BUSINESS SESSION 3

TOPIC: LONG DISTANCE TOWAGE - OFFSHORE OIL INDUSTRY

SPEAKER: John Mervyn Jones, Managing Director,
London Offshore Consultants Ltd., UK

COMMENTATOR:
Chris Steytler, Barrister, WA

ABSTRACT

This paper gives a brief resume of the long distance towage of offshore platforms having steel or concrete substructures. It comments on the role of the Marine Warranty Surveyor and his contribution in minimising the risks associated with long distance towages.

The paper includes reference to environmental considerations, the strength and stability of tows and the selection of towing vessels and their tow gear. Current projects worldwide are discussed, including relevant details of the Goodwyn 'A' project, Western Australia.

1. INTRODUCTION

This paper sets out to consider the development of the towage of offshore platforms and considers the risks associated with long distance towages. The importance of the role of the Marine Warranty Surveyor in contributing to reducing the risks associated with long distance towage is emphasised. Examples of various tow routes are considered and attention is drawn to tug and towing configuration as well as other key topics such as stability and strength. A few examples of long distance towage, particularly to offshore Western Australia, are highlighted.

2. BACKGROUND

2.1 OFFSHORE OIL INDUSTRY

The offshore oil industry has presented many complex problems for the towing industry, and today large offshore structures are towed long distances and installed in ever deeper water and more hostile environments.

There are two main types of offshore fixed oil platforms, those constructed of a steel substructure commonly called a jacket, and those constructed of a concrete gravity base structure. The deck, which usually consists of modules, is installed on top of the substructure to complete the platform. A steel platform, shown in Figure 1, consists of a steel jacket piled to the seabed with the deck modules being installed thereafter by a crane vessel. The concrete platform illustrated in Figure 2 consists of the concrete base and deck modules all assembled inshore and towed out as one unit.

In the development of an offshore facility, the structures can, in principle, be fabricated in any suitable construction site in the world, then towed to the offshore site. In many instances the remote location of the offshore installation site will require long distance towages, irrespective of the construction site.

