CHAPTER 15

SERVICES FOR THE OFFSHORE INDUSTRY

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15.1 Introduction

15.1.1 This market sector is concerned with all non-aviation services in support of the offshore industry. It includes survey and exploration, design and construction of offshore installations, towing of rigs and platform components, aqualung and pressure-vessel diving, pipe laying and all aspects of oil and gas production including the operations of supply vessels and tanker terminals. The primary area of interest is in the European continental shelf, particularly the UK sector, but the existence of global atmospheric and wave models provides the opportunity to supply both forecast and climatological information for operations worldwide.

15.1.2 This market sector is highly competitive, particularly when there is a decline in the market value of oil. While the major exploration/production companies still provide an important element, they are now looking to contractors to allow for the weather risk themselves, and these have thus become an area of expansion for meteorological services. The continental shelf area can be very hostile. Many activities are highly weather-sensitive and the provision of meteorological information can make a substantial contribution both to safety and to the reduction of costs (which can be enormous). When planning and carrying out operations many customers require a package of services which encompass both historical and forecasting elements. Historical data are required for design and strategic planning while forecasts are required for day-to-day operations. Many activities become difficult or impossible, and even dangerous, if particular thresholds of wind and sea are exceeded. In some cases very short-range forecasts are useful but the main interest lies in the period 12 hours to several days ahead because of the time taken to complete action stemming from operational decisions. The employment of extremely expensive facilities means that there is great economic pressure to minimize downtime, and it may be of crucial importance to predict up to a week ahead a suitable weather window for a particular operation.

15.1.3 Both instruments and communication systems are needed to provide or supplement those observations from offshore locations which are essential as a basis for climatological and forecasting services. Numerical atmospheric and wave-model output plays a central role in support of forecasting in the field and offshore and is becoming a major aid to downtime analysis. Marine expertise is invaluable. Moreover, as well as providing services, the Office gives advice on offshore meteorology to Government Departments, many public bodies and to the industry itself, both informally and by membership of committees whose activities involve many Branches of the Office.

15.1.4 The forecasting organization and procedures for helicopter operations are covered in the *Handbook of Aviation Meteorological Procedures* (Part 1).

15.2 Organization of the offshore oil industry

15.2.1 By international agreement the north-west European continental shelf area has been divided amongst appropriate nations, each nation having 'control' of its adjacent offshore sector. Each sector is divided into a number of blocks usually one degree of longitude by one degree of latitude. In turn each degree square is sub-divided into a number of operating blocks depending on the national practice.

15.2.2 From time to time each nation will hold a 'licensing round' whereby the petroleum producing companies may bid for permission to explore, evaluate and possibly exploit specific blocks. These grants are awarded usually to consortia with one company nominated as the operator, and others, in the same consortium providing a share of capital and eventually sharing in any profits from the development of reserves located.

15.2.3 Once a licence has been granted to operate in a given location, the first task is to survey the sub-sea strata by the use of seismic and geomagnetic survey vessels. If a petroleum bearing stratum is located the next stage is to evaluate its potential by the use of exploratory and appraisal drilling rigs. If this pre-survey indicates that the 'find' is commercially viable, or is likely to become so with anticipated fluctuations in the world oil price, it will be given a field name and the extraction processes and methods will be planned.

15.2.4 Until the mid-1980s most extraction involved the use of fixed platforms, some unmanned. A fixed platform involves the installation of a stable base structure on the sea bed — the 'jacket'. This structure is required in order to support all the necessary extraction plant and often a considerable amount of processing plant — virtually an oil refinery — at a remote offshore location. A complex system of valves and shut-off equipment has to be installed on the

sea bed in order to connect the drill stem to the petroleum bearing strata and the production facilities built on the jacket. In addition, pipelines have to be laid to deliver the product to a storage centre. At each of the stages in this exercise, which may last for ten or more years from initial discovery to production, meteorological factors play a vital part in the planning of activities.

15.2.5 Seismic and geomagnetic exploration vessels Normally these vessels will be conventional ships moving at a cruising speed of 5 to 10 knots. They will be sensitive to wind and sea conditions when wind speeds are in excess of gale force. Under certain conditions the sea-surface profile can cause interference with the recording of observations but, in practice, operators of survey vessels rarely take any service beyond the BBC shipping forecasts.

