“Commissioning of Offshore Installations in Building Yards”

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Organised jointly by:

Centre of Innovation
Marine & Offshore Technology
Ngee Ann Polytechnic

Society of Naval Architects & Marine Engineers, Singapore

Joint Branch – Royal Institution of Naval Architects and Institute of Marine Engineering, Science & Technology

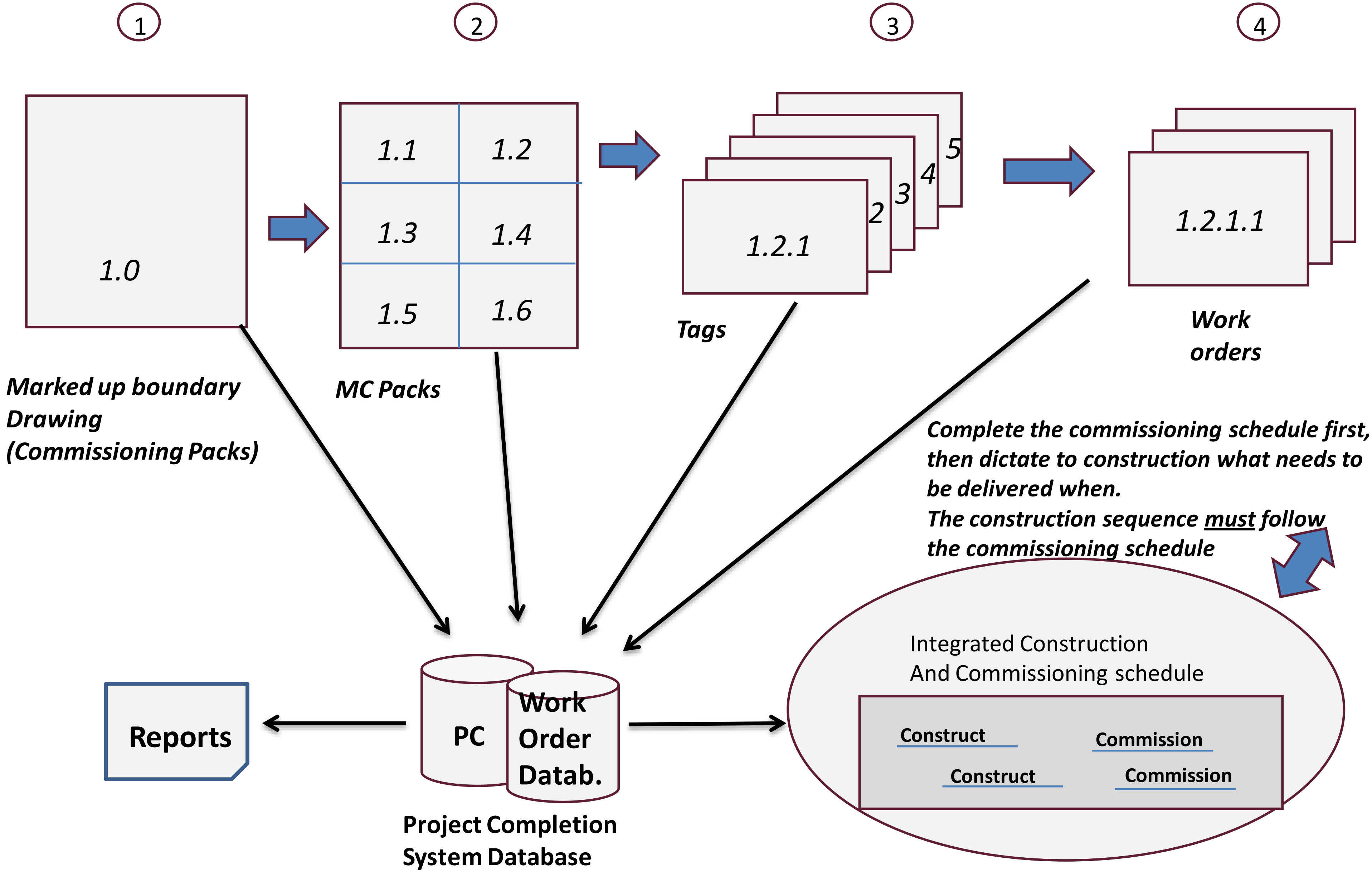
TOTAL "COMMISSIONING" ACTIVITY

Success in handing over a completely commissioned facility (such as a Drilling Rig or FPSO) to the operator, whether a new build or modification, is contingent upon the completion of numerous phases of the project, from the front end design and engineering through fabrication and final commissioning.

Before final hook-up and installation of an FPSO can be accomplished, three interrelated phases are undertaken :-

- **Mechanical Completion**
- **Pre- Commissioning**
- **and Commissioning**

Planning for them is critical to the schedule adherence, cost containment, successful installation and ultimate handoff for operation of the facility.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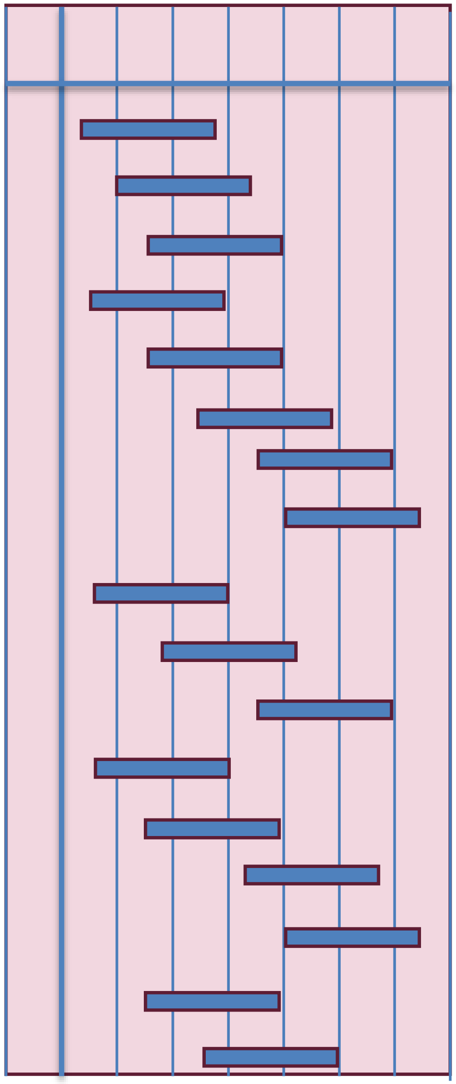
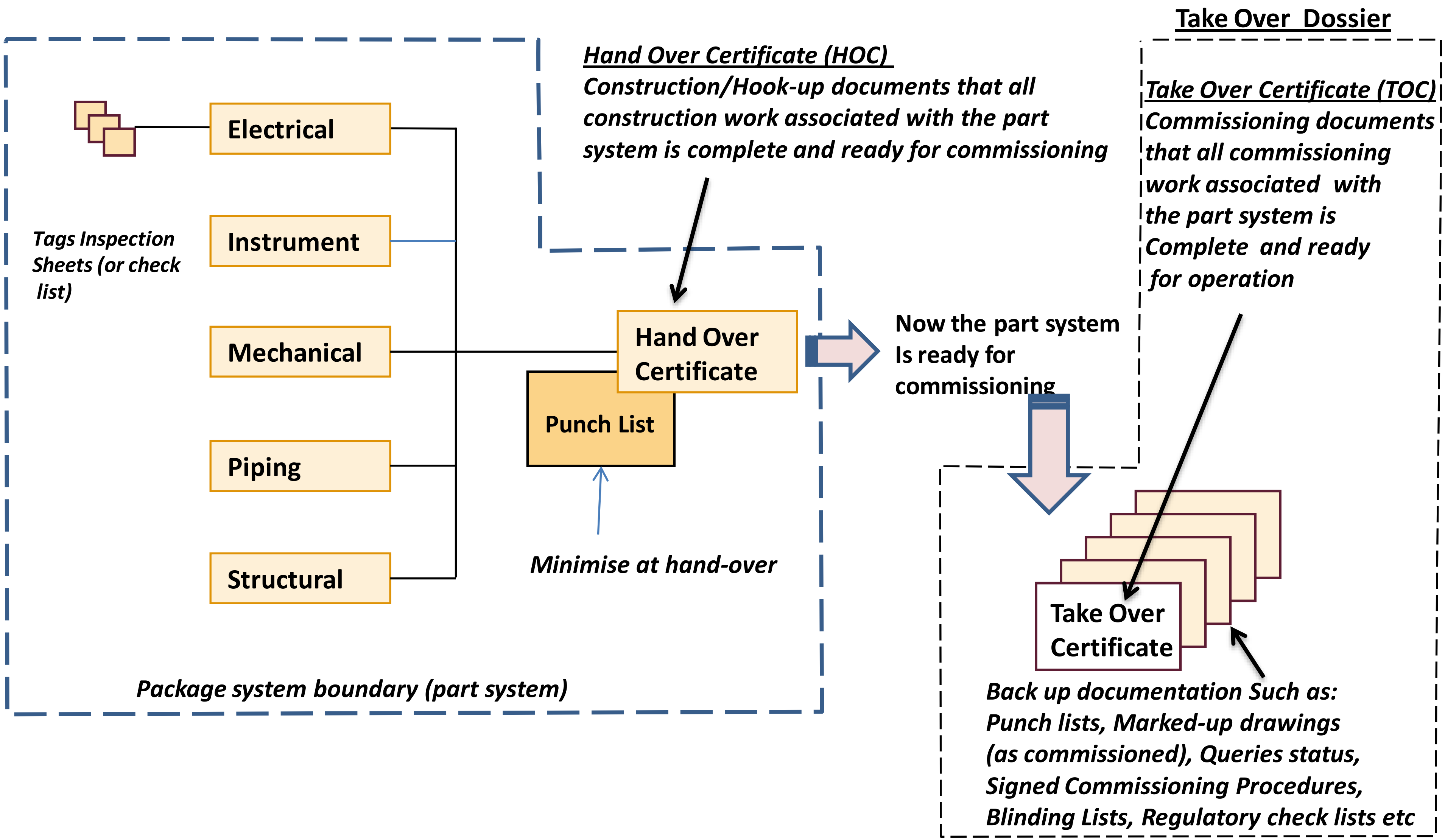
Marked up boundary Drawing (Commissioning Packs)
MC Packs
Tags
Work orders
Complete the commissioning schedule first, then dictate to construction what needs to be delivered when.
The construction sequence must follow the commissioning schedule
Integrated Construction And Commissioning schedule
Construct
Commission
Construct
Commission
Reports
PC
Work Order Datab.
Project Completion System Database