FIGURE 1 : TYPICAL EXAMPLE OF OFFSHORE PLATFORM WITH JACKET SUBSTRUCTURE

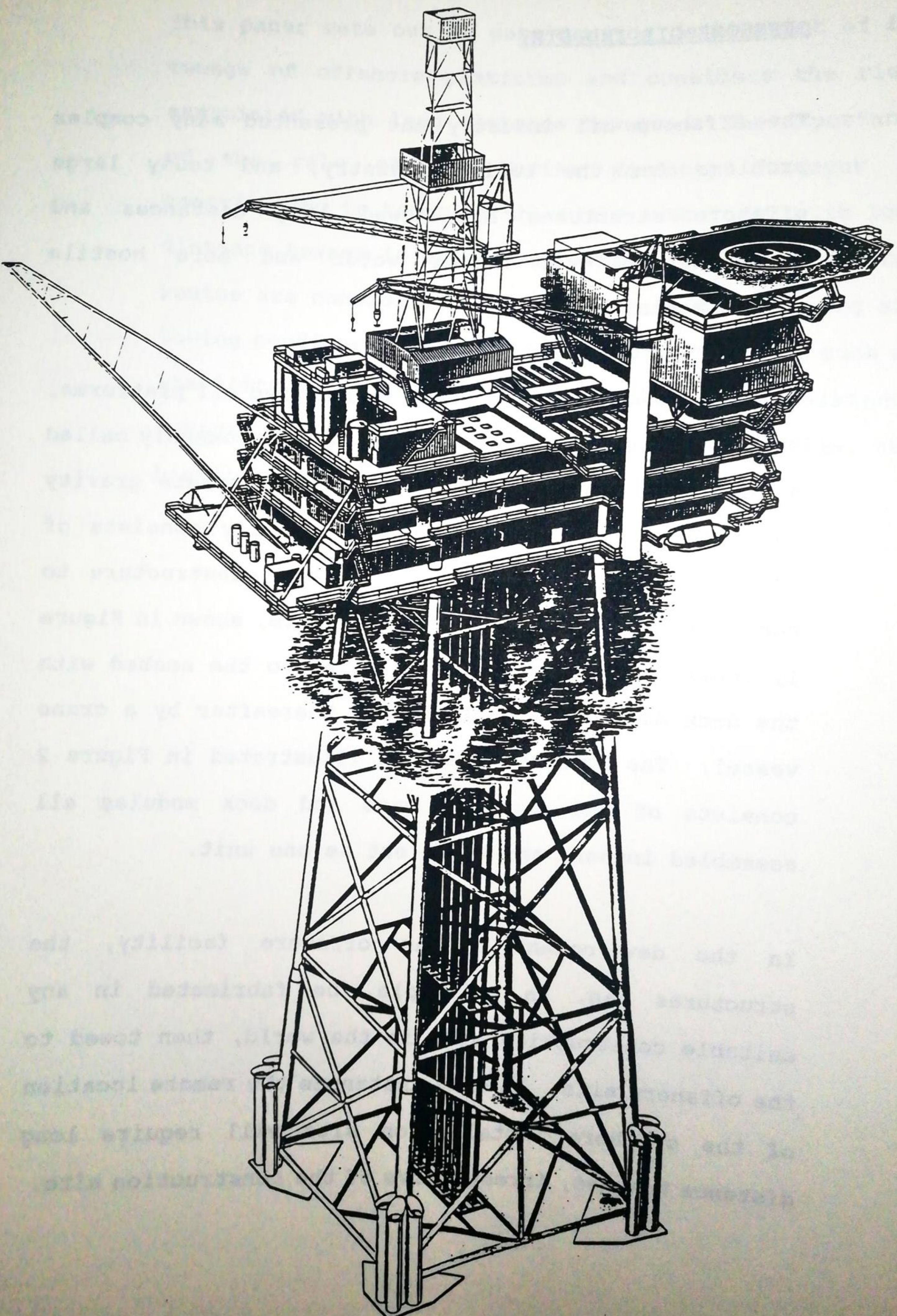
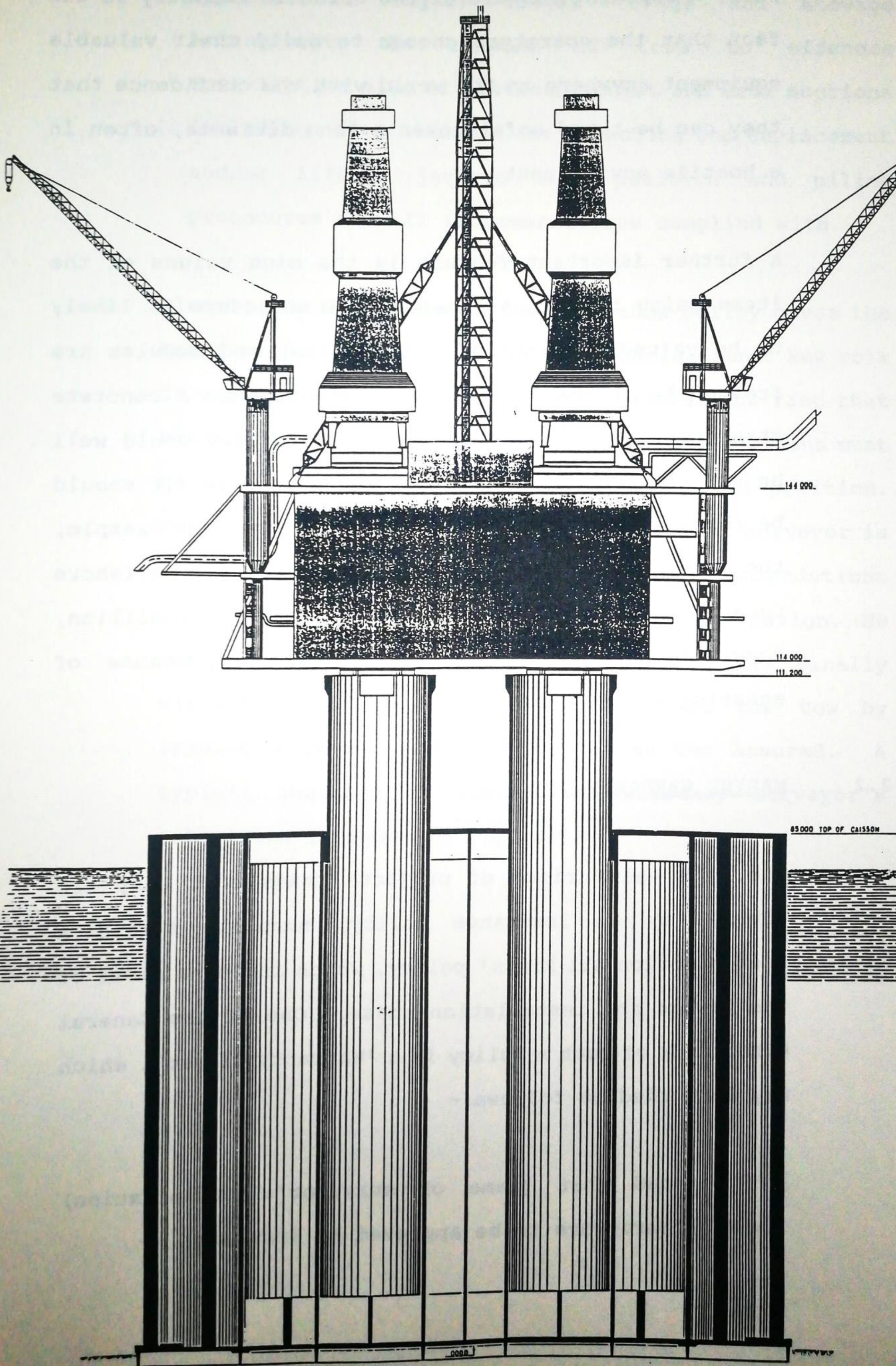


FIGURE 2 : TYPICAL EXAMPLE OF OFFSHORE PLATFORM WITH CONCRETE SUBSTRUCTURE



Thus, a striking feature of the offshore industry is the fact that the operators choose to build their valuable equipment anywhere in the world with the confidence that they can be towed safely over a long distance, often in a hostile environment.