15.2.6 Drilling, appraisal and exploratory rigs There are very few conventional drill-ships active in the area. In the southern North Sea most drilling is carried out by 'jack-up' rigs. These consist of a floating drill platform which has either 3, 4 or 6 extendable legs which can be 'jacked down' to the sea bed. By continuing this process the platform is forced to climb up the legs and eventually become supported above the sea surface before commencing operations. At the end of the drilling programme the process is reversed and the rig may be towed to another site.

15.2.7 In deep water semi-submersible rigs are used. These consist of a drilling platform which is supported on an arrangement of pontoons at some depth below the sea surface. These vessels often are self-propelled and can ballast up or down. Normally in transit, the pontoons will be above the sea surface but while drilling the vessel will ballast down to achieve a higher state of stability. They are held in position normally by a network of anchors, typically ten or more, which are deployed by specialized anchor-handling ships.

15.3 Importance of meteorological factors for operations

15.3.1 Weather sensitivity in drilling operations When any rig is in position and working it can continue to operate in wind and sea conditions equivalent to gale force 8, or even higher; the only activity which may be limited will be the loading/unloading of supply vessels. It is chiefly in the setting up or demobilization phases that weather becomes a major consideration.

15.3.1.1 Jack-up rigs For those platforms the most sensitive period is during jacking-up or -down. As the legs initially touch the sea bed, or are about to be detached from them, and the drilling platform is on the verge of floating, any vertical heave, pitch or roll can cause severe damage to the jacking mechanism or legs or indeed to the platform as a whole. Normally this operation is possible only when wave heights are less than about one to one and a half metres. During transit when the rig is being towed by the tug(s), the windage on the raised legs can be a matter for concern. The legs are usually of a lattice structure for strength, but nevertheless in winds of gale force or more the effect on the rig may be such that the tow has to seek shelter.

15.3.1.2 Semi-submersible rigs The wave-height period is one of the major factors in the prediction of the motion of any floating vessel. During transit, gale force 8 or more is normally acceptable in open waters until anchor deployment begins. Anchors are massive (up to 40 tons weight) and have to be transferred from the rig to the anchor handling vessel along with their pennant buoys. The anchors are launched up to a mile away from the rig in a precise location in order to avoid any sub-sea pipelines or other structures. The handling of anchors becomes difficult in sea conditions with wave heights over 2 metres and virtually impossible when they are over 3 metres. To set an anchor pattern can take 24 hours depending on how many anchor handling vessels are deployed; thus it is usually necessary to provide a forecast for a window of 24 hours of seas with wave heights less than 2 metres before the operation can be started.

15.3.1.3 Once the rig is actually drilling it is obviously connected to the sea bed, or more precisely to the current bottom of the well by the string of drill pipes. A certain amount of vertical motion of the rig can be catered for by a system of 'compensators' but there is a limit to the amount of movement in any plane which can be tolerated. It is important to note that it is not only the surface motion of the sea which affects the structure but also the motion at the depth of the pontoons. By observation it is recognized that it is the longer-period vertical motion which persists to a greater depth than the short-period surface motion and thus the vertical heave of the vessel can be greater than that perceived from the observation of the sea. It is also possible, by resonance, for the rig to heave by perhaps 50 per cent more than the height of the actual wave motion. Each design of rig will have its own natural resonant period and this is recognized normally by the rigmaster.

15.3.2 Construction projects Before any installation is designed, the marine climatology of its intended site will be investigated to ascertain the design limits involved in terms of fifty or one hundred year return periods for winds and waves.

15.3.2.1 Structures are built invariably at one or more construction yards and then floated out to be towed by a team of tugs to the final site. Jackets are built of either steel or concrete and can be either 'piled' or 'gravity'. Steel-piled jackets are of a lattice structure and may weigh tens of thousands of tons. Once on site steel piles are driven through the structure to pin it firmly to the sea bed. Steel or concrete gravity jackets (the latter may weigh hundreds of thousands of tons) are towed to the intended site and ballasted to be held in position by their own weight.