Project Commissioning Schedule

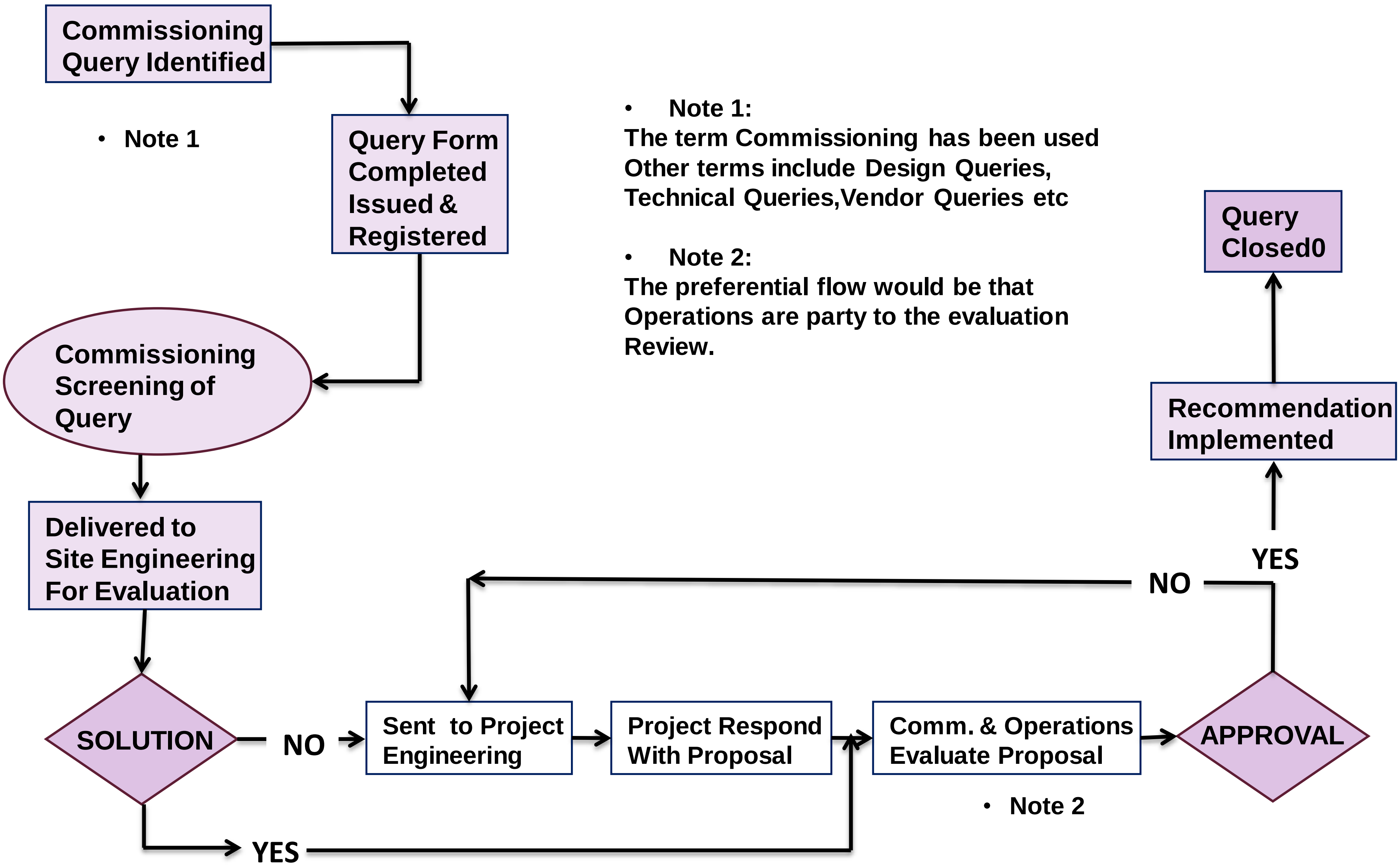


Boundary Drawings	Correctly marked up boundary drawings with all necessary physical break points identified
Project milestones	All important project milestones defined such that all activities can be linked to these
Part system numbering	All part systems uniquely numbered
Temporaries/ Pre-requisites	All temporaries identified with tie-in points. Required commissioning of temporaries defined as unique activities with unique system numbers. It is useful to use one system number for all temporaries and sub divide this system number for various temporary activities. All pre-requisite listing sheets produced.
Static/dynamic Commissioning strategy	A clear strategy on relationship between static checks and dynamic activities. For example; are you prepared to accept completion of static checks at module yards way ahead of the dynamic activities at the integration yard, or do you want to wait and do everything close-linked. Or do you want to do something in between the two alternatives.
Estimating strategy	A clear and simple estimating energy.
Commissioning Procedures index	(Commissioning procedures can be developed once you have defined the boundaries of the commissioning packages and you have sufficient vendor documentation in hand. The procedures are obviously not required to be fully in place before you build the schedule, but the relationship between procedures, commissioning packages, activities and numbering system must be in order. I.E. the procedure index.)



Once commissioned, the commissioning package(s) can be handed over to Operations as one operable entity – one or more part systems – (Take Over package)

PROCESS for HANDLING of COMMISSIONING QUERIES



MECHANICAL COMPLETION DEFINITION

To be mechanically complete, the construction activities on a specific portion of the project, such as the topsides, have been completed and accepted by the appropriate parties. In most instances, it is an integral part of the transition from construction into the pre-commissioning phase, but Mechanical Completion has specific attributes that lend themselves to being separately planned and conducted.

Mechanical Completion, as the final phase of construction is, mostly undertaken by area or by discipline and is performed by construction-type personnel with participation from specialized equipment suppliers, the engineering firm, and other contractors as needed.