A further important feature is the high values of the items being towed. A steel jacket structure is likely to be valued at about A$ 120 million, and modules are frequently of the order of A$ 100 million. A concrete structure fully completed and ready for tow could well be valued at over A$ 2 billion and this risk, it should be remembered, is concentrated in one tow. For example, the development costs of the Hibernia project, offshore Canada, are presently quoted as Canadian $ 5.2 billion, thus one can readily appreciate the importance of ensuring a safe towage.

2.2 MARINE WARRANTY SURVEYOR

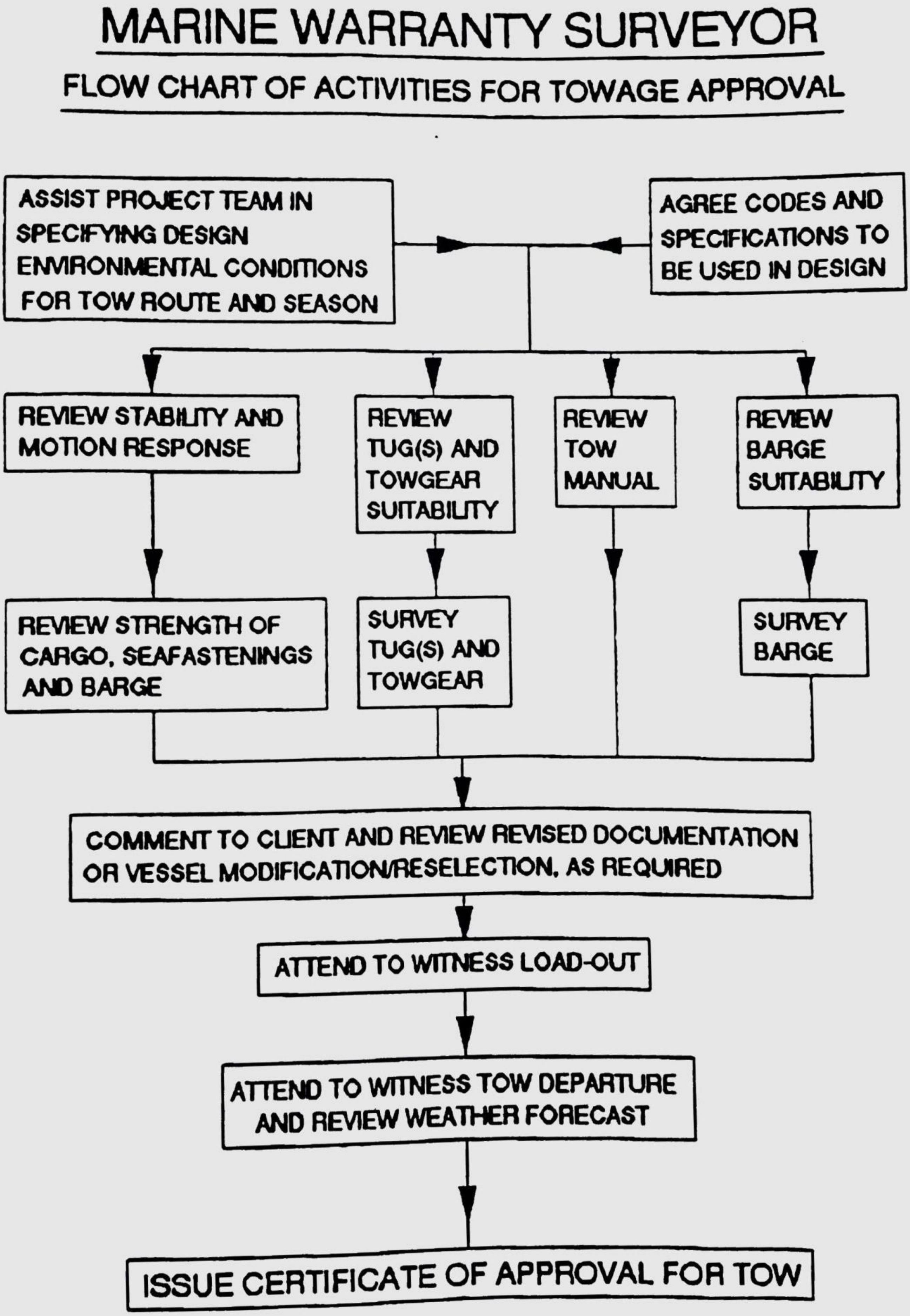
The high value risks of projects means that they are covered by an insurance policy, normally termed a 'Construction All Risks' policy, which includes cover of the towage and installation phase. One of the General Conditions of such a policy is a 'Warranty Clause', which may be worded as follows:-

"Warranted that (name of surveyor's organisation) and/or surveyors to be approved by Insurers, -

> Approval of tug(s) tow(s) towage and stowage arrangements in respect of tows to offshore installation site of platform jacket and deck sections including all procedures for launching and emplacement and/or lifting jackets into position and piling procedures and all recommendations complied with.

