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Seaway Heavy Lifting

A Global Decommissioning Challenge

Contents

Preface

This booklet is for engineers, strategic planners, decommissioning managers, (asset) managers, and those simply interested in and needing background information about the decommissioning of offshore platforms from the practical viewpoint. Seaway Heavy Lifting has been involved in North Sea platform installation and decommissioning for many years. Our unrivalled experience in platform removal, especially of the Southern North Sea, can be applied to most areas of the world backed up by our practical and common sense approach to projects.

Introduction

The purpose of this booklet is to provide background information about the offshore platform decommissioning or removal process and share the lessons that Seaway Heavy Lifting (SHL) has learned in its extensive experience.

The removal by SHL of the Conoco-Phillips Viking platforms in the Southern North Sea won many industry awards and from this project came much experience that has been used in subsequent projects world wide.

The industry's experience is that the time and effort required to successfully plan decommissioning and offshore removal is generally underestimated it is now well accepted that the early appreciation of decommissioning issues and the planning out of potential problems with an experienced marine contractor is at the heart of a platform operator's successful removal project. Conversely, deficiencies in planning and offshore preparation usually lead to increased costs and offshore removal problems, not to speak of safety hazards.

This booklet should provide a basic understanding of the planning issues in the offshore decommissioning process and give insights into the physical removal process that directly impact the removal of platforms anywhere in the world.

Executive Summary

The decommissioning of platforms is fundamentally different from installation in the same way that a building is not demolished in the same way it was built. It should not be underestimated as a project simply because it is unglamorous and at the end of field life. Removal of redundant platforms has the potential for creating significant problems for the reputation of owners if poorly planned and executed. It is not an investment project and the potential for high cost overruns is high without adequate planning.

Decommissioning is comprised of several interrelated issues the more important of which are:

- Regulation
- Technology
- Reputation
- Environment
- Planning and Cost
- Removal operation and sequence
- Timing/When

The degree of importance is relative to the platform location worldwide.

Decommissioning world wide operates under a set of regulations from the UN via the International Maritime Organisation. This requires full removal of platforms in less than 100m of water but permits part removal of structures to -55 m beyond this depth. Many regional agreements may put up more stringent rules and, for instance, ban offshore disposal in deep water as is the case for Atlantic Europe and the North Sea. National regulations reflect national interests within their 200nm Economic Zone and will deal with removal disposal of platforms and pipelines in a very individual way.

There are usually six stages to an offshore removal:

- Stage 1 - Engineering and planning phase.
- Stage 2 - Preparation of the topsides - cleaning, topside lift preparation, separation of process equipment and flowlines.
- Stage 3 - Subsea preparation - surveys, marine growth removal, cutting of risers and flowlines that would all prevent direct lifting of the jacket.
- Stage 4 - Topside removal to shore- the lifting operation.
- Stage 5 - Jacket removal to shore- the lifting operation.
- Stage 6 - Onshore demolition.

The removal of platforms uses offshore crane vessels as the most reliable and tested technology approach. Many alternatives have been researched in the field of single lift or buoyancy-aided methods but none has come to a fully commercial status.
Removing topsides by cutting in situ is viable but safety issues and the excessive number of man hours required offshore make this more difficult to plan.
Onshore disposal is not generally a problem since the platform enters into a well tried onshore environmental management scheme for recycling and disposal.

The upholding of the reputation of owners to do a 'good removals job and take your rubbish home, - an oft quoted phrase from environmentalists - is directly related to the amount of effort made to plan the removal, and engage interested parties in the roll out of the plans. The disposal of platforms, which may include leaving part of the structure in place, will always concern fishing and environmental interests. The ease of today's communications means that any aspect that does not meet public approval will be exposed and headlined. The premise for a good removals project and the contract between a HLV contractor and the operator is to enable decommissioning to be done safely, effectively, efficiently and on budget.

The better the planning for the project - essentially to minimize business risk - and the more information on the platform that is available then the less risk and cost to the platform owner. The earlier (even years earlier), that an offshore removal contractor can be involved then the better the planning. The best contract will have flexibility built in to take advantage of market conditions.

A typical removal operation would involve a crane vessel removing the different components; topsides, modules, jackets etc in a pre-determined sequence. The crane vessel then places them on pre-prepared cargo barges or the deck of the crane vessel for transport to a suitable onshore deconstruction site.

Key Features

- Decommissioning is fundamentally different from installation
- Platform removal by offshore crane vessels is by far the most reliable and tested technology
- Piecemeal removal of topsides is viable but safety and excessive offshore manhours is a big issue

Conclusions

Experience in the North Sea shows that platform removal it is NOT the simple 'reversal of installation' although this is often mistakenly considered as such before planning starts.

The heavy lift contractor and the operator's engineering or brownfield contractor should be involved in the planning of the decommissioning project right from when production becomes sub-economic.

Two items cause the most problems in the preparation and concurrent engineering stages:
- Firstly it is critical that all the relevant drawings of the topside and jacket are to hand, both as - built and modifications.
- Secondly the topside may have been changed structurally over time. Main girders, essential for lifting, are often removed in the course of the platform life.

When insufficient detailed information is at hand at the moment of tendering, and/or platforms have aged substantially overtime, operators should be realistic in their approach and accept reimbursement packages within the lump sum removal scope.
It is unrealistic to expect that the removal contractor can take the commercial risk associated with unforeseen extra work.

The highest risk associated with the topside removal is that the topside is not properly prepared by the operator as per the pre-agreed interface matrix, and that unidentified liquids are left behind. The highest uncertainties and thus risk, on the removal of jackets is with access to the pile for the cutting of the piles either internally or externally. Debris inside the pile might hamper access from the inside, while grout spoilage and debris underneath the seabed could cause problems on the outside. To mitigate this risk, the pile and conductor driving records could provide valuable information.

Cutting technology using abrasive and diamond wire is reliable although it remains a high risk part of decommissioning since it takes place underwater and often below seabed level.

Because the extent of the contamination of topside is not certain, even after an extensive inventory offshore, it is recommended to carry-out the cleaning of the topside at the disposal yard and the work associated with the removal and disposal of the hazardous waste being carried out on a reimbursable basis at pre-agreed rates.

Multiple platform removal contracts between operators, might at a first glance be attractive, however commercially this is not always necessarily the case. Generally the most stringent contract condition of each operator would apply while liability issues could develop between the different operators. Such disputes would inevitably cause an increase in the removal cost.

It is a misconception that a platform removal would cost less than an installation. The removal contractor's offshore work is at least equal, if not more, than on a platform installation. All preparatory works and work associated with making the platform safe -which for a new build is normally done at the fabrication yard- is in decommissioning done by the HLV contractor with its crane vessel on location.

Key Features

- Platform removal is not a simple reverse installation
- Planning and preparation is key
- Contracts should have reimbursable components for the "unknown"
- Platform removal generally takes longer than installation
- Piecemeal removal of topsides is viable but safety and excessive offshore manhours is a big issue

Background to Decommissioning and Industry Experience

The background to this subject requires a definition of decommissioning:
1. "Decommissioning is the process of the physical removal".
2. "Decommissioning is interrelated and interdependent".
3. "Decommissioning is not a simple reverse installation".

"Decommissioning is the process of the physical removal"

Decommissioning is the process which the operator of an offshore oil or natural gas installation or offshore wind farm carries out to plan, gain approval for and implement the cleaning, removal, disposal or re-use of the installation when it is no longer needed for its current purpose.

Unlike the installation side of the industry where management can change its mind and curtail field development and invest elsewhere, decommissioning obligations remain like death and taxes, unyielding and inevitable. Paying for decommissioning at the end of field life therefore becomes a major issue in time for management. Offshore platforms must be removed to some extent once they are no longer required. The extent of the removal; partly or complete, depends on the platform location.

A global challenge

The oil industry is experienced at establishing and controlling the huge costs of installing platforms. Exemplary efforts are made to maintain and reduce operating costs throughout the life of the installation. However, when it comes to decommissioning, the emphasis changes and the results become much more uncertain: the need for planning the decommissioning of offshore structures worldwide has never been more needed.

With over 7000 platforms world-wide, located in over 50 countries, industry and governments face decommissioning costs roughly estimated at US$100-200 billion. To further complicate matters, decommissioning of the world's platforms will take place mostly over the next 40 years, with the majority of smaller platforms in the shallow water of continental shelf areas going in the next 20 - 25 years. It therefore is not a long term issue.

The North Sea illustrates the problems facing most areas of the world which will eventually decommission platforms according to IMO regulations. This area of rough seas and changeable weather continues to give the industry most of the relevant platform removal lessons. There are over 600 platforms in water depths between 30m and 200m and a huge variety of structure types from 4- to 12- leg platforms with the occasional jack-up and concrete installations - in fact no two platforms are identical.

The majority of North Sea platforms - as is the case for the world's platforms - weigh between 3000 and 4000t but many very large steel structures in deeper water, mostly more than 30 years old, can weigh over 40,000t and concrete installations over 300,000t. The latter, as well as the large jacket platforms, are beyond the scope of this booklet although the aspects of planning still apply. There are about 50 comparable jackets to North Sea platforms world wide located offshore Brazil, the Gulf of Mexico, the Mediterranean, Africa and the Far East.