It involves fabrication, assembly and non-functional testing to confirm the integrity of the construction and installation.

To verify that a facility is mechanically completed, inspection or an oversight team must ensure that the final construction is in accordance with the project drawings, specifications, industry standards as well as all regulatory requirements from the authorities having jurisdiction.

WHAT MECHANICAL COMPLETION (MC) ENTAILS (Example FPSO)

The MC phase addresses structural, mechanical, piping, electrical, instrumentation and automation as well as topsides interfaces with export pipelines and subsea flowlines.

Each of these areas needs to be thoroughly confirmed as complete, tested to the applicable codes and turned over with documentation to the Pre-Commission/Commissioning team as mechanically complete.

During this phase of the work, depending on the regulatory agencies involved and the area of installation, the authority having jurisdiction (USCS, BOEMER, UK DECC, NPD, ABS, DNV, etc), will be involved in many aspects of the testing and approvals to allow the project to proceed further.

STRUCTURAL, MECHANICAL AND PIPING

Mechanical Completion of the structural, mechanical and piping portion of the project includes, but is not limited to :-

Verification that the piping systems, mechanical equipment and their supporting structure are installed, non-destructively examined, hydrostatically tested and flushed clean. Equipment and piping which required stress analysis and the resulting line stops, piping spring hangers, anchors, guides, etc, should be verified that installation is in accordance with the design data. Rotating equipment, including specialized larger pumps, compressors, generators and engine driven equipment, are handled differently.

STRUCTURAL

- Visual inspection for complete and correct installation
- QC documentation
- Welding
- Load testing of lifting lugs and monorails

MECHANICAL

- Visual inspection for complete and correct installation
- Internal inspection of tanks and vessels
- Alignment
- Load testing of lifting equipment
- Hot oil flushing
- Bolt tensioning
- Dimension control
- Preservation

PIPING

- Welding procedures
- Removal of all items subject to damage during flushing, cleaning and pressure testing
- Flushing of pipework
- Chemical cleaning and testing of pipework
- Drying of tested pipework
- Preservation of tested pipework
- Reinstatement of all items after testing
- Final inspection of pipework
- Test ISO's and P&ID's showing the extent of each pressure test
- Pneumatic and hydraulic tubing
- Hot oil flushing of pipework
- Bolt tensioning
- Pipe supports completed
- Insulation
- Flow coding

ELECTRICAL

Verification of the electrical installation / construction is more complicated, as much of it is field routed for best fit. In addition to normal inspection of each of the cables and wiring, all terminations should be validated for the quality and accuracy of the installation.

Some areas of inspection during this phase include, but are not limited to, cable and tray support, tray fill, grounding, integrity, stress cone installation for medium and high voltage cable, terminations, continuity and megger testing, as well as checking the bend radius of the final installation and tie down.

ELECTRICAL

- Visual inspection for complete and correct installation
- Insulation and continuity testing of cables
- Insulation testing of generator, transformers and motors, panels, distribution board, etc.
- Earthing checks
- Battery preparations
- Area completion
- Preservation
- Static check of switches and control devices
- Lighting and socket outlet checks
- Heat tracing

INSTRUMENTATION

Mechanical Completion for instrumentation systems includes validation of the instruments, valves and valve operators compared to the original design data to assure that process flow conditions will be met. As with the electrical MC, all wiring will need to be verified, inspected for continuity and insulation as well as loop checks for confirmation to the automation system. Both hydraulic and pneumatic tubing will be cleaned, flushed and pressure tested to assure that there are no leaks and that cleanliness meets required quality for the system it controls.

INSTRUMENTS / TELECOMS

- Calibration and testing of instruments prior to installation
- Visual inspection for complete and correct installation
- Insulation and continuity testing of cables
- Cleaning, flushing, pressure and leak testing of pneumatic and hydraulic tubing
- Adjustment of control, alarm and shutdown settings
- Loop testing
- Function testing of field instruments
- Area completion
- Function testing of control systems
- Hot oil flushing of instrument tubing
- Preservation

OTHERS

HVAC

SAFETY

MECHANICAL COMPLETION OF NON-OPERATIONAL SYSTEMS

SURFACE PROTECTION, INSULATION AND FIRE PROOFING

HANDOVER

Ideally, with good planning, inspection and engineering interface, the project's construction phase will conclude with a successful mechanical completion.

Upon conclusion of Mechanical Completion activities, a certificate should be issued stating that the relevant inspections and tests have been carried out according to the contract.

All of the support documentation and redline drawings and documents should be attached. The certificate will be accompanied by the punch list if the sail dates don't allow completion of all MC activities prior to moving to the next location.

MECHANICAL COMPLETION

- WELDING PREPARATION ACTIVITIES

MECHANICAL COMPLETION

- WELDING PIPING AND STRUCTURES

PRE-COMMISSIONING (PC)

Effective Pre-Commissioning planning and initiation of PC activities provide a necessary bridge between earlier project execution phases, including Mechanical Completion, and the final commissioning and start-up of the facility.

PC can be an essential mark between the transition from a discipline-based approach to one that verifies the functionality of systems, regardless of their location on the facility.

The planning required for an efficient Pre-Commissioning (PC) of an offshore facility is typically started during the early stages of detail design and commences immediately after Mechanical Completion (MC) has been achieved, which itself follows the engineering design and construction phases.

PRE-COMMISSIONING IS SYSTEMS DRIVEN

Whereas Mechanical Completion includes the non-functional testing of equipment to confirm the integrity of its fabrication and installation to the intended design,

Pre-Commissioning verifies the mechanical completion, the functionality of the system as well as calibration of the instrumentation to the facilities controls and control systems.

While MC is completed by AREA or DISCIPLINE, the Pre-Commissioning phase will be turned over to specialists who can address confirmation by SYSTEM, ensuring that it is complete and ready for final Commissioning and start-up.

This phase can best commence efficiently after all of the components are in place so that systems, rather than individual pieces, can be verified. The PC contractor also engages the design engineering firm, vendors, manufacturers and operating personnel for support and their expertise.

During the Pre-Commissioning effort, there can be many activities completed during the onshore phase and then moved offshore for completion of the system check-out.

Where practical :-

- Piping should be power flushed and dried;
- Communication systems tested to the fullest extent possible;
- Instrument and electrical loops will be verified;
- Instruments will undergo initial and final calibration;
- Pumps can be operated where possible;
- Motors verified for proper rotation and can be run and tested;
- Rotating equipment can receive initial (cold) alignments.

ORGANISATION AND PLANNING ARE KEY

The selection of a Pre-Commissioning team is one of the most important milestones that will need to be addressed. The team will be responsible for planning and supplying the critical support and leadership during this project phase.

The leadership as well as team members should, therefore, be experienced with the planning, tasks, schedule and project drivers regarding start-up, as well as its complexities.

Reference data provided by engineering and the other delivery teams will need to be organized by the PC contractor according to the identified systems and should reside in a location accessible to all who will be utilizing it.

Data includes, but is not limited to, PFDs, P&IDs, mechanical, electrical motor and ISA data sheets, instrument and electrical loop drawings, wiring plans and elevations for skids and modules, as well as the manufacturer's final data manuals for purchased equipment.

A potential shortcoming is in not obtaining the interface data from outside of the topsides delivery team, e.g. subsea, export pipeline, communications, hull fabricators equipment.

The key will be to provide a conscious effort to close these gaps early within the project so as not to impact the planned start-up date.

The PC work normally is broken down into discreet, manageable systems. The systems are separated according to the logical process flow, rather than by a package vendor.

For example, a heat media system might include a fired unit, heat recovery unit, storage unit and pumps, along with interconnect piping, instrumentation, controls and electrical, all of which have likely been supplied by different vendors and reside on separate skids. This systems breakdown is the logical process to verify construction, confirm the integrity of the design, and prepare the system for handover to operations as the phase goes forward.

The organization also allows for the commissioning of sub-systems within a system, without having to initiate work on the entire system. This avoids having to work around a finish to start on a system scenario, thus pushing the overall startup schedule past the desired outcome.

The PC of utility systems is typically the first to be addressed and completed. This allows life support for the offshore personnel in addition to minimizing the need for additional components to PC the process systems later.