Clearly, such a clause in the insurance policy gives the named marine warranty surveyor's organisation a key role in ensuring the safe towage. For example, the fact that his approval is required and all his recommendations must be complied with, puts him in a privileged position. Thus, in a large project the marine warranty surveyor is appointed at an early stage so that his recommendations where appropriate can be included in the design. He remains involved throughout the project and finally witnesses the preparations and approves the tow by issuing a Certificate of Approval to the Assured. A typical sequence of the marine warranty surveyor's activities is shown in Figure 3.

FIGURE 3 : FLOW CHART OF ACTIVITIES FOR TOWAGE APPROVAL



The marine warranty surveyor may be the only organisation which has the expertise to cover all aspects of the tow including the engineering design through to the final inspection and approval of the tug, tow, towage and stowage arrangements.

The relationship between the marine warranty surveyor and the tug master is important. The tug master is responsible for the conduct of the actual tow but he may have been issued with recommendations by the marine warranty surveyor who would have a deeper knowledge and understanding of the design and predicted behaviour of the towed unit. The marine warranty surveyor would not interfere with the safe running of the tug, but may be in a position to offer constructive advice in the event of some unforeseen event.

3. ENVIRONMENTAL CONSIDERATIONS

In many cases the design of an offshore structure commences prior to selection of a site for construction. As a consequence, an analysis of environmental data for various tow routes and seasons is undertaken in order to assess the effects of the tow on the structure. The environmental criteria which is established from statistical analysis of data, appropriate for the tow route and time of year, are used as input to the final design of the towed structure. At a later stage the criteria are used to select towing vessels and towline configurations. Finally, the criteria are taken into consideration when reviewing weather forecasts prior to tow commencing.

The statistical analysis of data that is required in order to define criteria is performed for all the sea areas encountered on route. Traditionally the simplified procedure of selecting the most severe area and applying '10 year return' conditions is adopted. The '10 year return' is defined as the most severe conditions likely to be encountered once every 10 years. Attempts have been made to establish criteria based on the time of transit and degree of exposure encountered in each sea area the tow passes through. However, the time of transit cannot be guaranteed. Severe delays can occur due to towing vessel breakdowns and the inability to make headway in heavy winds or seas. As a consequence the '10 year return' criteria is still widely adopted.

Typical parameters used to define the '10 year return' environmental criteria are the '1 minute mean wind speed (V_{1min})' and the 'significant wave height (H_s)'. The V_{1min} is the mean wind speed measured over a 1 minute period at 10 metres above sea level. H_s is the average height of the highest third of all waves in the '10 year return' period sea state. Examples of these values for tows to Australia are shown in Table 1 (Section 6).

