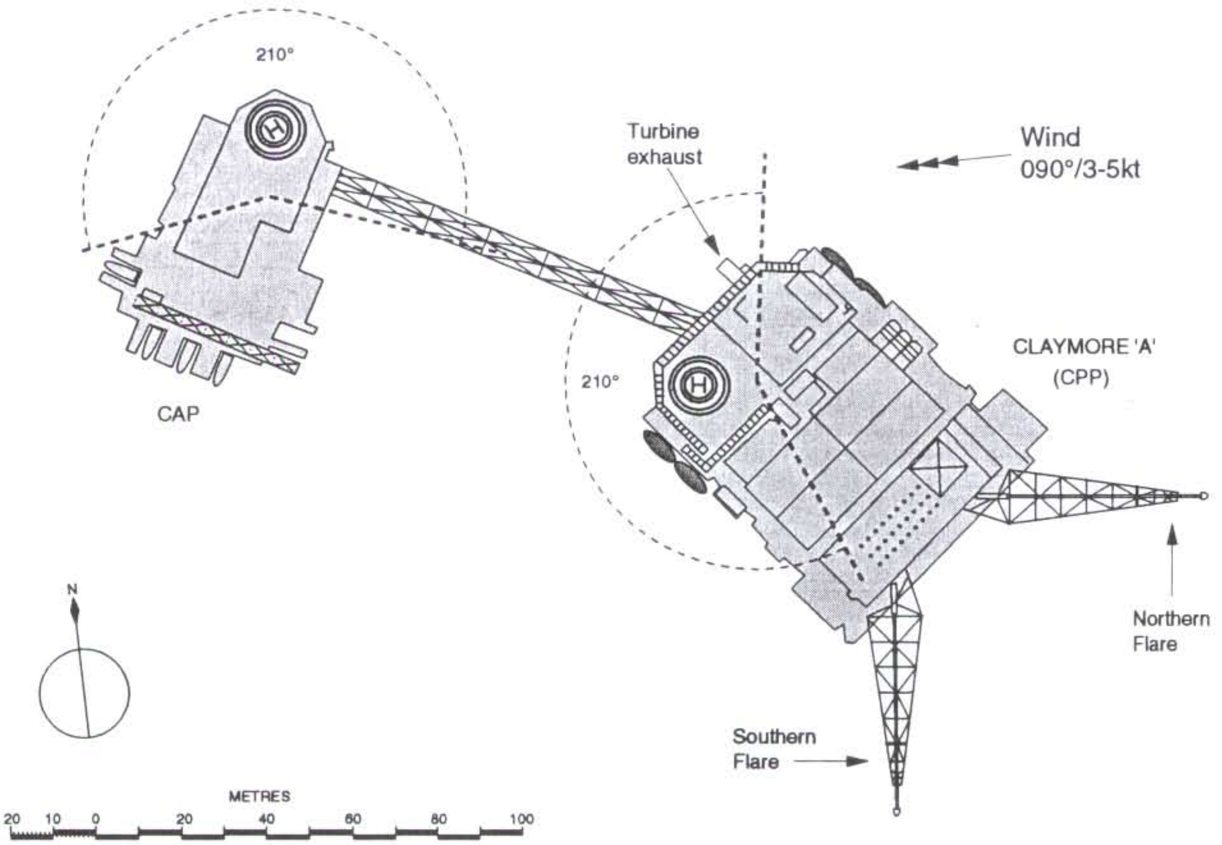
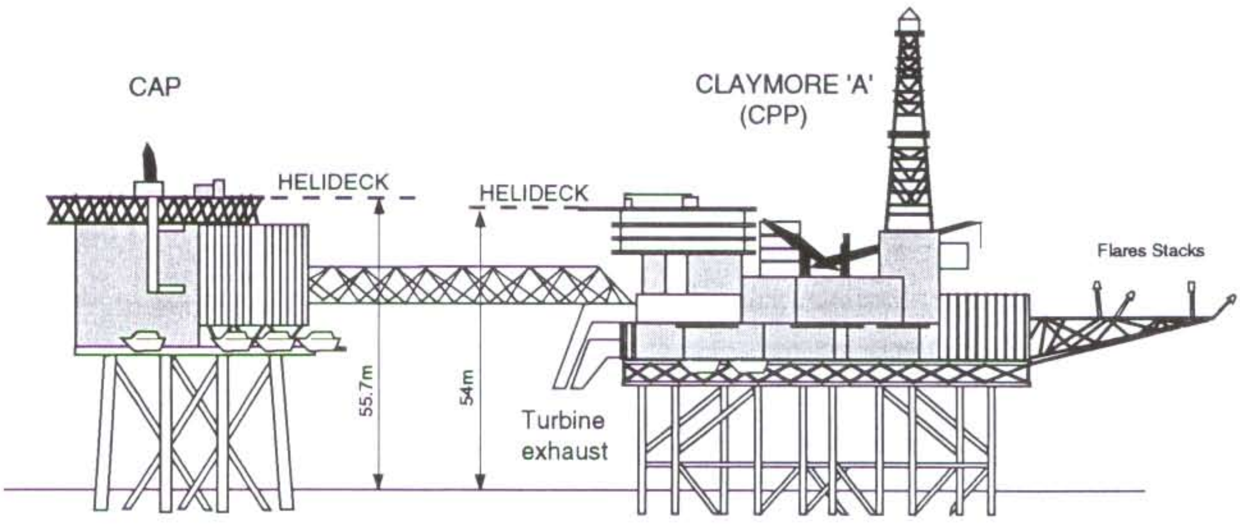


FIGURE 2. Rate of Descent and CVR annotation

CLAYMORE ACCOMMODATION AND PRODUCTION PLATFORMS



PLAN VIEW



PROFILE VIEW

Figure 3