Pre-COMMISSIONING

- **CHECKING MEASUREMENTS AND LEVELS**

PRE COMMISSIONING



COMMISSIONING

Commissioning take place when Mechanical Completion / Pre-Commissioning is completed for a system or part of a system.

Commissioning can be divided into three main activities:

- **Commissioning preparation**
- **Commissioning execution**
- **Commissioning documentation and handover to operation**

Establishment of a commissioning network and definition of commissioning packages early in a Project in order to establish fabrication/installation priorities and milestones.

Definition of commissioning of part systems is essential in order to achieve an early commissioning completion.

TYPICAL COMMISSIONING PREPARATION ACTIVITIES

The preparatory work shall consist of activities such as:

- **Development of commissioning organisation**
- **Development of system breakdown (part system)**
- **Commissioning packages definition**
- **Commissioning schedules**
- **Commissioning budget including spare parts for commissioning**
- **Commissioning preparation check records**

COMMISSIONING DOCUMENTS AND HANDOVER TO OPERATIONS

Handover of systems from Executor to project/operation shall be according to a formal procedure which as a minimum should consist of:

- **Completion acceptance certificate (signed by both parties)**
- **Commissioning P&ID showing the extent of the completed system**
- **Authority certificates (if any)**
- **Operational procedures and handbooks**

NORSOK	COMM. PREPARATION CHECK RECORD ELECTRICAL EQUIPMENT (Rev. 1, May 1996)	Check Record No.:	<Project>

System	:	Site Code	:	Area:
Subsystem	:	Comm.Package No.	:	
Tag No	:	Description	:	
P.O. No.	:	Supplier	:	

Chkp. No.	Check Description	Status		
		Supplier	Onshore	Offshore
01	Mechanical Completion Status.			
02	Preservation removed.			
03	Equipment cleaned.			
04	Earthing correctly installed. Megger-test performed.			
05	"Living Up Notice (LUN)" obtained.			
06	"In Operation" Tag fitted.			
07	All Safety Requirements satisfied.			

Executor	Name	Date:	Verified by:	Date:
Supplier:				
Onshore:				
Offshore:				

CONSTRUCTION AND COMMISSIONING DATA FROM ASIAN YARDS

Figures based on FPSO's, regardless of concept design, can only be universally applied to Asian yards

On an FPSO there are generally 95 – 105 systems

An average system estimate figure for commissioning is 1350 hours per system

Figures taken from Bendiksen and Young. Commissioning of Offshore Oil and Gas Projects 2005 Author House

ESTIMATING 'BALL PARK FIGURES' FOR FPSOs

(FPSOs where the hulls built in Asia)

1) Take the number of systems in the project and multiply by 1350

Project	Systems	(hours)
Project 1	99 systems	133,650
Project 2	105 systems	141,750
Project 3	100 systems	135,000
Project 4	107 systems	144,450
Project 5	103 systems	139,050
Project 6	105 systems	141,750

2) Take the normal size commissioning team of 90 direct men working 60 hours per week multiplied by duration in weeks normally 24 weeks, about 6 months

90 men × 60 hrs × 24 weeks	129,600 (hours)

ESTIMATES AND GROWTH POTENTIAL - GROWTH, FPSO'S

If you seriously deal with and resolve major issues the estimates can be expected to grow.

The figures below include commissioning and construction and how the scope changed for actual projects

Project	Commissioning original	Commissioning Last known	Comm/Construction TOTAL
Project 1	133,650	408,908	1,939,936
Project 2	141,750	308.962	2,387,000
Project 3	135,000	282,744	1,931,850
Project 4	144,450	351,880	2,096,908
Project 5	139,050	337,892	2,017,948
Project 6	141,750	350,264	2,058,234

Factor average = 2.44 (Original to Actual) - Based on experience

LOAD TEST FOR GAS TURBINE MANUFACTURER

After securing the order to supply three gas turbines for a new gas production platform, a major turbine manufacturer contacted Aggreko for a load test solution. Each turbine rated at 27MW with a voltage of 11kV 60Hz and a power factor of 0.9.

LOAD BANK RENTAL

Load bank rental solution gives the customer the ability to supply load from 0 to 100% in order to check various turbine parameters such as vibration, temperatures, fuel consumption and performance of ventilation.

LOAD TESTING

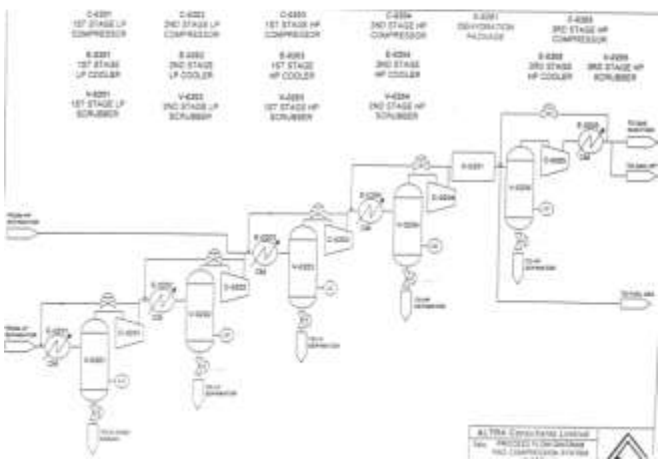
Aggreko's turnkey package gave the customer confidence that their equipment would function properly. In addition, the load bank test possibly prevented an expensive turbine failure after its installation of the gas platform at the seabed. Aggreko's solution alleviated our customer's concern over equipment efficiency allowing them to concentrate on other aspects of their project.

NITROGEN (N_2) TEST-RUN OF GAS COMPRESSOR TRAINS ONSHORE

In areas of the world where strict flaring limitations are imposed (now in most parts of the industrialised world), and / or where offshore Personnel Onboard (POB) is limited, the benefit of performing a full test run of the gas compressors on Nitrogen is a huge benefit.

The savings in offshore hours are tremendous as all major trouble shooting, repairs and control settings are done onshore.

GAS COMPRESSION TESTING WITH NITROGEN GAS



FPSO TURRET COMMISSIONING

A challenge for Commissioning:

- **Construction & Assembly**
- **Operability Under Dynamic Conditions**
- **Swivel**
- **Electrical & Instrumentation**
- **Disconnectability**

DRILLING RIG "COMMISSIONING"

INVOLVEMENT OF CLASSIFICATION SOCIETIES :

- DNV
- LLOYDS REGISTER
- ABS

Rules for Classification of Offshore Drilling and Support Units

A 700 Testing and Commissioning

701 Where specified by the rules, testing shall be carried out in the presence of a surveyor, and related requirements for test programmes shall be observed.

702 A test programme for harbour and sea trials shall be prepared by the customer and accepted by the Society. The programme shall specify systems and components to be tested, and the testing procedure. The Society may, in order to verify rule compliance, request additional tests and/or data to be recorded.

703 Procedures for Pre-commissioning, testing and commissioning for all the systems onboard that are covered by the scope of classification shall be prepared by the customer and accepted by the Society.

704 The tests shall give evidence as to satisfactory operation and performance in accordance with the rules. When testing control and safety systems, failure modes shall be simulated as realistically as possible.

705 The extent of participation by the Society should be clearly identified in the Quality Survey Plan (QSP) submitted by the customer and accepted by the Society only to ensure compliance with the requirement of Classification Rules and applicable statutory requirements.

Drilling rig construction project management

Lloyd's Register offers a range of project management and professional commissioning services for new-build or refurbished land and offshore drilling rigs.

Drilling rig construction presents huge project management challenges, particularly for a mobile offshore drilling unit (MODU).

These projects involve a multitude of advanced technologies and critical interfaces among complex systems. The history of drilling rig construction is littered with delayed deliveries, cost overruns and mishaps that undermine return on investment.

Sound project management is crucial to avoiding the pitfalls and adhering to your safety, quality, schedule and budget goals.

Over the last ten years, Lloyd's Register has been involved in the project management and commissioning of approximately 150 new-build and major upgrade drilling rig projects. We have accumulated a wealth of experience and information, all captured in a knowledge database, which we can adapt to any site or project that may arise.