4. STRENGTH AND STABILITY

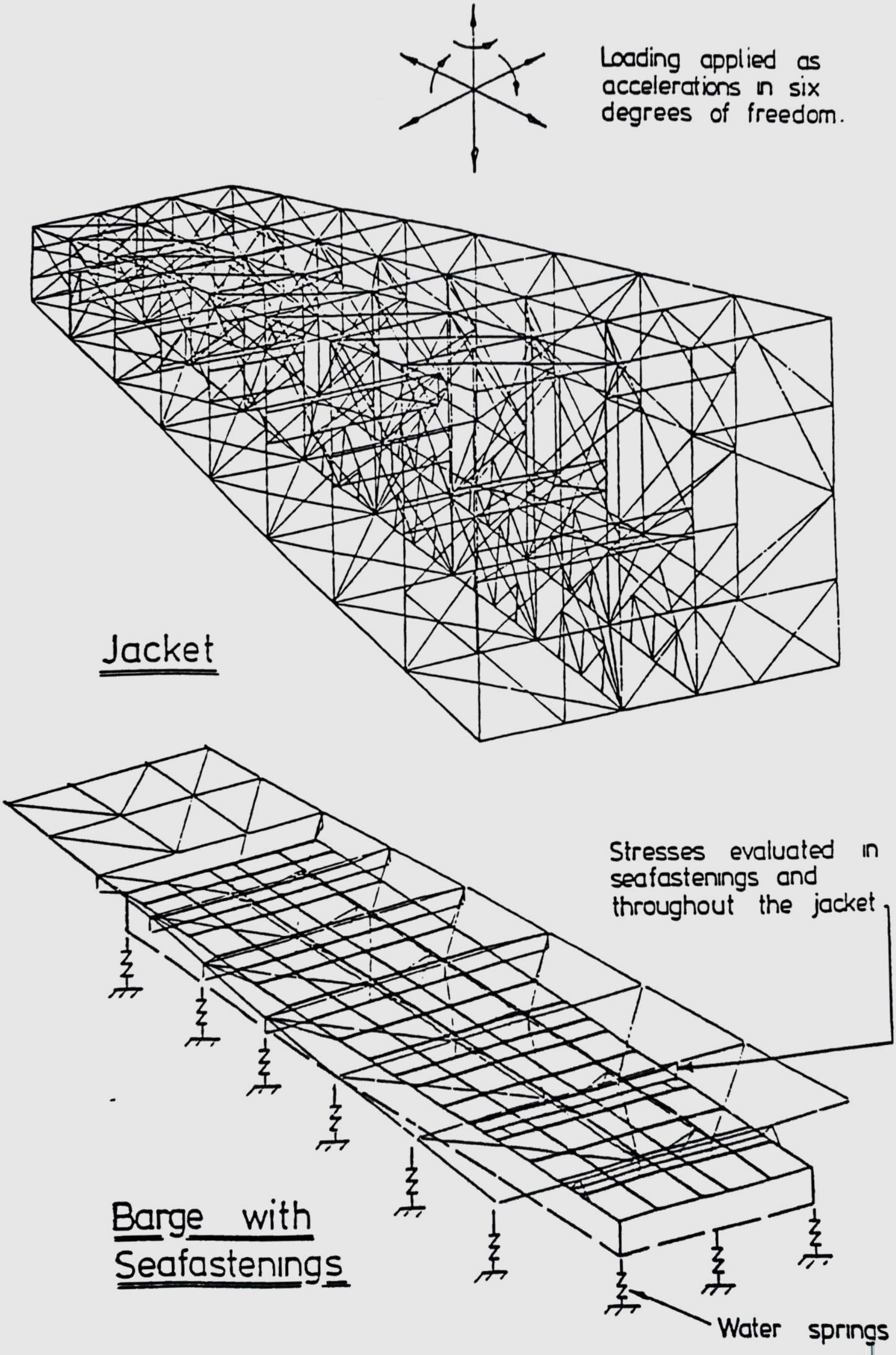
4.1 STRENGTH

The transportation forces are an important input to the design of the structure to be transported and, for tows on a barge, the sizing of members of the structure are often governed by the transportation load case.

There are sophisticated programs that simulate the motions of the towed vessel in the storm condition. Despite recent advances in computer-simulated motions, small scale physical model tests in water basins at specialist laboratories are often considered necessary to obtain realistic transportation forces. Such tests are accepted as being more reliable than computer based simulations particularly in very severe sea states. The forces and stresses, which result from the motions of the vessel, are analysed using one of the many tried and tested stress analysis programs. A typical structural model of a jacket, barge and seafastenings is included in Figure 4.

The large number of reversals of stress that may occur in a structure and its seafastening during a long distance towage means that there is a possibility of fatigue cracks developing in critical structural members thereby threatening the safety of the tow. This should be carefully analysed and checked.

FIGURE 4 : TRANSPORTATION STUDY - REPRESENTATION OF JACKET ON BARGE



For concrete platforms the only way in which the towage condition generally governs the structural design is the consideration of the inclination due to flooding of one of the compartments of the substructure.

4.2 STABILITY

The risk of capsizing or sinking during a long distance towage is minimised by applying appropriate stability criteria. As a general principle, the level of stability in a towage should be at least of a similar standard to that of any seagoing ship. The standards are empirical in nature, relying on the traditional approach of assessing the stability of the hull in still water and allowing sufficient margins to cater for the effects of waves and wind. The reason for taking a traditional approach in setting stability criteria is that the mechanisms for the cause of capsize in waves are not fully understood and cannot as yet be reliably predicted by analysis or indeed model tests. It is recognised that the typical criteria if applied correctly are conservative and there have been few losses of tows of offshore equipment due to capsize.

4.3 COMPARTMENTATION AND DAMAGE STABILITY

On all tows the compartmentation is carefully studied and it is recommended that all tows shall be able to survive with any one compartment flooded. Barges are always well compartmented and there is generally no difficulty in satisfying this criteria.

On concrete platforms it is often virtually impossible to fully comply with the recommendation. The problem usually arises in respect of the shafts which support the topsides; the volume of these is usually so large that flooding any one shaft would result in loss of the platform. However, studies show that there is most unlikely to be water ingress as a result of collision with the concrete walls of the shaft. In addition there are strict controls on possible water ingress through the ballast system or other pipework.

5. TUGS AND TOWING ARRANGEMENTS

5.1 TOWING VESSELS

The towing details are key considerations to a safe towage, and tend to be dealt with close to the actual tow departure. Towing vessels are frequently changed out at short notice and substitutions sometimes have to be made during a tow.

