

OFFSHORE INDUSTRY REQUIREMENTS AND RECENT METOCEAN TECHNOLOGY DEVELOPMENTS

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1. INTRODUCTION

This paper reviews the offshore industry's requirements for metocean data, and describes some recent applications. It also identifies the technology issues which we face in a fluctuating, unpredictable oil price market, and how the industry is addressing them.

2. METOCEAN REQUIREMENTS IN A WORLD OF FLUCTUATING OIL PRICES

Over the last few years, the offshore oil industry has experienced company mergers, together with considerable cutbacks in both budgets and staff as a result of oil prices, which averaged at around US\$ 13/bbl in 1998. Since then, the spot price of crude oil rose briefly to over US\$ 35 and has since fallen back to the mid-US\$ 20/bbl at the time of reviewing this paper. The future price remains uncertain and unpredictable, and in the context of such fluctuations, oil companies have been cautious in firming up budget and resource plans for new projects. Three years after the reality of US\$ 10/bbl oil, the spectre remains. As a result, there is considerable pressure to control operating costs and many companies still suffer from a loss of experienced staff from their global skill pool following downsizing.

Despite the continuing pressure on costs, optimism is slowly reappearing and staff are being sought to resource projects in exciting deepwater areas, particularly offshore West Africa, in the Gulf of Mexico and in areas such as the Caspian Sea. Fortunately, a good description of the metocean environment is required very early in the lifetime of a project, and a pick-up in the industry is quickly reflected in an increase in demand for metocean information. In two fairly recent cases, we have made use of deep water current data collected in the very early stages of exploration, to aid decision making: in one case, the selection of the rig, and in the other, the use of riser-fairings. In both cases, decisions needed to be made on whether or not to spend many millions of dollars while the costs involved in collecting the appropriate data were several orders of magnitude lower.

The value of metocean data can be increased through multiple applications - often there is more than one engineering application (e.g. engineering design, operations planning, iceberg management, etc.) for one data set. Similarly, there is frequently more than one set of data needed to achieve significant cost benefits. For example, it is necessary to have a combination of metocean data, the appropriate database facilities and the analysis tools, say for deriving response-based design criteria, in order to produce figures that engineers can use.

As well as an understanding of the effects of the environment on the structure, it is important to be aware of, and able to quantify through measurements, any likely impact of the structure (or operation) on the environment itself. A benchmark survey of the environment is needed before a drilling-rig arrives in a new area in order to measure the undisturbed condition. For this, a preliminary knowledge of the metocean conditions will lead to a better designed, more cost-effective and thorough Environmental Impact Assessment (EIA) of the area.

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3. COST SAVINGS

Some examples of the benefits of the expeditious use of metocean data are listed in Table 1. Of course, not every field development will benefit to the same extent, but, nevertheless, these examples show at least the potential for making better use of the information.

4. METOCEAN TECHNICAL REQUIREMENTS

It is not necessary in every case to collect field data at a new site of interest. The meteorological and oceanographic variables are in many cases spatially homogeneous over quite a large area. It is also possible to extend the range of existing measured data sets into new areas through the use of calibrated numerical wind, wave and current models (normally referred to as hindcast studies). This is a very cost-effective way of increasing the value of existing measurements. Even for sites where, for example, two to three years of measured data sets are available, properly verified hindcast models can provide a means of extending the data sets to, say, a 25-year period, thereby significantly improving an estimate of the extreme values.

BALANCING TECHNICAL, SAFETY AND FINANCIAL NEEDS

Despite the optimistic view outlined above, there are many arguments for not investing in a data collection programme; some of the pros and cons are given in Table 2.

<i>Activity</i>	<i>Type of saving</i>
Construction of new offshore structures translates into a 10 per cent	A 5 per cent reduction in design wave height reduction in steel costs. Savings are ~ 10:1.
On existing structures	Reduces the need for repairs or strengthening and increases the opportunity to add topsides weight for satellite developments. Savings vary from about 5:1 to 100:1 in the case that a completely new platform was required.
On new pipelines	Savings can be achieved on: - The design of the pipe and the near shore installation method. - The amount of concrete coating required in the deeper offshore sections as well as on the class of pipelay-barge needed for installation of the pipeline.
Installation of jackets	During installation, real-time directional wave data (including spectra) are used to plan and align the topsides facilities relative to the jacket.
On existing pipelines	Reduces the need for remedial action (e.g. spans).
Selecting Jack-ups, semi-subs or barges	A cheaper option becomes feasible.
In deep water	Correctly assessing the strength of the current and its direction relative to the waves makes it possible to assess the downtime for production facilities. If incorrectly assessed, significant loss of production may result.
On the Continental Shelf Edge, currents play a significantly more important role in defining development concepts	
Jack-up/semi/barge selection	A cheaper option becomes feasible.
All offshore operations	Measured field data are used to update and improve weather forecasts. Many operational decisions are made on the basis of the forecasts.
But	Increases in criteria which cost money in the short term, can save money in the long-run by protecting the investment. Under-design of facilities is not acceptable.