STAVANGER, Norway - A joint report issued by Moduspec and the Athens Group at ONS 2010 provides new insights on the causes and consequences of non-productive time (NPT) on offshore oil and gas assets.

The report, "The State of NPT on High-Specification Offshore Assets," found that more attention to the commissioning stage and more resources allocated to training are the primary opportunities to reduce NPT.

Other key findings included the following:

- **NPT impact:**

  a) Sailing delays (departing yard) cost between $12.2 million and $73.6 million for every rig delayed last (based on average day rate of $400,000;

  b) operating ("go live") date delays cost survey operators between $48.4 million and $2.4 billion;

NPT causes:

a) yards lack the experienced personnel to fulfill responsibilities under the turnkey model (the report cited the five major offshore yards, which went unnamed). Some 79% do not believe the yards did a better job of commissioning topsides in 2009 than in 2008; 21% think they got worse. Taking back control of commissioning was the number one priority of drilling contractors and operators;

b) crews lack the right skill sets/had inadequate training; and

c) difficulties in recruiting, training and retaining qualified personnel to perform topsides risk-management, risk mitigation and problem-solving.

"Through this report, the industry has clearly identified the causes and costs of non-productive time for their high-specification offshore assets," said Richard Sadler, CEO of Lloyd's Register. "Drilling in deep water is clearly a challenge. It is likely to become even more challenging as new shipyards enter the offshore construction market – diluting the skills of the workforce – as the technology becomes ever more complex and as we venture into increasingly hostile environs to recover the remaining energy reserves."

5.1 Testing of Base-mounted Winches and Other Lifting Appliances

Testing of base-mounted winches and other lifting appliance are to comply with the following requirements and procedures:

i) *Load Test* – After installation, the system is to be tested with a load equal to 125% of the rated capacity in the presence of the Surveyor. Satisfactory operation of power drives and brakes is to be demonstrated. After being tested, the system with all its components is to be visually examined for permanent deformation and failure.

ii) *Performance Test* – Testing in the presence of the Surveyor is to demonstrate that rated line pull can be achieved at rated speed with the outermost layer of wire on the drum.

iii) *Brake Holding Test* – It is to be demonstrated that the brakes have the ability to stop and hold 100% of the design load. Confirmatory testing to demonstrate the braking effect of variable frequency drive AC motors is to be carried out upon installation onboard.

5.3 Testing of Burner/Flare Boom

The adequacy of the boom's slewing and topping gear is to be demonstrated by testing after the boom's installation on the drilling unit. The details of the test procedure are to be agreed upon with ABS and witnessed by a Surveyor.

Functional testing of the completed burner assembly is to be carried out by pressure testing from the flexible line connection flange to the burner head.

SUBSEA EQUIPMENT “COMMISSIONING” TREE INSTALLATION ACTIVITIES

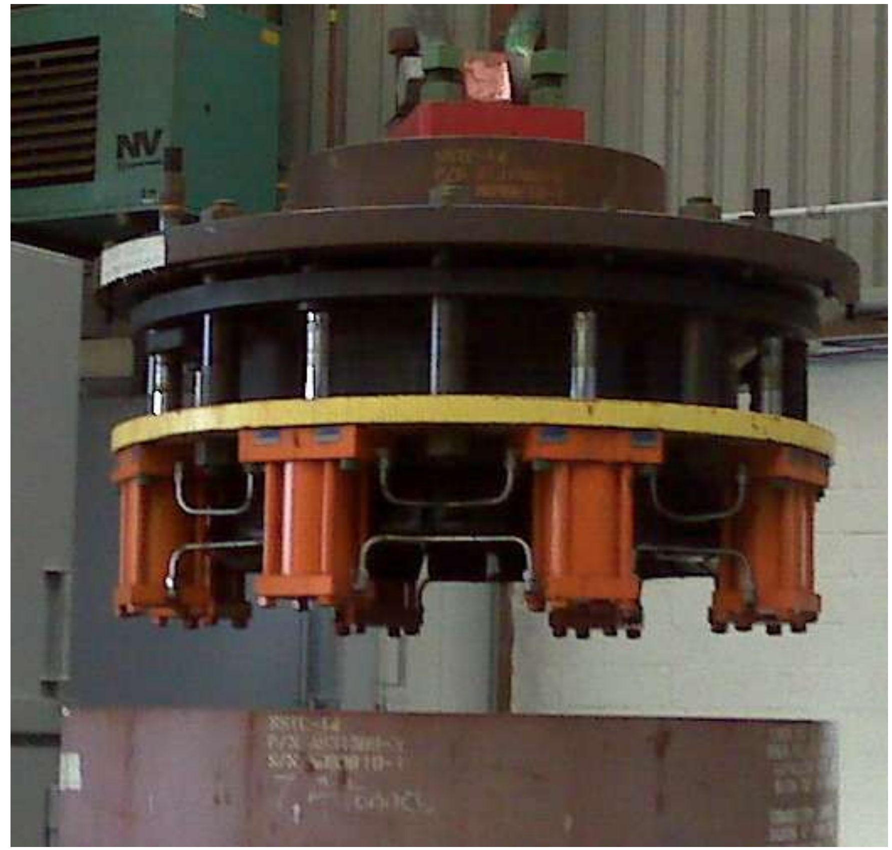
- **PRE-INSTALLATION ACTIVITIES**
  - **FACTORY ACCEPTANCE TESTING (FAT)**
  - **STACK UP TESTS**
  - **HYDRO / NITROGEN PRESSURE TESTS**
  - **SYSTEMS INTEGRATION TESTING (SIT)**

- **INSTALLATION ACTIVITIES**
  - **SHALLOW WATER INSTALLATIONS**
  - **DEEPWATER INSTALLATIONS**
    - **Installing the Debris Cap**
    - **Installing the Flowline Spools and Control Jumpers**

FAT (Factory Acceptance Testing):

This is a requirement to ensure product meets customer requirements. The Inspection and Test Plan (ITP) provide client with various inspection points (hold, monitor, witness) to access product integrity. External Expert Engineers sometimes participate in writting and witnessing FAT's for several subsea products.

SURFACE TREE FAT

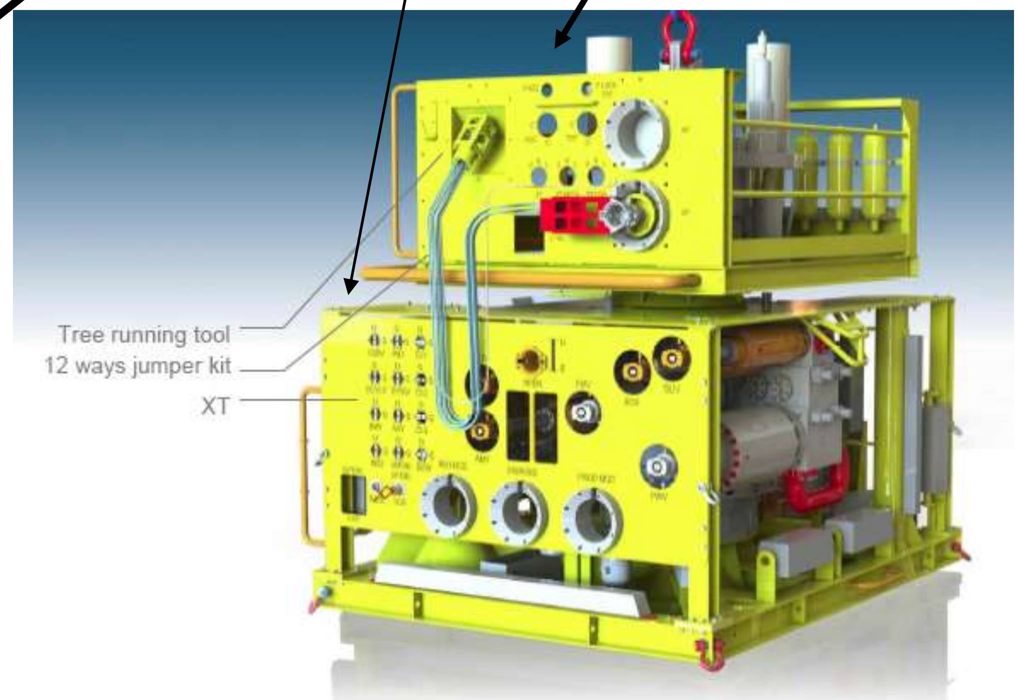


PRESSURE TESTING WELLHEAD CONNECTOR

X'MAS TREE STACK-UP TEST

Before Installation the components – Wellhead – Tree – Running Tool go through a "Stack-Up" test to confirm they fit and operate together before delivery to the seabed.