Towing vessels used for long distance towages used to be ocean-going tugs operated by major towing companies. However, today a large number of tows are undertaken by multi-purpose vessels which are frequently referred to as anchor handling/supply/towing vessels. These multi-purpose vessels are unlikely to carry the spare towing gear and salvage equipment which would normally be found on an oceangoing tug. Apart from the actual compromise in the design of the multi-purpose vessel there is a further disadvantage in that the vessel may be running as a supply vessel for months and thus the crew are not likely to be experienced in towing operations. Such a lack of experience may not become apparent in good conditions, but may be critical in the event of encountering difficulties with the tow. However, where multi-purpose vessels are frequently involved in towing, the owners ensure that their vessels are well equipped and manned with experienced personnel. Such owners are usually the major offshore vessel operators.

Unfortunately there are many other vessel operators who do not meet these standards and, where these companies become involved, there is a risk of falling standards.

5.2 TOWING POWER REQUIREMENTS

Towing vessel requirements are usually expressed in terms of 'bollard pull'. This is determined by a static test in calm water and does not reflect other key parameters of a towing vessel's performance in waves, such as displacement, manoeuvrability and seakeeping characteristics.

There are several methods of specifying or defining the required bollard pull for a tow but the most common method is to ensure that the towing vessel(s) can provide sufficient power to hold the tow in a fully developed gale (Beaufort force 8/9), which is defined in the following terms:-

Wind Velocity	20 m/s
Wave height	5 metres
Current velocity	0.5 m/s

The difficulty with this criteria is adapting it for more unusual tow routes and for areas which are particularly exposed, such as across the Great Australian Bight in winter, say from Adelaide to Fremantle. Therefore, a more stringent criteria would be recommended, so that the relationship between calculated towing resistance and tug bollard pull is as follows:

$$\frac{\text{Tug Bollard Pull}}{\text{Calculated Towing Resistance}} = 2$$

5.3 TOWING ARRANGEMENTS

The towing arrangements are critical to the safety of the tow, as once the tow has been connected the towing equipment is expected to remain intact even in severe weather conditions, thus adequate safety factors are included in the design. Figure 5 shows a typical towing arrangement between the towing vessel and barge. Figure 6 shows a jacket on a barge, which gives an indication of the size of jacket compared to the barge.

A nylon or synthetic rope pennant or stretcher can be inserted between the main tow wire and the pennant. This is considered a good practice provided the stretcher is properly constructed, of adequate length and well maintained. A major European towing company always inserts a stretcher and has no history of failure. Provided that the stretcher is stowed on a drum and properly protected it should have an active life of over 55,000 hours. Some towing companies prefer not to use a stretcher.