15.3.2.2 Normally the work onshore is a little different from any other onshore construction project, but is invariably on a large scale. It can be extremely hazardous moving the jacket from the construction yard to the site of launch, especially so in the sail-away from the yard. Normally winds in excess of 10–12 knots preclude any movement away from the shore; in addition tidal conditions and currents are factors which have to be taken into consideration. A sail-away requires 1.5 to 2 days of notice and usually there is a go/no go decision at sail-away minus 24 hours. Once under way and in open water most tows can cope with winds of force 6 to 8 but in coastal waters the limits are much lower.

15.3.2.3 On the site the structure has to be launched and positioned on the sea bed with a high degree of accuracy. These massive structures have to be located over previously prepared wells and sub-sea equipment already installed; the tolerances for positioning are measured in centimetres so that weather plays a crucial role in the operation. Normally a jacket cannot be launched and positioned if winds are expected to be in excess of 10 to 12 knots and wave heights above around 1.5 metres.

15.3.2.4 The next stage in the construction programme is to mount the topsides on the jacket. Topsides are designed on a modular system and assembled much like a 'Lego' building. Individual modules can weigh several thousand tons and are equivalent in size to a large several storey office block. Giant floating cranes, usually semi-submersible, are used to lift the modules into place. The limits for crane activity are around 10 to 15 knots of wind and waves no more than 1.5 to 2 metres. An individual module lifting operation can last for up to 12 hours and usually 24 hours notice of favourable conditions is required before the operation can commence.

15.3.3 Pipe laying and the sub-sea operations Most sub-sea surface construction work is carried out by semi-submersible craft although there are still a number of conventional ships and float barges in operation. Generally wind limits for operation are of the order of 20 knots and for waves 2 metres in height but in many circumstances the vessels can cope with conditions experienced in up to gale force 8.

15.3.3.1 An important consideration , particularly in the deployment of divers, is the wave period rather than wave height. There are two types of diving operations; air or surface divers who operate at shallow depths and breathe air and gas, or compression divers, who work at considerable depths and breathe a mixture of helium and oxygen. For the second category the movement of the surface support vessel is the major concern since it concerns directly the safety of the divers. The heave of this vessel will depend largely on the wave height and period. For surface divers the major criterion becomes the actual sea surface motion. A long slow swell of 2 metres does not preclude the working of a near sea surface operation. On the other hand, a short-period 'slap' or 'chop' or short-period wind waves make for extremely hazardous conditions for a diver working alongside, say, a buoy.

15.3.4 It is clear therefore that the offshore industry is engaged in a range of operations which are weather sensitive. These include installations which may cost hundreds of millions of pounds as well as those involving directly the safety of personnel engaged in the industry.

15.4 Observational data

15.4.1 Under Statutory Instrument 1019 (1976), operators of offshore installations are required to make simple weather observations, and in some cases also of waves, in support of local helicopter operations. It should be noted however, that they are not required by law to send these data ashore. By agreement with operators, the Office has installed Automatic Weather Station (AWS) instruments on a number of platforms. Together with CAA support (since the data may be crucial to safe helicopter operations) it tries also to encourage operators not only to make reliable observations regularly and frequently but to send them ashore promptly for national and international distribution.

15.4.2 To monitor and stimulate the observing network offshore, dedicated "offshore advisors" ((OP) staff) based at Aberdeen and Bracknell visit rigs and platforms to give free advice on the siting, calibration and operation of meteorological sensors and weather observing practices. Whenever possible, on-the-spot training is given to observers on offshore installations. With the cooperation of the Meteorological Office College, training courses are arranged onshore to meet demand from the operators.

15.4.3 Some offshore observations are passed ashore in international code forms; other data come in a simple code devised by LWC. Most offshore observations are sent to AWC where they are subjected to quality control and, when necessary, pressure and wind reports are corrected for non-standard exposures. Quality controlled data are then passed to (TC) in recognized code forms for national and international distribution and for archiving in the Main Marine Data Bank by (OP).

15.5 Offshore Market Sector

15.5.1 The Offshore Commercial Manager at Aberdeen Weather Centre is also the Office's Business Unit Manager of the Marine Weather Group, with responsibilities for the management of all commercial services in that sector (advisory or forecast), no matter whence they are provided. He or she is responsible to (CS) for pricing policy, and no agreements should be entered into without consultation with BUM (Marine Weather Group).