Essence of decommissioning

The essence of decommissioning is that, by definition, platforms are old - some over 40 years. Many have changed ownership several times and often no longer have "as built" information or installation records. Some have been left in situ after production ceased without adequate shut down or cleaning procedures and some will be structures weakened by age and lacking the potential of removal in the same manner as installation. For others, the topside has been changed over time and using installation lifting points is structurally no longer feasible. Many structures are isolated and stand alone, others form part of 4 - 5 platform infrastructures with attendant subsea pipelines and other subsea equipment. Others still may play a critical function in highly integrated transportation systems, others may be mothballed and ready for decommissioning. Therein lies the major problem of decommissioning - uncertainties and variables. Planning out these factors is essential, for without proper planning, the costs of offshore removal will rise, safety will be challenged and the environment endangered. Such an unplanned, risky, removal would be considered a failure even if the platform is ultimately retrieved to shore.

Successful decommissioning planning depends on identifying these variables and uncertainties, or influences, and properly analysing and creating conditions so they do not impact safety, the environment or costs.

Variables

There are four types of variables in decommissioning: tangible, unpredictable, behavioural, technological.

Tangible variables in decommissioning is clear: platforms must be removed in some manner at the end of their economic life. Technological variables include the established offshore marine equipment, the removal techniques, the availability and the cost savings they offer.

Unpredictable events such as regulation/legislation or political changes that alter the whole forecast of costs and techniques, as well as unforeseen offshore problems. Behavioural influences are crucial and depend on the relationship between people, groups, companies, contractors and governments. They are very difficult to predict and may have the greatest influence on planning. Decision makers in the operating companies who turn to expert advice are very much handicapped if this variable is not fully evaluated, or simply put, do not consult the contractors who will remove their platforms. An obvious fact but often overlooked as a planning tool.

In the following chapters we will mainly address the technological variables and try to make unpredictable events predictable.

"Decommissioning is interrelated and interdependent"

A second view of decommissioning is one that comprises several influencing and essentially interrelated factors including:

- Safety
- Technology
- Reputation
- Environment
- Cost
- Regulation
- Timing - 'when'
- Politics

Putting these and associated issues together may look something like this. This example is not exhaustive but, critically, all decommissioning issues are interrelated, interdependent and important.

Courtesy Tim Watson

Those issues that relate directly to the removal of platforms include technical aspects, cost, safety, 'when' and contracts and these are discussed later in the booklet. Referring to the decommissioning road map the various issues may be illustrated in the following paragraph. The words in bold type are whole subjects in themselves and highlighted for the reader who wishes to further improve his understanding of decommissioning.

The **political decommissioning** policies of a country that has jurisdiction in a location within its **Economic Zone** (up to 200nm from shore) will dictate those national or regional convention decommissioning **regulation that differ from** the UN **IMO guidelines.** In the North Sea area, the governing **OSPAR** regional convention requires all platforms to be removed. In other areas such as the Gulf of Mexico, national or US state regulations permit **in-situ disposal or "rig for reefs"**. In other areas such as Indonesia, the guiding regulations or conventions follow the IMO standard which permits **partial removal** (leaving part of the jacket in place) in waters deeper than 100m.

The reputation of the platform owners and governments in respecting the environment and safety of personnel and marine life is a critical aspect in the planning of technical removal. Cost is a secondary consideration to reputation in any location, but cost should not be allowed to become uncontrolled by having underestimated risk involved in the project. Risk can be minimized by using experienced contractors and by ensuring full knowledge of the platform structure and topside contents, seabed and environmental conditions etc. Experience gained by the contractors, both offshore and onshore in the North Sea, is a distinct aid to evaluating risk in other areas. **Liabilities** related to leaving long term debris on the seabed or improperly **abandoning wells**, should be planned out and minimized by project teams (which should include the selected marine contractor). The people who form the teams will have a variety of skill sets, including topside and structural engineering, public relations and marine expertise. Again from North Sea experience, the main contract with the heavy lift vessel owner should be one that gives maximum flexibility to the contractor to do the job when it best suits his vessel-schedule in return for cost savings.

In order for this contract to work best, the operator will have decided when (for example, within the next few years) the platform is to be declared redundant. This aspect has been the most difficult to achieve by the industry since the variables that determine the economic life of a platform are complex , e.g. gas price, operating costs, reservoir extraction rates, infrastructure demands. Some form of draft **removals programme** will be submitted to the **Decommissioning Authorities** for discussion and approval. In some locations this process can be up to 4 years in duration.
In preparation for removal of the platform, operators will have prepared the topsides for this event including cleaning and re-welding lifting points. Often reuse of the platform for the same purpose in another location is considered as the next step, but if not, then disposal onshore entailing recycling or reuse in another form is undertaken. This is carried out in an approved purpose-built facility that deals in major scrap volumes and where environmental waste disposal norms are followed. Once a platform is removed and pipelines removed (or left buried), the site is usually regularly monitored for a period of time to ensure that no further liabilities to others are left.

“Decommissioning is not simple reverse installation”
Decommissioning is NOT:

- The ‘reverse’ of the build and installation process
- A ‘scrapping’ job
- Unregulated
- Cheap!
- Without issues

Experience in the North Sea shows that platform removal it is NOT the simple ‘reversal of installation’ although this is often mistakenly considered as such before planning starts. This is as true as saying that the demolition of a house is the reverse of building it.

The following illustrates the fundamental difference between an installation project and a decommissioning project.

Installation *is time dependent* - it must be installed on time to realize revenue from production. Capital costs of installation often take second place. In decommissioning, *time is not the issue* as production has ceased, but *cost containment is critical* since there is no production and therefore *no revenue* to pay for costs higher than the pot of money accrued over the producing years for decommissioning.

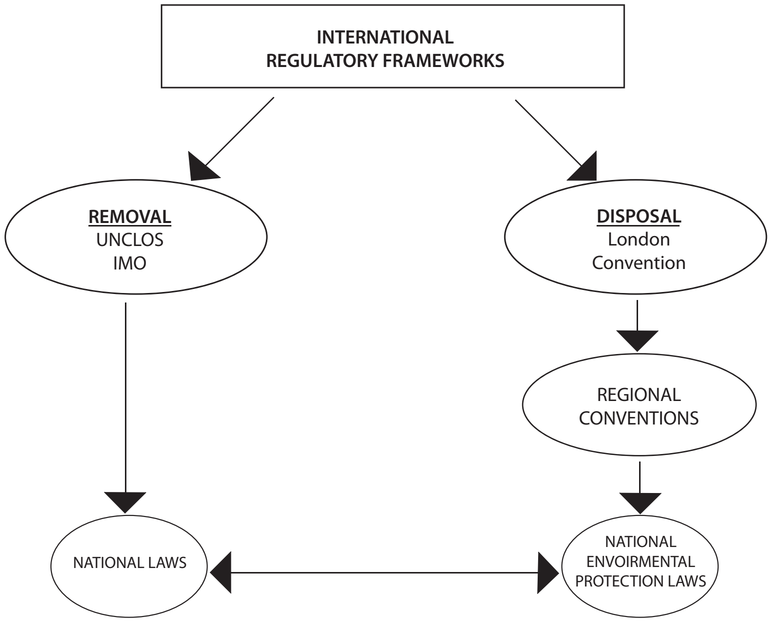
Regulation and Decommissioning Programmes

As a general rule a platform operator applies to the national government for permission to remove an offshore platform. This is after having convinced the authorities that the platform no longer produces oil or gas economically. The government uses the UN regulations as a basis for its own regulations for the removal. These national regulations vary greatly; some countries assume the decommissioning obligation by taking the platform from the owner, others require the operator to submit a decommissioning programme for approval, and others work closely and jointly with the company to ensure the best environmental approach for their circumstances.

The UN regulatory framework that governs decommissioning worldwide is relatively clear. However it does bring into play many different levels of legislation - from international guidelines and regional conventions, to national and local laws.

A key concept is the distinction between the *removal* and *disposal* of disused offshore oil and gas installations since they come under very different types of legislative frameworks. Whilst interlinked, the legal requirements for removal are primarily concerned with the safety of navigation and other users of the sea. The disposal of structures comes under the pollution prevention regulatory frameworks.

A brief description of the various international frameworks and the associated time line is given in Appendix 1.



Key Features

- International and national regulations apply
- Onshore and offshore guidelines may vary
- Trans border shipment of platforms could be an issue i.e. export of scrap/waste

Operators and Contractors

The relationship between operators and contractors in decommissioning is significant but much underrated. Industry contractors and service companies have taken over many of the roles, *but not the responsibilities,* that were the exclusive domain of the oil companies. The industry's workforce has been transferred from oil majors to contractor and service companies, some of whom are now the largest employers in the industry. Decommissioning is an area of significant expenditure for no returns, technical challenges, and technical innovation. In the Gulf of Mexico the decommissioning process is routine and at present generally confined to shallow water or light platforms. Elsewhere in the world, decommissioning has not yet become the emotive and costly exercise that is a feature of the North Sea. In all areas however, a close working relationship between operators and experienced marine contractors is a huge benefit. This reflects the emphasis on offshore expertise. From experience, it can be said that operators who take on board a reputable and experienced removal contractor ultimately pay less for a safe and environmentally sound removal than those who cut corners and try to use unsuitable equipment. Ideally the heavy lift contractor and the operator's engineering or brownfield contractor should be involved in the planning of the decommissioning project right from when production becomes sub-economic. However the biggest problem that both operator and contractor have is *'when is the start, when will the particular decommissioning occur'?*

The single hardest decision for the operator is not how to decommission but when to declare the platform ready for decommissioning. In the North Sea, decommissioning projects have been delayed up to 16 years and although this is an exception it is not uncommon to find that most early forecasts of decommissioning removals made 10 years ago were significantly wrong. There are several reasons for deferring decisions on decommissioning but are primarily as economic commercial factors and a reluctance to commit funds when production capital is a better investment. While these are perfectly understandable reasons for not setting a decommissioning date, nevertheless the resulting variable timing of decommissioning is the contractors' greatest problem that nullifies the most careful timeline planning of an intensely planning dependent industry.