FIGURE 5 : TYPICAL TOWING ARRANGEMENT

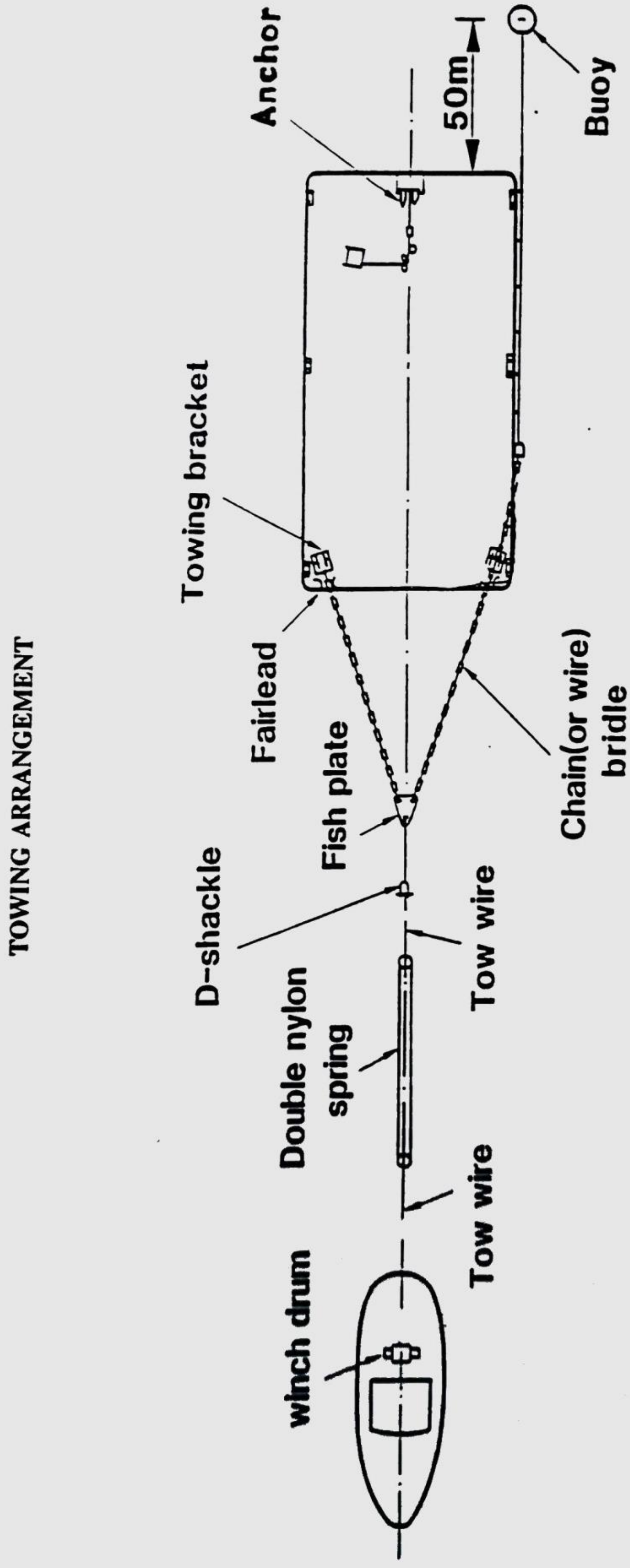
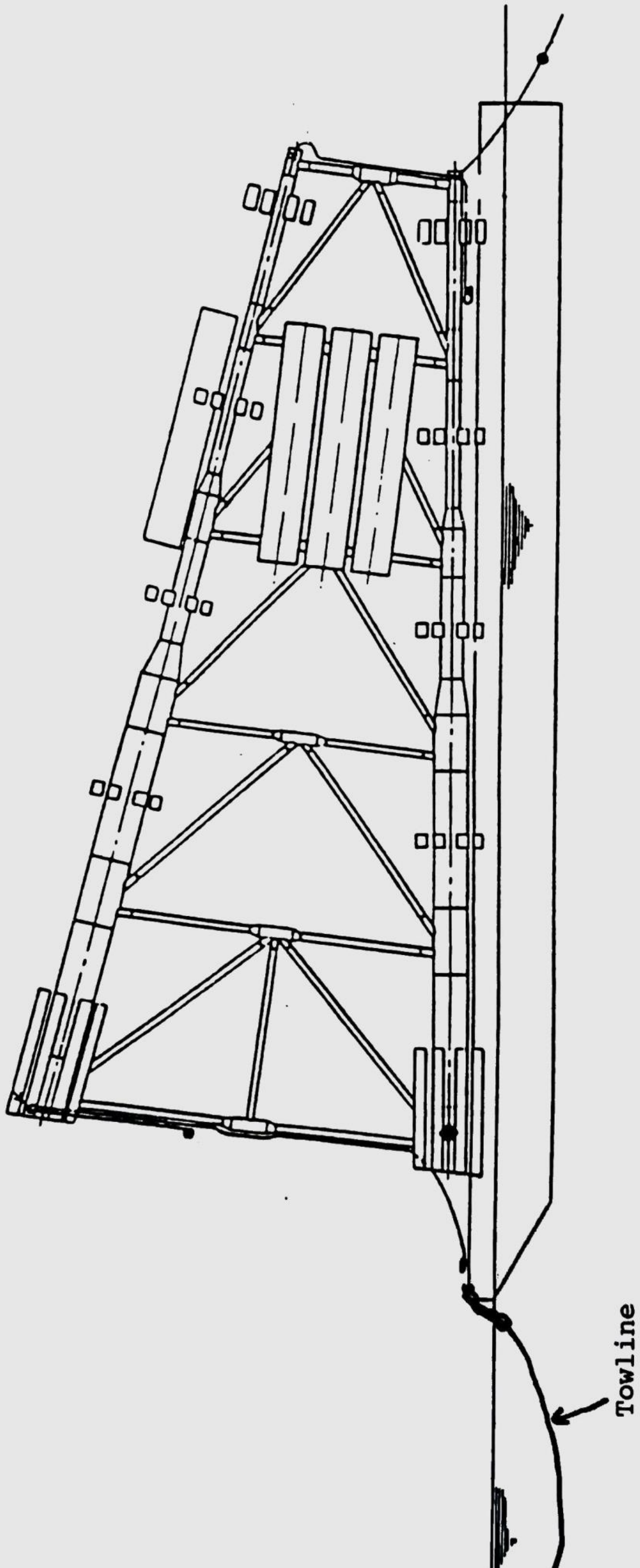


FIGURE 6 : EXAMPLE OF A JACKET ON A BARGE



The tow wire is the most important component in the towing arrangement, particularly if a stretcher is not inserted. The tow wire must be in good condition especially when considering a long distance towage, and must be of a proper length (see 5.4). Further, a spare tow wire of the same length and strength as the main tow wire should be provided on a spare drum and ready for instant use.

5.4 TOWLINE TENSIONS

The greatest risk in towing is the parting of the tow wire and such incidents are not uncommon. If the tow is well planned it should be feasible to reconnect the tow before it runs aground.