Table 1

Table 2

<i>Some arguments against an investment in collecting metocean data</i>	<i>The main arguments for an investment in collecting metocean data</i>
<p>We need to think several years ahead in order to have a reasonable chance of getting any return on your investment. The need for data may be realized too late to be of value to a project.</p> <p>The project engineer will probably have moved to a new job by the time any savings materialize in the project. There is also a reasonable chance that the project will be cancelled before it is possible to make any use of the data (let alone make any cost-savings).</p> <p>We probably have to spend several hundred thousand dollars to have any chance of making some savings.</p>	<p>If the project goes to maturity, the return on investment is between 10 and 100:1.</p> <p>If we do not have the data, we do not know how to design your facilities to the appropriate functional and safety standards, with the result that we either spend extra money unnecessarily or the design is inadequate.</p>

For obvious safety reasons, the offshore industry will avoid under-designing an offshore installation, hence the price paid for not having the right design data available when it is needed is essentially the cost of over-designing facilities for the future. However, these arguments must be balanced by considering the use of design criteria which are deliberately conservative for today's solution, but which will allow additional facilities to be added to the structure in the future without the need, and associated high costs, for major offshore structural modifications.

To make a proper comparison of cost benefits, we should take into account the discounted savings over the time period before the savings can actually be realized (which may be several years). This means that a strong argument is needed to persuade people to spend money now rather than save the discounted cash at a later date. Appeals to reason, supported by estimates of the costs of collecting the data, the potential savings and the consequences of not having the data available when the engineers need it, are usually the best approach.

SAFETY ISSUES FOR DESIGN CRITERIA

The approach to deriving criteria which might be used for design purposes is to take note of the uncertainty in the criteria which is caused by the lack of data in the early stages of the life cycle of a field development. This is shown schematically in Figure 1. The aim is to ensure that the criteria can be reduced as more data become available; the corollary is to ensure that the criteria are conservative when there is little data on which to base them. With experience, and by comparison with other areas where there are good quality data sets, this can usually be achieved - but it is essential to be aware of the costs associated with using criteria which may be too conservative.

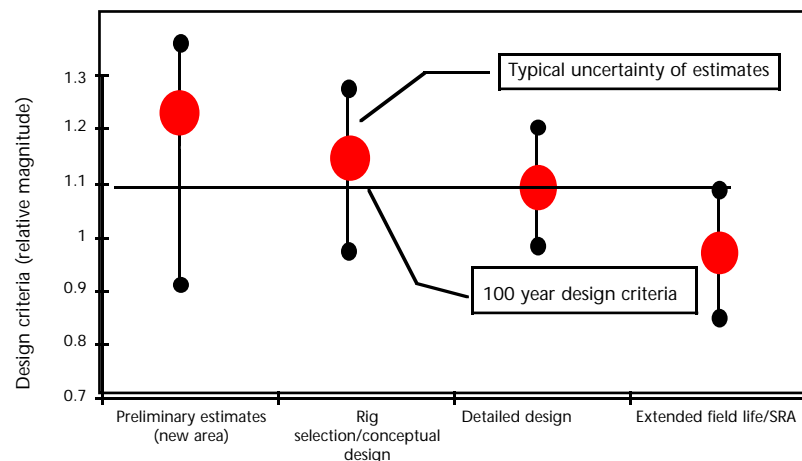


Figure 1—Design criteria according to the length of data sets.

Progress has been made at the front end of the life cycle of a field development; it is now feasible to make use of wave (and to a limited extent wind) data received from remote-sensing satellites which have on-board radar altimeters and scatterometers. The instruments produce their best data sets in remote deep water areas far from the coast and at high latitudes. Unfortunately, there are not yet enough of them to provide coverage that is sufficiently dense to be able to form a satisfactory means of deriving criteria in low latitudes subject to relatively small scale tropical storms. However, it does mean that in areas where they are able to provide good quality data, the conservatism can be confidently removed at a relatively early stage of the field development life cycle.

The uncertainty in the estimate of the 100-year extreme is principally due to the length of the data set. For design purposes (in which the '100-year' return period parameters are required), a hindcast period of 25-30 years is normally considered adequate - beyond this length, the return on the effort invested does not normally warrant the cost involved. However, an increasing number of applications (e.g. for platform reliability studies or minimum deck elevation studies) require estimates of parameters with very low probabilities of occurrence ($\sim 10^{-4}$). In these cases, either the data set needs to be increased substantially, or other more imaginative approaches are needed. However, this does assume that the underlying physical processes are stationary. If it is suspected that climatic cycles are significant and may be influencing the data sets, a much longer data set may be required to identify the period of the cycles and quantify their effect on the extreme values.