It is unfortunate that since they are not kept informed of possible decommissioning dates by operators, heavy lift contractors do not feel involved. More importantly they are not then in a position to offer any contractual flexibility - meaning that there can be no cost savings offered to the operator.

Operators can do much to improve their long term planning and consequently reduce their exposure for decommissioning a platform, i.e.:

- Start the planning early so that there are no surprises and all information about the project is collected. This includes weights, sizes, as built drawings, modifications and seabed conditions. Often this data is difficult or impossible to obtain since many platforms have changed ownership and file storage over the years; hence surveys or experienced assessments about the original installation will be needed.
- Involve heavy lift contractors before the platform becomes sub-economic.
- Include stakeholders such as fishermen and environmentalists' in the planning. Consult widely to ensure there are no hidden problems.
- Be prepared to be flexible, make information available and give meaningful timeframes.

Ultimately the operators will be responsible for writing and managing the decommissioning plan and the heavy lift contractors would provide specialist input. Compared to the vast improvements made in the design and build of platforms the decommissioning and removal techniques are basically unchanged except for the sizes of crane vessels. This provides reassurance to the operators that the techniques are proven even if the job may be unique. The ability to work together towards the successful completion of the project will be greatly enhanced by a combined involvement in the planning and study process.

Key Features

- Operators to interact with their removal contractor
- Knowledgeable and experienced removal contractor contributes greatly to the success
- Early involvement of the removal contractor can result in cost savings
- Flexibility on decommissioning window pays off

Offshore Removal

Overview

Offshore removal generally has six stages:

- Engineering phase, involves operator, engineering company and the marine contractor to assess feasible methods of removal.
- Preparation of the topsides by the company - cleaning, topside lift preparation, separation of process equipment and flowlines.
- Subsea preparation by the company's subsea contractor, e.g.- surveys, marine growth removal, cutting of risers and flowlines that may all prevent direct lifting of the jacket. These stages are often concurrent with engineering work if required.
- Topside removal and transportation to shore.
- Jacket removal and transportation to shore.
- Onshore demolition.

This section describes the salient features of the topsides and jacket removal process. However, offshore removal does not start with the physical removal of the platform. It starts well before at a much earlier phase in fact at the tail end of the production. At this point, the operator should have the plans approved and should start with the preparatory work for the physical removal, including well abandonment and the clean-up of the platform.

Plug and abandonment of the wells

Plug and abandonment of the wells is a responsibility of the operator as the long term liability of the plugged wells remains with the company. In some cases wells are killed years before platform removal, in others just prior to removal. This service is generally done by the specialized contractors under supervision of the oil company's representative. P&A of the well is beyond the scope of this booklet. In some locations, it is permitted to flush the pipelines and process piping with water and re-inject the water back into the wells; hence cleaning is completed before the wells are all abandoned. Once the wells are killed, it is recommended to have the same specialized contractor also sever the conductor casing at approx 6m below mudline. To prove that the cut was made successfully, the

conductor string should be lifted approx 0.5m and rotated 45 degrees.
The conductor string can be retrieved by the rig in sections of approx 12m, or in one string by the heavy lift vessel. The latter is generally most cost effective. If the wells are killed by a rigless process then the HLV contractor would cut the conductors when removing the platform.

Preparatory work

The purpose and importance of preparatory work cannot be over emphasized since it reduces offshore time and hence cost. Preparatory work to the platform and site, above and below water, may be done either by the operator using production crews and contractors or, if economical and feasible, by the lift contractor. The work packages would be decided as part of the planning exercise. Preparation of the topsides includes process cleaning, topside lift preparation, separation of process equipment and flowlines. Subsea preparation includes surveys, marine growth removal, and the cutting of risers and flowlines which could prevent direct lifting of the jacket.

Engineering phase

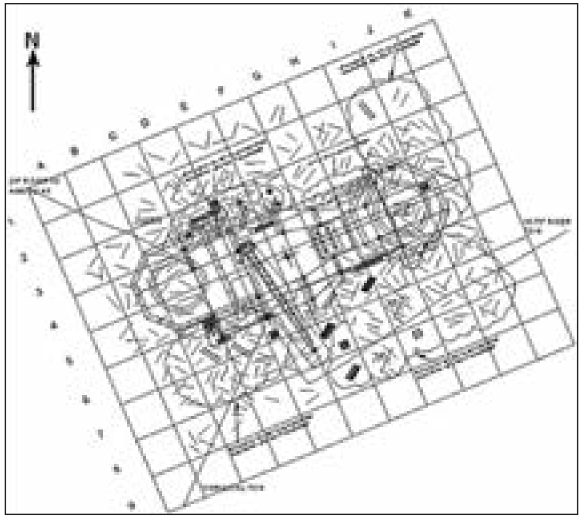
Once the offshore removal contractor is selected and the removal contract has been signed, the contractor can start its engineering work. Subject to the size of the platforms and the complexity of the topside (for example, will removal require a single hook lift or is it a 20,000t topside of multiple modules which have to be separated before lifting), the engineering phase could run from six months to two years before the offshore removal works actually starts. Irrespective of the size of the topside, preparatory engineering work is, from experience, always heavily underestimated. Detailed lifting plans are prepared especially for modules which have to be split, plus work-packages with each containing a number of job cards describing the activities required in detail. This ensures that the offshore removal can take place in a safe and efficient manner. During the preparation and associated platform visits it often becomes clear that topside drawings no longer reflect the actual condition. Further investigation is required to assess the changes and whether or not, for example, main girders have been removed from the module, making a straight forward lift no longer possible.

To start the engineering works, technical data required by the contractor from the operator would typically include:

- Field layout and coordinate reference system.
- Subsea pipeline and other subsea facilities.
- Hazardous materials survey (asbestos, scale, paint etc).
- HSE related matters survey (safe access, safety materials, contaminated piping and equipment etc).
- Structural fabrication and welding details.
- Structural steel materials information;
- Structural information of existing platform structures.
- Structural drawings (as-built).
- Dimensional control, weight data and CoG data for topsides, modules and bridges.
- Structural drawings of padeyes and steel reinforcement.
- Structural Analysis for lifting and transportation (for purpose of proving structural integrity).

And additionally for jackets:

- Marine growth information.
- Flooded member check.
- Property thickness measurements.
- Anode locations.
- Details of risers/caissons/J-tubes and other appurtenances.
- 3D seabed survey results.
- All pile data relevant for cutting (grout, stabbing points etc).
- Drill cuttings and other seabed related issues.



Seabed Survey Debris Inventory

During the engineering and preparation phase the following major activities are done by the contractor (with other activities possibly required):

- Review Company supplied weight reports and CoG calculations.
- Design rigging and sizing of padeyes/padears.
- Review design of existing lift points.
- Design transportation grillage / sea fastenings.
- Design removal aids, tugger points, sling platforms etc.
- Evaluate items to be removed from the topsides and jacket prior to lifting e.g.walkways, stairways riser, caissons etc.
- Develop procedures for topsides removal and disposal.
- Evaluate pile cutting procedures.
- Design lifting method for jacket.
- Design removal aids, tugger points, sling laydown on jacket.
- Develop procedures for pile removal.
- Develop procedures for jacket removal.
- Develop procedures for pipeline cutting and burial of pipe end.
- Define of maximum allowable sea state under which operations can be carried out.
- Develop work schedules and planning.
- Prepare platform removal manuals.

A design brief is prepared by the marine contractor's engineering department, which describes the design basis for the removal engineering work and which provides a reference to all codes, specifications, project requirements, environmental data, and design criteria. The brief is used by the HLV contractor's project team to develop the engineering work required to confirm and verify that all engineering work complies with project and statutory requirements.

The contractors engineering planning includes design documents, drawings (anchor plans, lift drawings, barge layouts, etc,) calculations (padeye strength calculations, etc); procedures; reports.

Offshore execution

A typical removal operation would involve a crane vessel positioning itself (either by anchoring or DP) adjacent to a platform and removing the topside and/or modules in a pre-determined sequence. The crane vessel then places them on pre-prepared cargo barges or onto the deck of the crane vessel for transport to the selected onshore deconstruction site.

Offshore lifting operations do not fall into a single common category. Some crane vessels suitable for a lifting operation on one platform may be unsuitable for a similar lifting operation at another location. Unlike installation whereby the design of the platform can take into account the installation method and the HLV to accomplish this, in decommissioning this flexibility does not exist, and the market must be assessed to select the most suitable HLV.

The main aspects to be considered for the selection of the optimum crane vessel for the removal of platform topsides are as follows:

- The revolving lift capacity, the lift height and the lift radius of the vessel's crane.
- HLV Contractor's reputation and removal experience.
- Contractor's flexibility in relation to other commitments.
- The lift weight, dimensions and relative position.
- Anchor patterns and/or DP.
- Compatibility of vessel specifications to the required operational area i.e., operating draft and access to work area, access to demolition yard's quayside, etc.
- Suitable deck load capacity and storage space where transportation or temporarily storage on the deck of the HLV is necessary.
- Availability- hence the need for operator flexibility on timing.