15.6 Climatological services

15.6.1 Climatological information is essential for the design of offshore installations. When calculating design stress, the engineer is guided by the meteorologist and the oceanographer who deduce from the available climatological data what adverse conditions of weather and sea are likely to be met or exceeded over a given period. These include for example, the extreme winds and waves likely to be experienced by a structure over its planned lifetime, or the frequency of environmental conditions outside defined limits for an item of equipment. Similarly for the strategic planning of operations an enquiry might relate to the probable amount of downtime due to severe weather. All requests received at outstations for marine climatological information should be referred to CS, Marine Advisory Service (MACS), who provide a consultancy service for all seas of the world.

15.6.2 Manager, Marine and Legal Services (CS) oversees the work of the MACS and gives professional advice as needed. Such problems as extreme value analysis, vertical profiles of wind over the sea, variability of air and sea temperatures and the possibilities of ice accretion can be addressed. He is also responsible for liaison with the Health and Safety Executive (HSE) and UKOOA Metocean Committee on matters concerning offshore data and analysis.

15.6.3 Whereas the Main Marine Data Bank includes observations made from ships for more than 100 years and covers all seas of the world, only a proportion of these data include reliable observations of wave heights and periods. The visual wave observations from ships filed in the data bank provide a far larger and more representative block of wave information world-wide than the measured wave data archived by the Institute of Oceanographic Sciences (IOS).

15.6.4 As waves are caused mostly by wind, it is possible to use wind data to estimate wave heights and periods. This can be done by making use of a variety of statistical methods developed by IOS and others, but operational numerical wave models have generated an archive of "hindcast" winds and sea states which can be accessed to produce analyses on a grid-point basis. The resolutions of these models is about 25 km in west European waters and 50 km globally.

15.7 Forecasting services

15.7.1 As indicated in paragraph 15.1.2, forecasting has a most important role in support of the offshore industry, and it is essential that adequate advance warning is given to allow time for operational decisions to be implemented. Forecasting for the industry is a highly specialized task and those involved must be fully aware of the operational implications of their predictions which vary from one activity to another.

15.7.2 For this reason, expertise in offshore forecasting is concentrated in specialist centres. Services are provided or coordinated by AWC where dedicated rosters of staff provide full 24-hour cover for routine forecast issues, warnings and consultancy. Most of these issues are made directly from AWC by telex, document facsimile or radio-telephone (R/T). AWC also provides daily briefings at the offices of the major oil companies located in that city. Specialist services for the tanker terminals at Sullom Voe (Shetland) and Flotta (Orkney) are provided by staff at Sella Ness and Kirkwall respectively. Certain services for the southern North Sea are also provided by Norwich WC. These offices all come under the technical supervision of AWC for offshore services. Any requests for offshore forecasting services received at outstations should be referred to the Offshore Commercial Manager at AWC.

15.7.3 The numerical wind- and wave-model predictions provide an essential framework for the preparation of all detailed forecasts for the offshore industry. Graphical output from the fine-mesh version of these models is available as a customer product in its own right providing a pictorial representation of wind, sea and swell up to 36 hours ahead. These data are received directly at Aberdeen Weather Centre where software enables forecasters to derive site-specific tabular and graphical forecasts ahead to 5 days. These forecasts are tailored to the specific customer site and

operational threshold. This output can be presented in fax, telex or directly onto MIST. Generic MIST offshore software allows interactive displays of wave and winds, as well as weather charts to be sent or dialled in for by users. Detailed forecasts for 5 days ahead are issued twice daily, and for special projects, trends up to 8 days ahead can be provided. Precise arrangements are dealt with according to customer requirements. Forecast data include charts of winds at 10 and 50 metres above sea level, significant wave heights and periods, maximum wave heights, swell height, period and direction, weather, cloud and visibility. Gale warning services can be provided if needed, though in common with all site-specific forecast and warning services, warnings for the offshore industry are not constrained by the coastal sea area gale warnings issued by CFO (see chapter 18), which are not mandatory in this context. The AWC offshore bench forecasters maintain contact as necessary with the marine bench forecasters in CFO.