The reasons given for breaking of the towline are various and include:

- encountering very bad weather
- damage to the line due to fouling on the seabed, propeller or tow,
- abrasion of the line in the area where it crosses the stern of the tug.

There are many actions which can be taken to avoid towline breakage resulting from the above and it therefore has to be said that inexperience of the crew is often the root cause of the failure.

High dynamic loads are often experienced prior to parting of the line. In the author's opinion a major contributory factor is often an inadequate length of towline, since dynamic loads are higher for shorter towline lengths. Many anchor handling/supply/towing vessels have towline lengths of about 800 metres and this is considered by the author to be inadequate for long distance towages, in areas of the world where severe weather may be encountered. These tows should only be undertaken by towing vessels with tow wires in excess of 1,000 metres in length and ideally 1,500 metres. This then gives the tug master the opportunity of towing on a long towline, i.e. over 1,000 metres in length, so that peak loading in the towline can be reduced if necessary.

6. CURRENT PROJECTS

The highest value project ever undertaken in the offshore industry is the development of the Hibernia field which lies in the Atlantic Ocean about 315 km east of St. John's, Newfoundland. This will involve a large number of towages from various parts of the world, for assembly in Newfoundland, and the final tow out is scheduled to take place in 1995. This tow will take about 10 days, in waters which are subject to severe weather, including fog and icebergs. By careful planning and by the use of the most sophisticated towing vessels and experienced personnel it is believed that this long towage can be undertaken without unnecessary risks.

In Europe, the North Sea continues to be an active area, with field developments using steel, concrete and tension leg designs. Platforms are now being placed in water depths of over 300 metres.

In the Far East opportunities are arising in the China Sea, which involve towages from the Singapore area and the People's Republic of China. Particular attention has to be given in this part of the world to the frequent and severe typhoon activities.

In New Zealand, the 'Maui B' platform will soon be installed in a water depth of 100 metres some 35 km offshore from the South Taranaki Coast, in the Tasman

Sea. This project involves a number of high value towages from the Singapore area and Japan.

In Western Australia the Woodside Offshore Petroleum, Goodwyn 'A' platform will be installed in 1992. This will consist of eight main towages from four different ports, two in Australia, Fremantle and Adelaide and two from overseas, Ulsan in Korea and Batam in Indonesia.

Typical wind and wave criteria for towages to West Australia are shown in Table 1. The tow route and season can be seen to have a considerable effect on criteria.

TABLE 1 : TYPICAL WIND & WAVE CRITERIA FOR TOW ROUTES TO N.W. AUSTRALIA

ROUTE	SEASON (S.Hemis)	WIND VELOCITY m/s	WAVE SIG. Ht. M
1. KOREA	WINTER	26	8.0
2. SINGAPORE	SUMMER	24	7.0
3. SINGAPORE	WINTER	21	6.0
4. ADELAIDE (Via Torre Straits)	WINTER	33	9.5
	SUMMER	29	8.5
5. ADELAIDE (Via Bight)	WINTER	36	9.0
	SUMMER	28	7.5

The weight and value of the structure under tow and the distance and duration of the voyage are of particular interest when considering the safety aspects. A summary of these parameters is shown in Table 2, for the Goodwyn 'A' project. The high values of the structures and the large distances of tows are of particular importance.

TABLE 2 : SUMMARY OF GOODWYN 'A' TOWAGE

TOW	WEIGHT (TONNES)	VALUE (AUS.$)	FROM/TO	DISTANCE (N.MILES)	DURATION (DAYS)
JACKET	17,500	100 m	Indonesia/ N.W. Shelf	1,700	11
MODULE SUPPORT FRAME	1,750	N/A	Indonesia/ N.W. Shelf	1,700	11
PROCESS MODULE/ WELLHEAD MODULE/ FLARE TOWER	7,225	120 m	Korea/ N.W. Shelf	3,500	25
RECYCLE MODULE/ STRIPPING COLUMNS MODULE	4,700	80 m	Korea/ N.W. Shelf	3,500	25
ACCOMMODATION/ HELIDECK/ POWER GENERATION/ UTILITIES MODULE	5,200	200 m	Cockburn Sound/N.W. Shelf	1,000	8
PRIMARY PILES	10,400	25 m	Adelaide/ N.W. Shelf	4,500	35
INSERT PILES	5,400	10 m	Adelaide/ N.W. Shelf	2,200	15
DRILLING PACKAGE	N/A	60 m	N/A		

N/A = Not Available

The total value of equipment to be towed is in the region of 600 million dollars and the failure of any one tow to arrive safely and on time could be very detrimental to the whole project development.

7. CONCLUSIONS

The values of structures being towed over long distances are increasing and it is particularly important that high towing standards are maintained. The expertise of tug owners and crews varies considerably, as does the standard of equipment used. The employment of competent and experienced Marine Warranty Surveyors to certify long tows will help to ensure a uniform and high standard of towage, such that risks are reduced to a minimum.