Weather downtime is the most complex criteria to assess and should be included in the removal lump sum of the contractor since he knows best the dynamic behavior of the crane vessel. The lifting operations offshore are restricted by a combination of:

- Wave height, swell and period
- Vessel position in relation to prevailing environmental conditions
- Individual vessel stability and motion response
- Wind strength
- Water depth
- Ability to transfer personnel

The decision to continue operations in limited weather is always based on the judgment of the vessel captain. By studying the statistical meteorological data for the anticipated removal period the contractor can estimate a mean weather downtime for the operation.

Ideally the removals contract requires the HLV contractor to remove both topsides and jacket as this is generally more economic. However in some cases the operator may choose, or have no option, to remove the topsides by taking it down piece by piece offshore (known as piece-meal or piece-small method) using a demolition contractor, to leave only the topsides main support frame and the jacket to be lifted by the HLV. This is usually only appropriate in cases where the structural integrity of the topside has been changed over time such that lifting is no longer an option without major strengthening of the modules and reinstating new girders. Piece-meal removal has not yet proven to be particularly successful in cost and time savings especially in the GOM and the North Sea. Generally, lifting of the complete topside is preferred, not least because the significant number of offshore man hours involved in the piece-meal removal of the topside can cause a safety issues which should not be under estimated. In addition, re-use of deck structures or components and equipment is no longer possible as the deconstructed equipment is often exposed too long to the highly aggressive salty offshore atmosphere.

Major Decommissioning activities- preparation, subsea work, topside removal, jacket removal

Preparation & Engineering
It is usual, but not always if agreed otherwise in the HLV scope of work, for the operator to perform the initial stage of preparatory work using its production offshore crews and contractors who are obviously the most familiar with the platform. This work is normally done when the platform is still operational and in custody of the operator.

From the contractors perspective thorough preparation of the platform always reduces offshore time and hence cost. However this message very often does not get through to the operator HLV contractors work within tight seasonal schedules and it is not in their interests to prolong offshore time beyond that planned, hence they are focused on ensuring that preparation work is thorough and that any extraneous work needed while the HLV is on location is minimized. The early co-operation between operator and the HLV contractor in this critical area is the key to a successful decommissioning project. Delays in the offshore execution will usually be due to poor preparation of the platform.

From the lifting aspect there are two types of topsides. The smaller single-lift project in which there is little or no preparatory work, and the larger platform topsides with multiple lifts. The latter will require much more preparation work and a good deal more planning. Likewise, jackets differ greatly and the associated preparatory work will vary in extent.

Signing up a removal contract with a heavy lift contractor at an early stage ensures the methodology of removal is fully understood and agreed and that all preparatory work can be done economically and efficiently. The HLV contractor can advise the operator what has to be removed and what can be prepared in the hook down phase reducing costly re-work to the minimum. Moreover with good co-operation, extensive offshore preparation can be done if required without an expensive heavy lift vessel on site, which again reduces the total removal costs. The organisation for the overall management, coördination, and

Courtesy of Dr Nabavian, PSN Advanced Integrity Group execution of the removal activities associated with the above work packages is developed jointly in co-operation with the operator and HLV contractor.It is vital to agree who is responsible for the various elements of the preparatory works which needs a high level of attention as key activities are easily overlooked. There are many examples of this in recent decommissioning projects. Two items cause the most problems in the preparation and concurrent engineering stages.

Firstly it is critical that all the relevant drawings of the topside and jacket are to hand, both as - built and modifications. This is often more difficult that it seems since platforms can be 25-30 years old and documentation may well have been 'lost' over the years with office moves, mergers and field ownership changes. The method of data storage will have changed meaning that much work will have to be done by technical staff to update the data or retract the old files if information is to be widely shared.

When insufficient detailed information is at hand at the moment of tendering, and/or platforms have aged substantially overtime, operators should be realistic in their approach and accept reimbursement packages within the lump sum removal scope. It is unrealistic to expect that the removal contractor can take the commercial risk associated with unforeseen extra work.

Secondly the topside may have been changed structurally over time. Main girders, essential for lifting, as well as the original lifting points are often removed in the course of the platform life. These will have to be restored and tested. It will be a time consuming project and best carried out well before an expensive HLV is alongside waiting to lift.

Typical topsides preparatory work that would be carried out by the operator, is as follows:

- Isolate topsides.
- Clean-up the platform, and remove all liquids.
- If LSA scale is present, remove by established procedures and in compliance with regulations.
- Flush and purge allm process systems. If piping within the topside is to be cut then it should be cut directly after flushing and is sealed off. The location of the cut is made in close communication with the HLV contractor.
- Install start points for scaffolding or install scaffolding on the topsides for the HLV riggers. Rope access is often considered.
- Non Destructive test (NDE) critical structural members and joints.
- NDE existing topsides pad-eyes that are to be used.
- Install and NDE topsides pad-eyes or trunnions removing existing pad-eyes if required by the engineering assessment. This work is often required on multiple lift topsides where access to the lift points is not available at the same time. Note that pad-eyes may have to be installed later as well after a module is removed.

- Install and NDE topsides reinforcement and other additional steel work, as required.
- Note that when trunnions are used at the bottom end of the deck a spreader frame can be used with vertical slings connected to pad-eyes so that the frame takes the horizontal forces. This is a much cheaper arrangement than reinforcing the deck.
- Isolate any above-water subsea pipeline and umbilical.
- Disconnect jacket and topsides appurtenances including risers, caissons, and j-tubes. Remove remaining small items from the platforms.
- Remove all liquids from the platform.
- Establish a horizontal gap of at least one (1) meter between the pipe-ends running through the cut line between the components of the structure to avoid snagging during removal of the modules. The pipe ends may also be blinded if required to avoid emissions of hydro carbons.

- Replace topsides grating panels in areas which are considered to be unsafe.
- Cut open hatches for sling path access.
- Weld down deck hatches.

Clearly in developing the removal methodology mentioned above, the precise who-does-what-and-when (called by some the 'preparatory work interface matrix') is critical to ensure that time is not lost nor safety compromised.

Underwater preparatory activities vary greatly between platforms and there is no set approach. In most cases this work is done by the operator's subsea or diving contractor and executed well before the HLV contractor arrives in the field.

A typical subsea preparation plan would:
- Survey debris around the jacket footprint of the jacket and the removal of significant debris (greater than 30x30cm). A typical survey would have a radius of 50m around the platform and be performed by a ROV.
- Confirm structural integrity and condition of members (flooded member check).
- Check on any pipeline or scour rock-dumps or other protection devices.
- Check presence of grout spoilage on the conductor framing, mudmats and around the jacket legs.
- Prepare the seabed to perform external cutting of the platform piles if internal cutting is not possible, i.e. piles are grouted internally (hence one reason for good as-built information).
- Consider removal of marine growth prior to lifting jacket. The value of this and the amount removed is often debatable and will depend upon the extent of marine growth found in the survey and the operators own policies. As a guide, if 50% of the structure down to -10m LAT is covered and the growth is 50mm or more then it should be removed. Removal may be by using a diver operated waterjet at -10m and if necessary, in a sea swell, continue with manual scraping at the splash zone for safety reasons. Most marine growth will be hard (mussels) or soft.
- (anemones and weed growth).
- 3D seabed survey is recommended 10m around the jacket legs to get an understanding of the presence of any debris underneath the seabed. This is of importance when soils need to be excavated around the jacket piles.

Preparation for topside lifting inevitably needs work required just prior to lifting operations. Not all preparatory work can be done prior to arrival of the HLV, due either to limited access or as a result of the planned removal sequence. Since the HLV will be on site anyway this stage is usually performed by the HLV contractor. Given the cost of this work compared with carrying out work prior to the HLV arrival, the importance of agreeing the makeup of the pre HLV work packages and responsibilities in order to minimize offshore time is clear.

Typical preparation activities for the HLV contractor once mobilized to the site would include
- Anchoring out and positioning the HLV at the platform. Particularly important here is the position of live producing pipe-lines in the area which were not there on installation.
- Making the platform safe; re-instate walkways, indicate the no-go-zones etc.
- Preparing the platform topsides for removal by a single or multi lifts.
- Performing a ROV pre-removal debris seabed survey around and inside the jacket.
- Checking that all pre-lift preparatory work on the platform is completed.
- Installing trunnions and pad-eyes not done in the preperation phase.
- If conductors are cut at this stage, preparing the conductor for lfting off.
- Welding out and inspection of jacket pad-eyes, trunnions, or lift lugs which could nog be pre-installed.
- Performing a ROV visual survey of all miscellaneous structures attached to the jacket to verify it's safe to lift.
- Disconnecting the modules / topside and cutting them loose from the main structure.

Topside removal procedures

After completion by the HLV of the pre-lift preparatory work the rigging is attached to the topside. The exact method of how the rigging is connected and what kind of rigging arrangement will be used is determined during the engineering phase of the project.

Most topsides can be lifted using a four point/single hook lift arrangement, without the use of a spreader frame/spreader beam in the same manner as the original installation method. Alternatively a spreader can also be used as determined by the contractor, reducing the horizontal forces in the top deck of the module.

Once lifted free from the platform jacket, the topside is then lifted either on to a transportation barge or on to the deck of the HLV. A typical sequence of activities offshore would be as follows:

- Install the topside rigging.
- Hook-on the topside rigging to the crane (main) hook.
- Obtain approval from the company and a Marine Warranty Surveyor to lift.
- Cut the topside loose from the main structure.
- Lift the topside off the platform and back load it onto the grillage/load spreaders installed on the cargo barge or HLV deck.
- Secure the topside package to the grillage and disconnect the rigging.
- Prepare for the next lift.