WELLHEAD TREE RUNNING TOOL



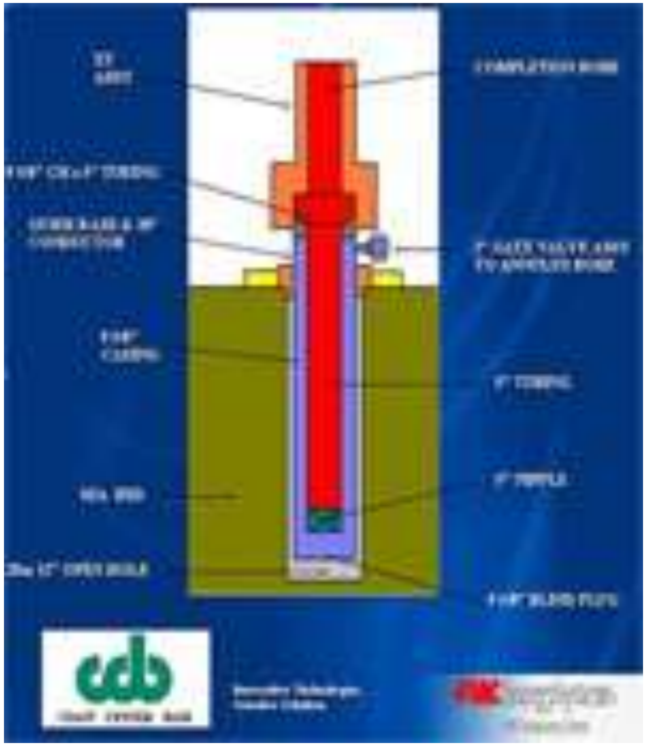
Note Shallow water Tree being run on Guide Base

Test of Protective Cover

HYDRO OR NITROGEN PRESSURE TESTS

Hydrostatic and Nitrogen Pressure testing facilities are performed to verify material integrity and connection sealability, with pressure capacity to 30,000 PSI. Service is provided to the recognised codes & standards conducted within a modern and safe testing environment. This could be at the Tree Manufacturers facilities or an external test house. It often utilising a below ground level test pit and steel composite enclosed test cells.

Manufacturers Test Facilities



Full Scale Subsea Test Well

At Docksides Facilities

Norway's first full scale sub sea test well.
The test well is a replica of a sub sea well, located at 50 metres water depth by the deepwater quay front, where parameters such as pressure and temperature may be regulated to simulate most well environments.

The well itself is 25 metres deep, and the principle sketch (right) illustrates the construction.

SIT (System Integration Testing)

On completion of manufacture, assembly and pressure testing a procedural set of system checks is conducted prior to shipment and deployment

This is the most critical testing stage, where installation and operational conditions are mimicked.

Systems Integration Testing for Subsea Development

DECOMMISSIONING REQUIREMENTS AND ACTIVITIES

REGULATIONS / REQUIREMENTS

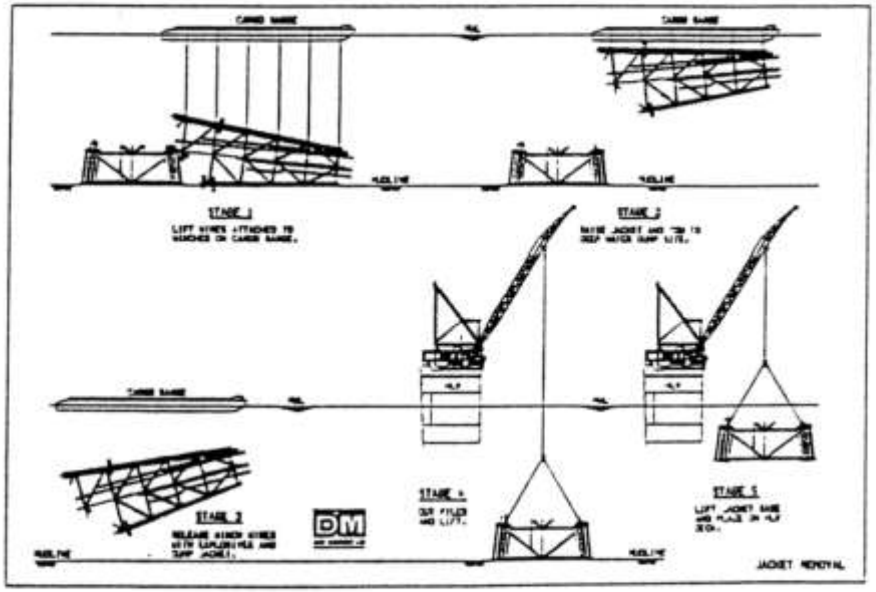
EXAMPLES :

- **PLATFORM REMOVAL**
- **SUBSEA EQUIPMENT REMOVAL**
  - **Trees**
  - **Manifolds**
  - **Flowlines and Pipelines**
- **FPSOs**

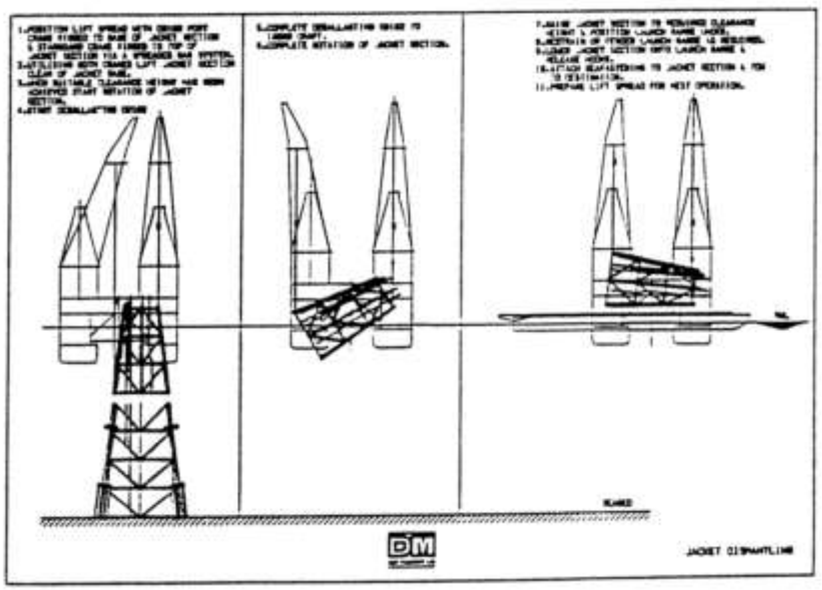
OSPAR 98/3 REGULATIONS WITH RESPECT TO OFFSHORE FACILITIES REMOVAL

Installation (excluding topsides)	Weight (tonnes)	Complete Removal to land	Partial Removal to land	Leave wholly in place	Re-use	Disposal at Sea
Fixed Steel	<10,000	Yes	No	No	Yes(3)	No
Fixed Steel	>10,000	Yes	Yes (1)(2)	No	Yes(3)	No
Concrete - gravity	Any	Yes	Yes(2)	Yes	Yes	Yes
Floating	Any	Yes	No	No	Yes	No
Subsea	Any	Yes	No	No	Yes	No