ROLE OF REGULATORS

In states where they exist, regulators can play an important role in ensuring that adequate quantities of the right data are collected to ensure that justifiable reliability levels for offshore structures are maintained. If there is a regulation stating that certain data should be collected, this can often ease the process of getting adequate funding at the right time. Most operators are satisfied with a good balance of regulations which enable 'fit-for-purpose' structures to be installed and hence adequate metocean data to be collected.

5. JOINT INDUSTRY PROJECTS

Prior to the recent trend within the industry for company takeovers, significant cost-savings could be made by individual companies if a number of them working in a region or on a particular technology item, decided to work together in joint industry projects (JIPs). In addition to saving costs, the risks (e.g. of losing equipment and data) were also shared. In practice, this meant that additional funds became available to enhance the technical content of the programme and provide resources for improving the safety of the equipment and ensuring good return of the data. Since metocean data is rarely considered to be strategically sensitive or confidential, it has not been difficult to obtain an agreement to join forces in collecting such data. The only real disadvantage is that it takes longer to get the technical scope of work defined and the several contracts agreed and signed.

However, owing to recent company takeovers, the number of companies now available to form JIPs continues to reduce and consequently the cost-saving per participant reduces. For metocean engineers, this has resulted in difficulties in obtaining start-up funds for new JIPs and, inevitably, delays in the projects. Nevertheless, several new regional projects are under consideration and we expect they will be able to start as optimism within the industry continues to improve.

The offshore metocean industry has been successfully instigating joint industry projects for many years, the main vehicle for establishing such collaborative efforts being the International Association of Oil and Gas Producers (OGP). Some examples of recent regional cooperative projects are:

- The Gulf of Mexico Storm Hindcast of Oceanographic Extremes (GUMSHOE).
- The North European Storm Study (NESS/NEXT) - a major hindcast study of north-east European waters of wind, wave and current conditions in storms, as well as over several continuous years.
- The South East Asia Meteorological and Oceanographic Study (SEAMOS) - a wind and wave hindcast study of typhoon and monsoon conditions in the South China Sea.

- The West Africa eXtremes study (WAX) - a wind and wave hindcast study of storms in the South Atlantic which produce primarily swell conditions offshore west Africa. The study has recently been supplemented with the results from a current model study.
- The Caspian Sea Metocean Study (CASMOs) - a proposal to use a hindcast model to derive wind wave and current conditions for the Caspian Sea.

Uncertainty and fluctuations in the oil price may persuade some oil companies to focus on in-house technology developments which have a reasonable chance of delivering results in the short term. There may also be a tendency to farm out non-strategic, longer-term technology into joint industry projects - where this is feasible.

Some of the technology projects in which the industry is involved are:

- SAFETRANS (Definition of criteria for long ocean tows).
- WACSIS (WAVE Crest Sensor Intercomparison Study).
- 'Response'-based design criteria for offshore structures (fixed, floating and pipelines).
- Maximum wind gust speeds in squalls and tropical cyclones.
- 10-4 (developing a better definition of very low probability events).
- ISO (development of international standards for the design of offshore structures (fixed steel, concrete, mobile jack-ups and floating systems)).

There are often synergies between these projects. For example, during work on the ISO code, setting minimum deck elevations was identified as an area of major uncertainty, and it was recognized that resolving the issue required a better understanding of two aspects of the problem. Firstly, we needed to know the distribution of crest heights in storm conditions (and consequently an understanding of which data sets we could consider reliable). Secondly, the new procedure for deck heights requires extrapolation of the distribution of crest heights to very low probabilities (return periods of 10,000 years). Hence, the ISO work led to the WACSIS and 10-4 projects, the combined aims of which are to define a rational procedure, for use anywhere in the world, for defining the minimum air-gaps for fixed structures.

6. DATA MANAGEMENT

6. Enormous quantities of data are produced nowadays (both directly from instruments or from numerical models) and we do not underestimate the task of managing the metocean data once it has been collected. Managing data includes not only storing it, but also being able to access it quickly and efficiently once it has been collected. Effective access to our data is not only a prerequisite of enabling the 'value' to be extracted from the investment, but it is also a necessary form of safeguarding the investment so that further value can be extracted in the future. Although the power of computer hardware is increasing substantially, building and maintaining the appropriate software is still a significant cost item.

7. CONCLUSIONS

7. There is a steady continuation of interest in the collection of metocean data and in continuing development of metocean technology. Certainly the funds presently available are smaller than in the past, and time-scales to get projects off the ground are longer; however, it is still recognized that metocean technology can be a key contributor to developing cost-savings while visibly maintaining safety standards.