The main risk associated with topsides removal is that the topside is not properly prepared as per the pre-agreed interface matrix, that liquids are left behind without proper identification so that contractors have no idea what they deal with, or that preparatory works have been done differently to that agreed in the engineering phase without informing the contractor. The consequence of these can be substantial and may require costly re-work by the HLV contractor with its crane vessel on site.

Although the contractor transports the topside/modules to a designated pre-agreed dismantling yard, it remains the full responsibility of the operator to have all licenses and paperwork in-place to import the structures from offshore. Different countries have different rules and guidelines and it would not be the first time that cargo barges were held in custody and offloading was not permitted due to a lack of the right paperwork.

Jacket removal

With regards to jacket removal, two types of jackets are identified, both requiring a complete different approach:

- Simple jackets which can be removed in single lift.
- Complex jackets requiring offshore structural separation(s) before lifting.

Simple jacket, single lift removal

For this type of jacket, the highest uncertainties and thus risk, is the cutting of the piles either internally, externally or sometimes both. Subsea cutting is on the critical planning path of all decommissioning operations. Should a cutting operation be delayed it will tie-up the marine spread; i.e. the crane vessel, barges, etc. Access to the pile either from the outside or from the inside is required to remove the jacket.

Piles generally have to be cut 6 meters below the seabed. To avoid having the contractor excavate large holes around the jacket legs, access from the inside is strongly preferred. However this is not always possible: in one case debris had been dropped into the pile during pile installation and internal soil plug excavation to approx 6-10m below seabed was impossible. In another case, although it was known that piles had to be cut from the outside, there was no easy access on the outside to the pile due to grout spoilage on the seabed. Both cases cause substantial extra work to remove the jacket, while this could have been averted if more attention had been paid to a potential problem in the preparatory phase. It cannot be stressed enough how important the original jacket installation and pile and conductor driving records can be at the planning stage to reduce these uncertainties, records which would include details of the soil conditions at the site as well about the grouting operation.

Complex jacket, subsea separation before lifting

In the case of large jackets, the jacket will have to be separated prior to lifting. This is a difficult, costly, complicated and time consuming operation that takes considerable planning and knowledge of the structure for success. Braces may have to be removed as well as entire jacket rows. Braces are best cut with hydraulic shears where the number of handling activities is generally less than other cutting methods, resulting in reduced offshore delays. Once severed by the shear, X-braces in a jacket row can be removed with the heavy lift vessel crane. For that purpose, specialized equipment such as special jaws, forks etc. are required to hook-on and lift these braces safely.

For the removal of row sections of the jacket and/or for the removal of the top section of a jacket, the jacket legs are cut by a diamond wire. (See further details on this tool in the section 'pile cutting'). A 'Z' shaped cut is made in all legs, to ensure sufficient stability of the "cut section" once all legs have been severed. When all legs have been successfully cut, the jacket section is hooked on and lifted. Because the elevations of the cuts are never the same, the contractor should give special attention to the grillage design on the cargo barge (or HLV) to accommodate the unequal loads. Lifting of the bottom section of the jacket must be studied extensively during the engineering phase. Installation of lift points at the same elevation on this type of structure is close to impossible. Moreover, suction underneath the mudmats and possible soil, drill mud or grout on top of the mud mat could result in excessive high loads that exceed the structural strength of the bottom elevation of the jacket. Hence detailed engineering studies and pre-surveys by divers are required to minimize these substantial uncertainties.

Subsea separation of the jacket structure will not be further addressed because of the extent of this activity, and because every jacket needs to be looked at in detail. It is emphasized that for jackets requiring subsea separation, the operator should align himself already in a very early phase with a heavy lift contractor. Detailed engineering studies essential to develop the safest method.

Pile Cutting

Typical issues associated with the pile removal are:

- Seabed and soil conditions.
- Presence of any debris underneath the seabed in the vicinity of the piles.
- Removing of soil plug approx 6-10m below mudline. Piles are generally cut 3-6m below the seabed. Therefore, soil needs removing 2-3m deeper for access by the cutting tool.
- Removing of soil plugs from skirt piles by means of drilling (in case of hard clay).
- Access to the pile internally and verification of the piles internal diameter using a 'Chaser'.
- Use of a 'pile-top' drilling rig if piles need to be drilled out (in case of clay).
- Use of an airlift if the pile soil plug can be removed by airlifting (sand, soft clay).
- Cutting of the piles internally using abrasive jetting or explosives.
- Cutting of the piles externally if they are grout filled using diamond wire.
- The removal of pile sections out of the jacket leg: This is not always possible since they may have been damaged during installation.

The pile severing techniques as described in the following sections can be used for skirt piles and through the leg main piles. Where applicable, comments are given for a specific foundation pile concept.

Typical 'chaser' to verify pile access

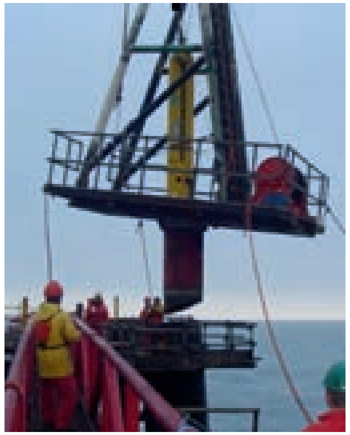
Internal pile cutting

Commonly it is not known how much soil needs to be removed since the internal heights of the soil plugs are unknown. Prior to commencing soil plug removal, the internal pile clearance of the 'through the leg' pile will be verified by means of a "Chaser", a piece of pipe conical on either end, which is run up and down inside the pile to seabed level to confirm free access.

For internal cutting, the soil level should be a minimum of 2m below the required cutting elevation to allow for clearance for the cutting tool and to allow for soils entering the pile through the abrasive jet cut. The removal of the soil plug is usually done by means of airlifting. Here an airlift string is stabbed inside the pile with the HLV crane. By inserting air at the mouth of the pipe, water and sand are evacuated to the top of the pile at jacket top level.

When the jacket foundation consists of skirt piles, the soil plug is removed by air-lifting or water jetting. In the event that the soil consists of very hard clays and drilling is required, the skirt pile is extended upwards with pipe or drill casing to support the pile top drill rig required. After the soil plug is removed, internal pile cutting at pre agreed depth (-3 to -6m) is carried out with abrasive jetting. The principle of abrasive water jet systems is to utilize the kinetic energy of abrasive particles entrained in a high velocity water jet to erode the target material.

The efficiency of the cutting depends upon the velocity of the particles and distribution of the grit within the jet profile. Most conventional methods use a cutting head with a nozzle mounted on a manipulator lowered inside the pile, which is connected to an abrasive water jetting system on the surface through an integrated umbilical. A manipulator holds the nozzle and controls the travel at a constant speed along the cut path. The cutting jet is a mixture of water and grit (typically copper slag) that is delivered at high pressure through the nozzle to the work piece. A track is set up on the member allowing the nozzle to be guided around the member at the required cut line. The nozzle is held approximately 5mm from the work piece. Initially the tool is on hold, with the abrasive jet on, which produces a 7mm diameter hole in the pile wall. The tool then is driven around the track, at the applicable rate for cutting, in one direction for 400 degrees to ensure a 360 degree cut. The main risk in abrasive cutting is that the cut is made in an up - or downward spiral and thus not returning at its starting point. Unfortunately, to date the specialized contractors



have still not developed a method to prove 100% that the pile is fully cut. Hence proof of cut can only be made by lifting the pile using the crane. Abrasive cutting can be performed both internally and externally depending upon the make up of the tool. Recently, an abrasive cutting tool was used to cut jacket legs and jacket braces from the outside. Through leg piles are usually removed as part of the jacket lift and offloaded together with the jacket on to a barge or the HLV. In several removals the pile could not be extracted from the jacket leg as they had been bent and had become stuck in the jacket leg during the pile installation. Whether the pile installation reports mentioned this is not known.

External pile cutting

The cutting of piles filled with grout or those inaccessible internally by other means, is usually carried out using a diamond wire cutting tool from the outside. Sufficient soil will have to be removed around the pile in order to gain access to the pile at the cutting depth. Hence the importance of knowing about and being prepared for the prevailing soil conditions as well as the presence of debris around the pile underneath the seabed and possible grout spoilage on the seabed. Because the tool is substantial in size and the tool is engaged with the pile while cutting, a hole of substantial size around the leg is required to be dredged which may refill if the seabed is sand. A sizeable hole will be difficult to achieve if the soil is clay.

The advantage of a diamond wire tool is that it is suitable for cutting through multi-layered materials (e.g. steel-grout-steel) and, by passing the wire through the cut object, it demonstrates that that the pile is cut through. The diamond wire saw is an endless loop of diamond wire running over an assembly of drive guide wheels.

The assembly is moved externally at a controlled speed over the section to be cut. The wire itself has a steel core fitted with carbon steel beads spaced at regular intervals that are covered with diamond particles. Typical cutting times for a platform leg would be about 6 hours excluding deployment and installation. Installation of the saw around the pile could be a time consuming operation and the actual duration will depend on the accessibility of the pile; size of the dredged hole (which gives maneuverability) and the presence of overlaying mudmats, braces etc. When Z-cuts are made, a number of piles, if not all, can probably be cut from another vessel before the HLV arrives in the field. In all circumstances the hole around the pile should have been dredged before the HLV starts the jacket removal operation.