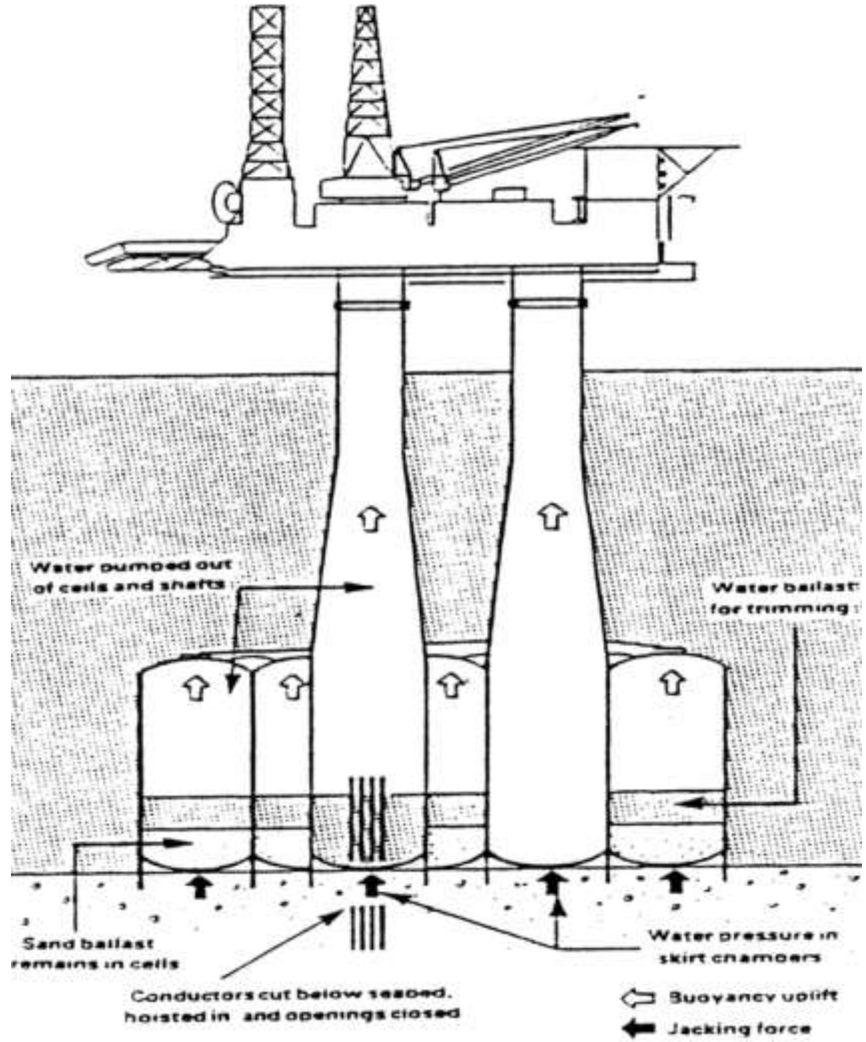
JACKET REMOVAL



TOPPLING AND LIFTING



CUTTING AND LIFTING SECTIONS

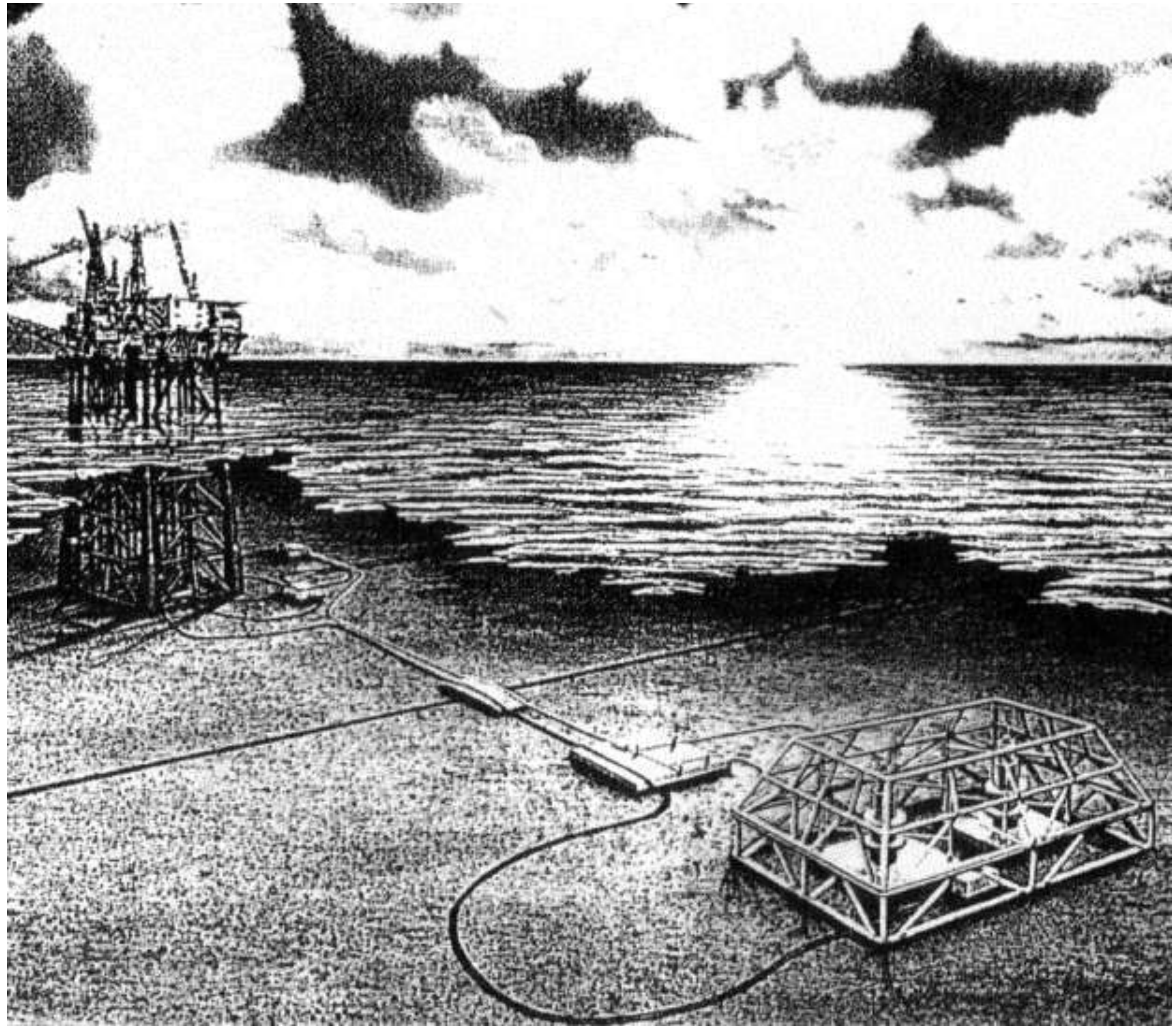


CONCRETE PLATFORM -

REMOVAL OR REMAIN IN PLACE?