15.7.4 Another important service for the offshore industry is the provision of a forecaster to give on-the-spot advice at an operations centre or offshore. Such a service can be especially valuable during critical weather-sensitive operations such as the towing of large modules and subsequent assembly of new structures. By interpreting forecasts directly in terms of current activities, and advising the Offshore Installations Manager (OIM) and Section Engineer Managers face to face, a forecaster can pin-point significant weather changes far more precisely than can be done remotely from an office onshore. This not only reduces the risk factor but also enables the use of weather windows to be optimized. Effective communications, both for the receipt of observations and the transmission of forecast model guidance are essential to the operation, and special arrangements are made to provide this through HQ. For offshore detachments suitable training in offshore survival is mandatory. This is arranged as necessary using monies available from a vote maintained by (F&S) (for which advance estimates are essential), coordinated through (CS).

15.7.5 Forecasts for tows and rigs and structure models over the continental shelf are provided on request by AWC who, in addition to having numerical and other guidance from CFO, can draw on the marine expertise of (METROUTE). The service for tows which go beyond the continental shelf should be provided (normally) directly by (METROUTE).

15.7.6 Forecasts and warnings for construction yards ashore should normally be provided by the WC in whose area of responsibility the yard lies (see Annex C to chapter 1) but AWC should be informed of any new services. When a structure is launched any continuing commitment which involves sea-state forecasting should be passed to Aberdeen who will always give advice on offshore matters at any time

15.7.7 Forecasts for the offshore industry can be provided for locations anywhere in the world. The Met. Office has an office in Singapore which provides specialist services to the offshore industry in SE Asia. Other international requirements are handled by the International Forecast Unit (IFU) at Bracknell. Any commercial enquiries for international forecasts should be referred to the BUM (Marine Weather Group) at Aberdeen Weather Centre.

15.8 Numerical modelling of the sea surface

15.8.1 FR-Division is responsible for the development and operation of sea surface models. The current global version provides coverage on a grid of 1.5° latitude and 1.875° longitude. A fine-mesh version provides a regional coverage of European waters, including the Mediterranean, Baltic and Black Seas on a grid of 0.25° latitude by 0.4° longitude (approximately 30 km). The global wave model is integrated to 5 days twice per day and the regional fine-mesh wave model output to 36 hours twice per day. Hindcasts are generated on a 6-hour cycle. The models generate two-dimensional wave energy spectra at each grid point which are compressed for output by integrating over direction to produce significant wave height, period and direction broken into wind sea and swell components.

15.9 Liaison with external bodies

15.9.1 Government regulation of, and liaison with, the offshore industry is provided through the DEn. Normal contact with the Department is through the Marine Technology Support Unit (MATSU) at Harwell through Products Manager (CS).

15.9.2 Liaison with the IOS at Wormley is normally through Manager, Marine Products Branch (CS) though other Branches also have some contact. The head of the wave-modelling group in (CF) has involvement with a number of international wave-modelling and hindcast studies, including the North European Storm Study (NESS) where the Office has an overall coordinating role. This project is sponsored by oil companies and European government organizations.

15.9.3 The interests of oil companies working in British waters are co-ordinated by the United Kingdom Offshore Operators Association (UKOOA). Meteorological and oceanographic matters are the concern of the Metocean

committee of UKOOA, P Met O AWC and Marine Products Manager being the Office representatives. Members of other branches may also attend by invitation to discuss specialist topics.

15.9.4 International coordination of industry interests is achieved by means of the Exploration and Production (E and P) Forum. By invitation, a senior staff member is a Permanent Associated Member, and attends meetings of appropriate sub-committees to advise on meteorological matters.

15.9.5 Aberdeen WC staff regularly lecture to courses run by the Scottish Offshore Training Association (SCOTA). The aim is to provide several lectures a year. Their main aim is to inform oil company staff about the benefits, and limitations, of weather forecasts as an aid to operational decision making. They also provide useful feedback. The Officer-in-Charge Aberdeen WC and the Offshore Commercial Manager maintain continuous liaison with oil company managers.