Explosives, Shaped charges

Explosives are used on some occasions and in some countries for severing of the piles. Two types of explosives are known; bulk-charges and shaped charges. With bulk charges, a relative high charge of explosives is installed in the pile to severe the pile. The disadvantageous of bulk-charges is that the cut is never square and it could tear open the pile. Shaped charges are much more sophisticated. Substantial smaller charges are needed and a square cut can be made. Shaped charges can be installed on the outside as well as on the inside of a tubular.

When explosives are used, all vessels are moved out a sufficient distance from the platform prior to detonation. The disadvantage of explosives is the environmental damage and the risk associated with the situation if one or more of the charges are not detonated.

Lifting of jacket

Once all piles have been severed, the contractor can make an attempt to lift the jacket. Because piles may have been bent during the installation and consequently stuck in the jacket legs, the jacket can be lifted with the main piles in place. A disadvantage of lifting the jacket with the piles is the uncertainty that one or more piles are not fully cut, while this is known immediately when piles are pulled out of the jacket leg one by one. Moreover, the pile stubs that still penetrate the seabed could cause substantial friction resulting in a higher than necessary hook load during the initial lift-off of the jacket. The exact method and how the rigging is connected to the jacket for lifting are determined during the engineering phase of the project. Typical possible methods include the following:

- Welding out of new trunnions-type lift points on jacket leg cans or.
- Welding out of new pad-eye type lift points on jacket legs or.
- Welding a lift frame on top of the jacket or.
- Cutting holes in the top of the pile/jacket leg for the purpose of connection shackles.
- To break the friction alongside the pile stubs and break possible suction underneath the mudmats, an uneven rigging length is generally selected so that one side of the jacket comes free from the seabed first.

Prior to lifting of the jacket the following structures are removed or secured:

- Temporary work platform
- Extraneous piping such as caissons, conductors
- Pre-cut piles
- Loose grating or any other loose structure

Once the rigging is connected, most procedures then require the operator's and the operator's Marine Surveyor's approval before the jacket is lifted free from the seabed and slewed towards the HLV deck. Pile stubs sticking out underneath the jacket legs (approx. 3-6m) are cut-off and the total length of the piles recovered is recorded. Once the pile stubs have been removed, the jacket can be placed on pre-installed grillage of the cargo barge or onto the deck of the HLV and sea fastened for transportation to the demolition yard.

After the final lift there is usually a post removal seabed survey carried out by the heavy lift contractor approx 15 m around footprint of the jacket to prove there are no dropped objects by the contractor. Upon completion of this the HLV is demobilized,

The authorities generally require the operator to carry out a ROV survey and trawler runs over a much larger area to prove that no debris of substantial size is left behind. With regards to the removal of jackets which have to be separated below the water surface offshore prior to lifting, the authors refer to the brief paragraph above that removal of these type of jackets requires a substantial level of engineering and a detailed description of the procedure is beyond the scope of this booklet.

Key Features

- Platform structural information is required to reduce odds on delays
- Carry out 3D seabed survey
- Pile cutting is one of the most critical activities
- To sever jackets, shears, diamond wire or abrasive cutting can be used

Onshore disposal

Onshore disposal is the primary method of decommissioning offshore structures. The onshore dismantling of offshore structures is a specialized business and requires an appropriate facility or purpose built dismantling site in order to undertake these activities in an environmentally acceptable manner.

The selection of a site suitable for the offloading and dismantling of the structures is made by the operator in conjunction with the HLV contractor on the basis of economic, environmental operational criteria and contractor's vessel specification. The selection criteria may include the following in random order:

- Sailing distance from the location
- Water depth of the port
- Offloading and heavy lift capabilities
- Yard space
- Bonded areas and covered/open storage capacity
- Adequacy of safety, environmental and waste management systems
- Decontamination facilities
- Security arrangements
- Adequacy of material control procedures

In order to perform demolition work in a safe, efficient and environmentally friendly manner, the site requires a relatively large work area, storage and dedicated facilities where cleaning can take place without pollutants and impurities escaping into the surrounding land or sea. A watertight floor is required with a proper bund wall or water/fluid collection system around the topside work area during demolition. Such a system ensures that no liquids can leak into the environment during the dismantling.

Demolition methods vary but will involve landing the components, then cleaning, stripping and sorting for recycling, reuse or waste disposal. Landing uses the HLV crane vessel, yard craneage, or occasionally multi-wheelers. Internal transport over the yard would be by cranes, skidding or multi-wheelers. Prior to any work on the topside or any separation of the module the modules are inspected (even if the work has largely been done offshore) and where hazardous materials are identified, a specialized contractor will come in to remove material such as asbestos, mercury LSA contaminated piping, oil and sludge contamination etc. There may be final flushing of piping, vessels and tanks to ensure that no contamination has been left. Methods used depend on the inspection and local requirements and may range from simply flushing by fresh water to use of chemicals and/or mechanical cleaning. Hazardous material is treated separately and disposed of in compliance with the local rules and regulations. Because the extent of the contamination is not certain, even after an extensive inventory offshore, it is recommended to carry-out the removal and disposal of the hazardous waste on a reimbursable basis at pre-agreed rates.

Once the topside module is confirmed as clean, salvageable equipment and components will be removed from the topside. Modules may be cut and segmented using a combination of shears and burn torches to a transportable size at the yard or shipped in bigger pieces to a scrap yard for final reduction.

The dismantling contractors' experience is that ordinary burners are quite efficient when operated by experienced personnel. This method does not require the use of expensive nibblers or dedicated cutting equipment.

Most of the marine growth on the jacket structure will be in the zone down to 30m below water level. Several removal methods are available, but the most cost effective and by far the most environmentally friendly way, is to use high-pressure water jets.

The jacket structure is usually divided at the yard into sections weighing between 40 to 60 tonnes. Experience has shown that this section size allows for easy handling and further reduction using lighter cranes and equipment. Several methods for cutting tubular steel members exist although excavator mounted shears are commonly used. During the demolition of the platform, all components are separated. As such, copper, steel, zinc, plastics, grout, etc are separated and collected for recycling. On the-Conoco-Phillips Viking project a total of 99.7% of the 9700t of offshore structures removed was recycled.

The disposal contractor will usually establish a "Duty of Care" system for monitoring and recording of all material and components handled. The final proof of proper disposal documentation should give details of materials sent for recycling, reuse and waste. Record keeping and documentation elements of waste management are implemented according to the relevant Pollution Control and Environmental Protection Legislation and Policy in force in the particular country of the dismantling site. This will detail and track where all materials are eventually sent. This is particularly important for waste products such as chemicals, biocides, oil contaminated materials, asbestos materials, LSA scale, Halon, Freon, Pyrophoric materials such as Hydrogen Sulphide (H2S), and PCBs.

Throughout the onshore dismantling process it is the responsibility of the operator to check that disposal of its platform is properly carried out.

Key Features

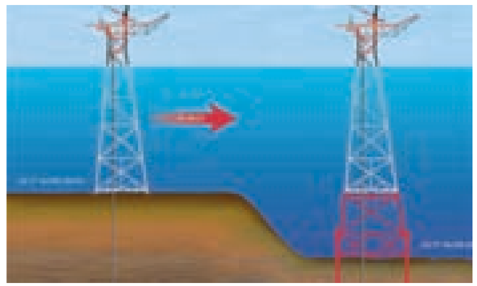
- Disposal of hazardous material at 'rates' is more cost effective
- Dismantling yards must have a watertight floor to prevent leakage of contaminated water
- With the collaboration of the owner, a high recycling percentage is possible

Re-use of facility

There are a number of issues, considerations and planning stages of re-using an offshore platform. As a general rule, due to age and specific usage, redundant offshore platforms have no future, sooner or later, other than proper dismantling, recycling, and disposal. It should be said that decommissioning is the last stage in the operating life of a facility. The extended use of installations usually by a change of ownership is a re-use option in place that may considerably extend field economic life. Such options will attract new, perhaps leaner more focused owners and may include work or usage around or from the installation even though the installation itself is a decommissioning candidate. In general the decommissioning liability is transferred to the new owner.

In effect the platform can be re-used for:

- Future tiebacks of satellite wells, subsea wells or marginal fields.
- Use as a tie-in connection to other fields.
- Future improvement in enhanced oil recovery techniques extending economic life of the field/well being exploited.
- Extended reach, sidetracks or horizontal wells drilled from subsea wells tied back to the installation to develop untapped reservoir areas.
- Further reservoir development based on 3D/4D seismic acquisition, processing and interpretation.
- Gas or CO^{2} storage.



Courtesy of ATP Oil and Gas

The second stage of re-use is for production purposes at a new location. This would involve removal and relocation in another field or selling to another company for production purposes. This practice is common in the Gulf of Mexico where jackets have even been extended to match water depths at the new locations, but in the North Sea and in other areas the re-use market is still in its infancy.

Here, re-use and/or reconfiguration of jackets is found to be uneconomical and introduces a high field development risk from possible recertification problems. However successful transfers of platforms have taken place, notably Wintershall K10C to Clyde Q4A in the Dutch sector and GDF-Suez K12 topside was revamped and redeployed as the G16a-A platform topside three months later. Recently the Welland topsides from the UK was shipped to West Africa. Whilst there are possibilities for reusing or selling steel facilities at new locations, there are several operating parameters that dictate the feasibility of achieving this, including the following:

- Estimated time for new build
- Cost for required modifications for operations and/or HSE requirements
- Cost of removal and transport to a new location
- Cost to make the facility compliant for the new location

Re-use of a steel jacket is generally not economical and a high risk. Apart from the uncertainty of the structural integrity and the possible consequential delays when welds of jacket nodes need to be repaired prior to re-installation, it is also not certain whether the jacket and piles can be removed without damage. Cases are known where piles appeared to be bent and could not be extracted from the jacket leg or mudmats and bottom brace elevations were damaged during the recovery of the jacket due to grout spoilage or sand on the mudmats.