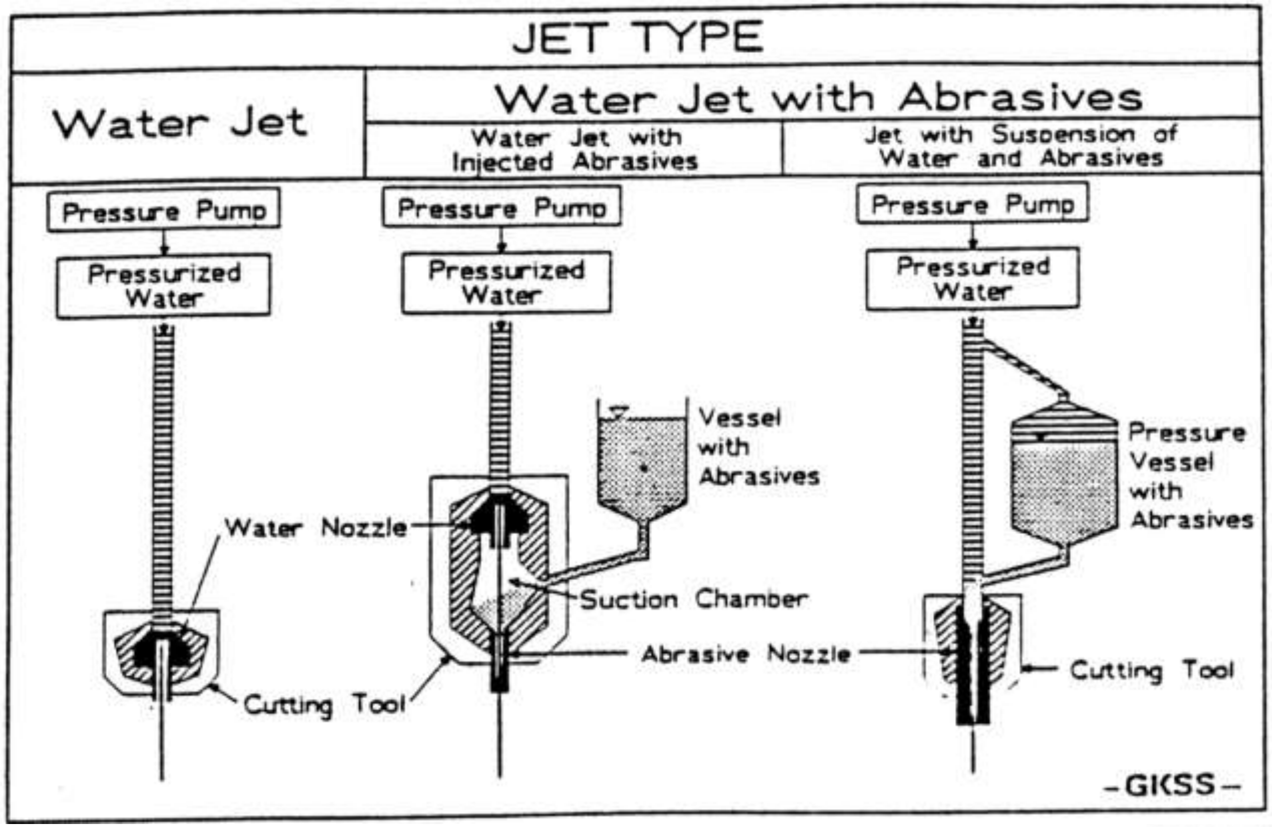
STAFFA FIELD

START-UP 1992, DECOMMISSIONED 1996

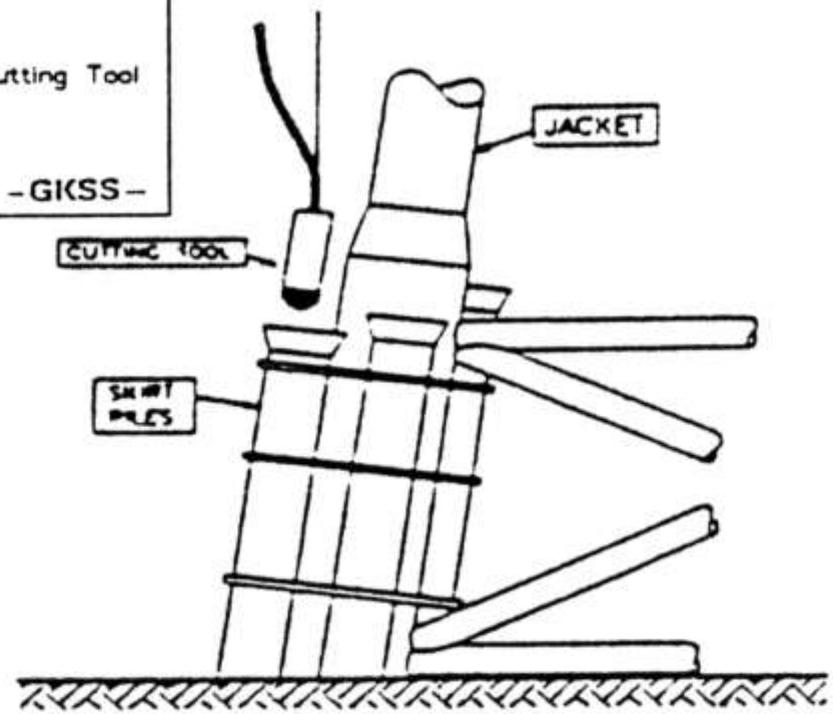


TEMPLATE REMOVAL

- **Disconnect Flowline**
- **Cut Piles**
- **Lift Weight to Unstick from Seabed = 2 times its weight in water**



WATER JET CUTTING TECHNIQUE

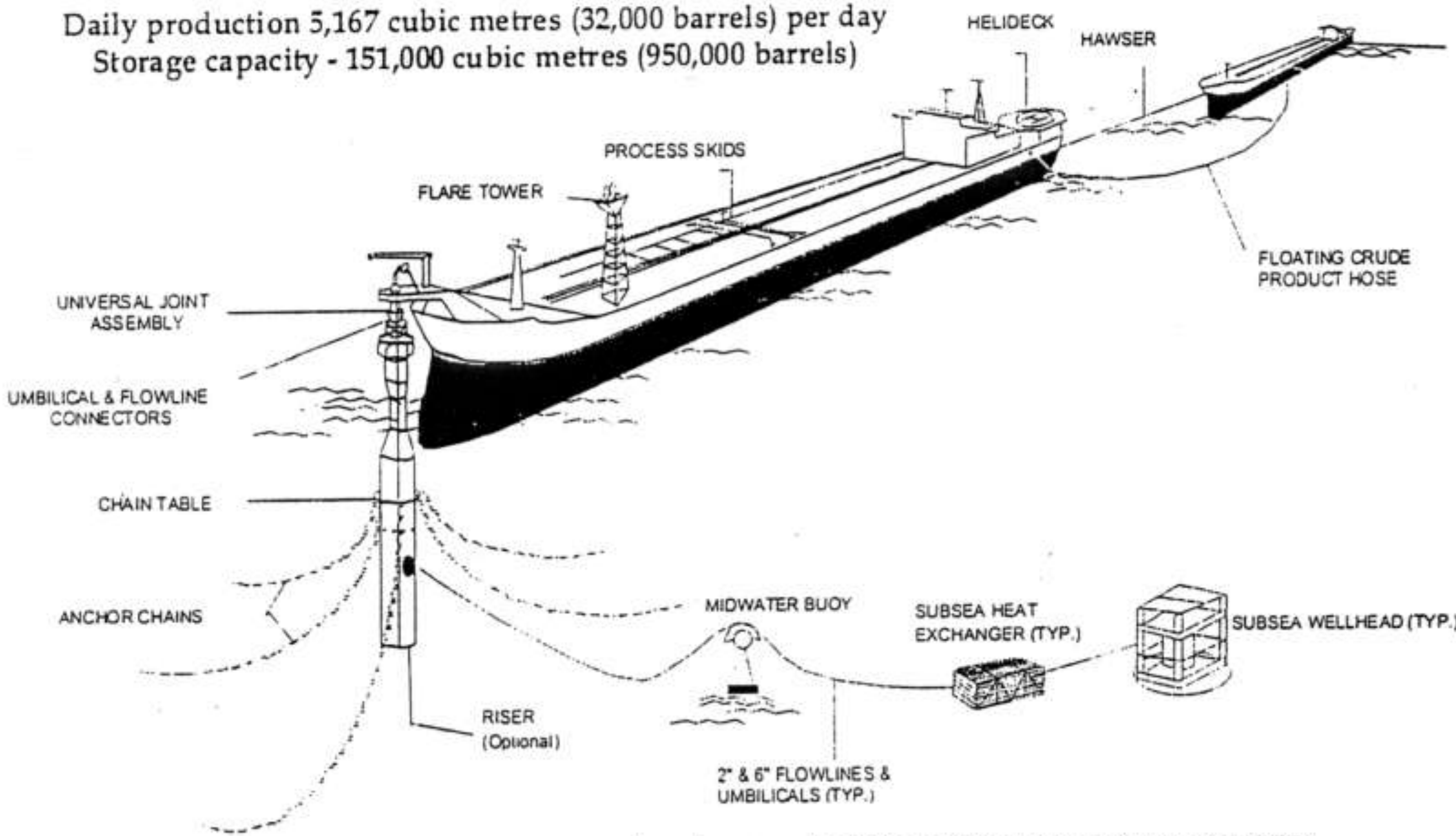


WATER JET CUTTER MANIPULATOR BEING LOWERED INTO THE SKIRT PILE

FPSO RE-DEPLOYMENT TO NEW DUTY AT END OF FIELD LIFE

Artists impression of Elang Kakatua Field Production Supply Operation

Daily production 5,167 cubic metres (32,000 barrels) per day
Storage capacity - 151,000 cubic metres (950,000 barrels)



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