Even if there was a site perfectly matching the conditions for a re-use platform there is a reluctance of in-house engineers especially from the majors and engineering contractors to commit to second hand equipment. The realistic reasons given include the need to update instrumentation for compatibility and safety purposes. The time and cost of modernization or de-customization also has the potential of exceeding the new build cost.

Of great importance is the question of liability in the event of failure of the component, failure that could have great consequences for life, the environment and economics.

If re-use of the installation as a whole is not possible or conversion leads to equipment becoming redundant, then re-use or resale of some of the major items of equipment is an option. Generally it can be considered that the greater the standardization of a unit, the greater the resale value. Saleable items need to be identified and catalogued and should include information on size, weight, design, capacity, dimensions, run hours, present condition and certification, etc. The ease with which certain packages can be split should be noted if the possibility exists to sell or reuse the equipment as individual items. Typical packages which could offer the greatest potential for sale/ re-use would include: Cranes: Fire Pumps: Emergency Generators: Main Generator Packages: Glycol Dehydration Units: Drilling Equipment: Electrical Equipment: Separators: Pumps: Process and Utility Vessels: Heat Exchangers: Living Quarters.

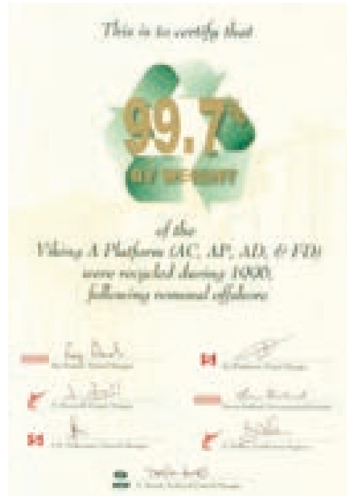
It would be a mistake to over simplify the issue of reselling a structure either partially or in its entirety for re-use and to regard re-use as a straight forward exercise or expect substantial cash flow from it. There are several areas where potential difficulties may arise not least marketing and maintenance. For re-use at the end of life, operators would need to plan to maintain the asset at a high standard, with any mothballing period being minimized to avoid rapid decay in the installation's condition. The price for the buyer is generally heavily over-estimated by the seller. Consequently the expected sales price is set too high resulting in potential buyers ignoring possibilities. Resale values for used equipment are low and the cost of marketing may therefore exceed revenues obtained. This is not the case in areas such as the Gulf of Mexico where, with a large offshore market looking for bargains, re-use of equipment is well established between potential buyers relatively close by to each other. There are always companies who specialize in second hand equipment and these should be the first port of call. Generally it would be the onshore dismantling contractor who would assume this task as part of the contract remuneration package for dismantling the platform.

The best example of re-using parts of a platform in non oil industry ways was the Viking field where awards were won by the Conoco-Phillips, the operator, and HLV contractor Seaway Heavy Lifting who imaginatively created the conditions to re-use 99.7% of the removed installations. As an illustration of what can be achieved, the projects team managed to re-use the materials as follows:

- The large steel deck sections were adapted and incorporated in a new quayside.
- Pipe bridges were used as quayside gangways.
- Jacket leg extensions were used as piling for quayside extensions.
- Pumps and generators found a new use in Russia.
- Nickel cadmium batteries were used in sustainable onshore energy projects.
- Temporary accommodation was refurbished for Third World use.
- Lifeboats were donated to Sea Scout organizations.
- Other uses were found for storage tanks, davits, winches and gas refrigeration plant.

This outstanding achievement has remained the benchmark of the industry ever since and was only achieved by the active support of Conoco-Phillips. It indicates that there are potentially many opportunities for the alternate use of a wide variety of an installation's components arising from an onshore deconstruction operation. The commercial value to the operator was close to zero if not negative. The public relations value though was substantial.

A redundant offshore facility could be used to serve purposes other than the petroleum business such as carbon sequestration and wind farms. Generally, such uses envisage the infrastructure remaining at its present location. Possibilities for these options are not generally considered a viable alternative for the majority of structures. And, of course, decommissioning obligations will be assumed by someone, be it owner or taxpayer sometime in the future.



In summary, re-use of a redundant platform is, at first sight, an attractive consideration to prolong the value of the initial investment. However in most cases decommissioning of the platform must be carried out and this cost will inevitably influence any decision to go ahead.

Key Features

- Re-use of entire platform is a risk but not impossible
- It is not uncommon that main piles are stuck in jacket legs
- Re-use of topsides require modifications to comply with current regulations

Contracts and Contracting Strategy

The premise for a good removals contract between a HLV contractor and the operator is to enable decommissioning to be done more effectively and efficiently and to allocate the risk and responsibilities where these belong. The General Terms and Conditions of a HLV decommissioning contract are outside the intent of this technical booklet. However the technical data required for a typical decommissioning or removals contract with a HLV contractor can be extensive and is often critical. Moreover, operators generally tend to use their 'on-the-shelf installation' contract- or worse their 'on-the-shelf fabrication' contract. These contracts are not suited for a decommissioning purpose and require extensive negotiations and alterations to allocate the risks where these belong.

General decommissioning contract issues and strategy

Removal contracts differ substantially from installation contracts and seek in general to reduce business risk not to ensure a timetable is met. As an example:

- When considering a decommissioning project contractors need time to look at the platform(s) before bidding to improve their understanding of risk and scope. Risk influences the cost of the project.
- Information provided on as-built status and integrity in the bid specification for both topsides and subsea decommissioning activity should be as comprehensive as possible to reduce risk.
- Any decommissioning contract should be as flexible as possible on time but with as tight as possible on scope to manage risk and reduce cost.
- The ownership of the platform remains at all stages of the removal with the owner/ operator. This should be kept in mind when drafting the removal contract.
- "Unknowns" should be clearly marked by the operator. Where risks can not be overseen a reimbursable mechanism should be introduced and agreed.

Multiple platform removal contracts

Multiple platform removal contracts between operators, might in the eyes of management appear attractive, but commercially this is not always necessary the case. There are a number of reasons for this. The most stringent contract condition of each operator will generally apply which could have a knock –on price increasing effect. As an example any delay with the removal or disposal of one platform (A) could have a consequential effect on the removal of the following platform (B) and several questions arise. For instance, would the owner of platform A then pay for the additional removal costs associated with platform B? Would the owner of platform A then accept any liabilities of platform B? Can both platforms be transported on the same cargo barge? And what if something happened during transportation caused by A or B?

Who takes the blame?
Such uncertainties, where liabilities need to be defined and responsibilities designated to owners makes drafting a removal contract close to impossible.

For the company's technical personnel involved in decommissioning, there is a significant part to play during preparation of the contract by providing vital technical information and support to the contractor. From experience, honesty, an open mind, and realism are the corner stones of a successful decommissioning contract.

Strategic Planning

Experience has shown that a company's contracting strategy must be clear in being prepared to undertake decommissioning of a platform as soon as possible after cessation of production, having previously prepared a decommissioning programme, and having had this approved by the Authorities. Also critical is having a contract with a HLV contractor in place to take advantage of flexibility in the HLV schedule. If decommissioning depends on other inter-field factors such as production interdependency, the strategic plan should focus on the sequence of removals, batch removals of the complex, part mothballing and a 'wide opportunity window' HLV removal contracts. Strategic planning in this manner will focus companies towards the management of decommissioning within the operations envelope, so maximizing on operational resources, minimizing maintenance programmes and minimizing decommissioning business risk.

The latter is the critical issue. The better the planning for the project, essentially to minimize business risk, then the less cost or cost overruns to the owner. The earlier (even years earlier) that a removal contract can be put in place, with technical details and procedures framework agreements to follow, then inevitably the better the planning. Experience has shown time and time again that, in decommissioning, the better the planning the better the offshore execution and ultimately, the less variations to the contract and thus less cost.

Timing of removal issues

Crucial to any planning and business risk assessment is timing of removal. Generally the contractor is technically prepared to undertake a project and often can fit in a small decommissioning project in a vessel's schedule. It tends to be the operator who is unready to engage the contractor on an opportunity basis by not having made the decision to decommission a platform nor have permission to do so. It is the lack of having a proper removal strategy in place to make use of a removal opportunity which contributes to driving removal costs up. There are a number of key issues that partly explain why this situation is prevalent worldwide such as economic and commercial considerations, partner influences, oil price, and focus on operations or allocations of funds for development rather than decommissioning. These issues must be addressed if the contractor is to be brought in early and planning for decommissioning must always be an integral part of late field life operational planning.

Engineering Procedures and Engineering Issues

One of the important but most difficult decommissioning tasks is the compilation of operator's platform data for the contractor. With platforms often 25 or more years old and having changed ownership perhaps several times, installation as-built data is often lost or incomplete. This should be remembered when planning a decommissioning project since the quality of this data will engender risk and consequently the price and possible unforeseen variations of the contract. Once again, early co-operation between the owner and contractor will do much to ensure that this lack of data does not affect the execution. The worst thing to do is to provide the contractor with limited information and imply that the data is accurate and complete.

Key Features

- A removal contract differs from an installation contract
- The responsibility of the platform remains with the operator
- Unforeseen risks at contract award should be reimbursed at 'rates' under the contract
- Involvement of the removal contractor at an early stage prevents re-work

Costs and Budgets

It is a misconception that a platform removal would cost less than an installation. The removal contractor's offshore work is at least equal to, if not more than, a platform installation. All preparatory works and work associated with making the platform safe which for a new build is normally done at the fabrication yard, is in decommissioning work done by the HLV contractor with its crane vessel on location.

It is well understood that there is a general underestimation of decommissioning costs by operators. Recent decommissioning projects in the North Sea have shown a final cost overrun between 30 and 50% of the budgeted cost estimate. A recent project was reputedly 100% over budget due to extensive offshore time. In real terms the cost greatly exceeded the installation costs, i.e. by hundreds of millions of pounds. Furthermore, costs for the same type of operation vary greatly between locations, e.g. the Gulf of Mexico versus the Gulf of Suez or the North Sea. These cost differences are mainly driven by the local environmental conditions, governmental guidelines (allowing structures to form reefs in situ or total onshore recycling of jackets) and the costs of major equipment like drilling rigs and heavy lift vessels.

It has been said that successful decommissioning depends upon 'planning, planning and planning'. This is undoubtedly true, but it should be added that really successful decommissioning depends upon having the right information available during the engineering phase of the project. Only with accurate and good information can a proper offshore schedule be prepared and a good cost assessment made.

By generating accurate decommissioning costs, operators are able to assess the tax and insurance aspects of a particular facility, thus allowing the company to know precisely how to report the net investment value. The accuracy of the cost evaluation affects the audit assessment of asset value information.

Over-estimating decommissioning costs produces an unnecessary over -accruals situation and elevates the cost of bonds and Letters of Credit. It follows that the larger the liability the harder it is for an operator to borrow against future income. By under-estimating decommissioning accruals, decommissioning costs will not be covered and worse, falling production cannot support the decommissioning cost shortfall. Getting cost estimates right therefore is good business and is an appropriate factor to be included in the definition of a successful decommissioning project.

Decommissioning estimates must cover every aspect of the removal process and the costs considered must be up-to-date and relevant to the specific platform. The cost drivers in decommissioning are well appreciated-it is the expert estimating of each element's cost that provides confidence in the final figure.

Typical cost drivers would be:

- Well abandonment
- Cleaning of the topsides
- Engineering and Management
- Preparation of the platform for removal
- Removal of subsea equipment
- Cleaning, burial or removal of pipelines
- Removal of structure topside and jacket
- Disposal
- On-going liability

Within these general areas, the major cost elements might include:

- Rigs
- Diving Support Vessels
- Offshore Accommodation which may be temporary on top of the platform or an accommodation jack-up
- Heavy Lift vessels or crane barge-daily rate and time offshore.
- Cargo barges
- Tugs
- Project Management
- Engineering
- Insurance
- Underwater cutting

- Making the platform safe
- Topside separation
- Topsides preparation for removal lift, including cleaning
- Structural steel fabrication
- Pipeline cleaning, re-burial, removal, removal of pipeline mats

It is unlikely that decommissioning costs will go down as experience is gained since normal market forces - competition, technology experience and expertise - that might be expected to lower costs are less significant players in the decommissioning industry. For example, the two largest cost elements are the cost of a drill rig and those for a crane vessel. For decommissioning, both types of equipment are in direct competition with field development and platform installation. As stated above, being prepared to remove a platform enables an operator to take advantage of short term rate changes which in rigs and support vessels can be significant. This is a variable and uncontrollable element which has been known to have halved or doubled in short periods due to supply and demand restraints and competition from other market segments.

However costs are mainly reduced by dedicated planning of appropriate decommissioning methodology started very early in a project combined with a wide removal window and a balanced removal contract which recognises the potential lack of accurate information available.

For decommissioning cost estimates to be accurate and meaningful, there must be an understanding of all underlying influences. Such influences are wide ranging. As an example, companies must be clear on their policies on safety, environment, utilization of offshore rated vessels and reputation management since all of these issues will influence the nature of the cost estimate. As an example, if a company policy resulted in underestimating these factors, decommissioning could look relatively inexpensive. However experience has shown that when projects are not properly executed the extra costs to get things right again could be excessive, easily doubling the budget. The other extreme is to increase costs for reputation reasons to a point where there is little gain in environmental or safety benefit. Consequently, to prepare a reasonable budget becomes a matter of judgment experience, with a clear company vision. Budgets should be revised frequently to account for the change in main cost drivers while a reasonable contingency should always be incorporated.

By working with contractors and consultants across the globe, operators can accurately determine the current costs of decommissioning offshore structures in a variety of locations. By utilizing the experience of industry experts involved in the various steps of the decommissioning procedure, specialized engineering companies and contractors who have completed a number of platform removals around the world, operators can consolidate global information about time and costs involved in platform removals. Using this information, they can establish and maintain an up-to-date cost evaluating system, incorporating the above described price fluctuations of the major cost drivers. From this data base consistent and accurate decommissioning estimates can be assessed and utilized for financial and planning purposes.

Key Features

- A removal contract with a large window is more cost efficient
- Successful decommissioning depends on sound planning
- It is unlikely that decommissioning costs will fundamentally decrease

Acknowledgement

Seaway Heavy Lifting thanks Mr. Tim Watson for his extensive contribution to this booklet. His expertise and extensive knowledge on decommissioning made it possible to prepare a booklet which should be of interest to a large variety of people in the industry from top management to engineers. His everlasting enthusiasm ensured that we finally finished the book.

If the reader has any questions or any suggestions, please do not hesitate to contact us.

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Appendix 1

International Frameworks and Conventions - timeline

1958 Geneva Convention
The current regulations have evolved from earlier conventions such as the 1958 Geneva Convention on the Continental Shelf, article 5 (5) which called for the total removal of all marine based structures. This international convention came into force long before deep-sea structures were ever emplaced.

1982 UNCLOS
The Geneva Convention was superseded by the UN Convention on the Law of the Seas 1982 (UNCLOS), Article 60 (3) of which permits partial removal of offshore structures provided IMO criteria are met.

1989 IMO Guidelines
Headquartered in London, the UN International Maritime Organization (IMO) sets the standards and guidelines for the removal of offshore installations worldwide. The 1989 IMO Guidelines mandated the complete removal of all structures in waters less 100 metres and substructures weighing less than 4,000 tonnes. Those in deeper waters could be partially removed leaving 55 metres of clear water column for safety of navigation.
After 1 January 1998 all platforms were designed so as to be feasible for complete removal. The opposite is therefore of some importance - platforms built before 1998 were NOT designed to be completely removed which is by far the majority of platforms in the world today.

1972 The London (Dumping) Convention
The London Convention (LC) is based at the IMO headquarters in London. The Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter (1972) was the first attempt to control 'dumping' of waste and material at sea. Dumping from vessels, aircraft and platforms and other materials on a list was banned. Other materials outside the primary list of prohibited materials had to have a special licence.
It has proven to be effective in providing a global basis for the application of sea disposal principles and a forum for discussion, negotiation and exchange of information.

1996 London Convention Protocol
This significant initiative seeks to be more environmentally minded than the London Dumping Convention. It will move away from a list of materials which may not be dumped to a limited list of materials which may be disposed at sea all others being prohibited. Waste can only be dumped after a rigorous assessment to ensure this is the best practical environmental option.

Regional conventions
In addition to the international legislative framework, there are a number of regional conventions that govern marine disposal in specific areas. These include for example:

- The Mediterranean (Barcelona Convention)
- Red Sea & Gulf of Aden (Jeddah Convention)
- Black Sea (Bucharest Convention)
- Kuwait Region (Kuwait Convention)
- West & Central Africa (Abidjan Convention)
- Baltic (Helsinki Convention)
- North East Atlantic (OSPAR)

The only regional convention that requires more demanding removal standards than the IMO and provides detailed guidance on the disposal of offshore structures is the **OSPAR Convention** that governs the North East Atlantic region. There are 16 contracting countries to the convention all of whom are in the European Union except Norway. Most importantly the region includes the North Sea. If differs from all other regional conventions by requiring since 1998, and following environmental protests over Shell's Brent Spar disposal plans, that all platforms be removed to shore irrespective of water depth. There is no partial removal in OSPAR as permitted by IMO except where special permission (derogation) is given to leave the base of the jacket structure in situ. The first decommissioning project using this derogation was granted to BP for the 40,000t North West Hutton platform in 147m water depth completed in July 2009.

Decommissioning programmes

The UK Government has published very detailed guidance (probably the most detailed worldwide) for operators on the decommissioning of disused offshore oil and gas installations. This decommissioning programme format, together with programmes from the US, now form the basis of many national regulations with local changes made as necessary. For example the Thailand Government is currently compiling guidelines along these lines.

Programmes will usually describe the platform(s) and the marine location. It will detail environmental and oceanographic conditions and detail how the company will mitigate any adverse environmental effects during decommissioning. Together with a project timeline, the programme will provide details of the removal method, usually developed with the marine removal contractor. An indicative cost estimate will be presented and the programme will describe how the seabed will look after the decommissioning project is complete. There is no set format, and it is usually a joint project between operator, contractor and the decommissioning team. It may or may not be a public document for public discussion as in the UK, this depending upon the policy of the host Government.

Disclaimer

This booklet gives general information about removal of offshore platforms.
It is subject to change without notice.

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Published in May 2011
By Seaway Heavy Lifting Engineering B.V.
The Netherlands