UNIT-2
TYPES OF OFF SHORE VESSELS

Offshore vessels are ships that specifically serve operational purposes such as oil exploration and construction work at the high seas.

There are a variety of offshore vessels, which not only help in exploration and drilling of oil but also for providing necessary supplies to the excavation and construction units located at the high seas.

OFF SHORE VESSELS

- Oil Exploration and Drilling Vessels
- Offshore Support Vessels
- Offshore Production Vessels
- Construction/Special Purpose Vessels

Each of this category comprise of a variety of vessels.

Oil Exploration and Drilling Vessels

- Oil exploration vessels, as the name suggests, help in exploration and drilling of oil at high seas. The main types of exploration vessels are:

- Drill ship
- Jack Up Vessels
- Semi-submersible Vessels
- Offshore barge
- Floating Platforms
- Tenders

Offshore Support Vessels

- Certain offshore vessels provide the necessary manpower and technical reinforcement required

so that the operational processes in the high seas

continue smoothly and without any undesired interruptions.

Such vessels are called as ‘offshore support vessels.’

Offshore Support Vessels

- Offshore supply vessels transport the required structural components to the designated high seas sector along with providing assistance to supply freight as well. The constructional aspect of these vessels can be purpose-built to suit the operational demands.

Some of the main types of offshore support vessels are

- Anchor Handling Tug Vessel (AHTV)
- Seismic Vessel
- Platform Supply Vessels (PSVs)
- Well Intervention Vessel
- Accommodation Ships

Offshore Production Vessels

- Offshore production vessels refer to those vessels that help in the production processes in the drilling units in the high seas.

FPSOs (Floating, Production, Storage and Offloading) can be enumerated as an example of these types of offshore ships

. Main types of these vessels are:

- Floating Production Storage and Offloading (FPSO)
- Single Point Anchor Reservoir (SPAR) platform
- Shuttle Tankers
- Tension Leg Platform (TLP)

Offshore Construction Vessel

- Ships that primarily aid in the construction of various high seas structures are known as offshore construction vessels.

- Other offshore vessels’ of these type also include those that provide anchorage and tugging assistance and those kinds of ships that help in the positioning of deep sub-water cable and piping lines.

Offshore Construction Vessel

- Main types are:

- Diving Support Vessel
- Crane Vessel
- Pipe Laying Vessel

Offshore Construction Vessel

In addition to these, those variances of ships that

provide aid in case of any emergencies

occurring in the high seas and those types of

vessels that undertake researching and analysing

activities in the high seas are also included under

the offshore vessels’ classification.

Offshore Construction Vessel

- The ever-growing need to explore and suitably harness the potentialities that the high seas offer has led to a huge growth in the need and demand for offshore ships.

Coupled with the advantages of technological researching and suitably resulting developments, the present-day fleet of offshore vessels across the world is one that portrays the huge strides taken in the maritime sector.

Some famous offshore vessels are:

- North Sea Giant – World's Tallest Offshore Vessel
- Neptune – Powerful Jack-up Vessel
- Type o – Semi-submersible heavy transport vessel (SSHTV)
- Bourbon Front Platform supply vessel
- Solitaire – The Largest Pipe Laying Vessel in the World

Anchor Handling Tug Supply (AHTS) vessels

- **Anchor Handling Tug Supply (AHTS) vessels** are mainly built to handle anchors for oil rigs, tow them to location, and use them to secure the rigs in place. AHTS vessels sometimes also serve as Emergency Response and Rescue Vessels (ERRVs) and as supply transports.

- Many of these vessels are designed to meet the harsh conditions of the North Sea, and can undertake supply duties there between land bases and drilling sites.[1][2] They also provide towing assistance during tanker loading, deepwater anchor handling, and towing of threatening objects.

Anchor Handling Tug Supply (AHTS) vessels

- AHTS vessels differ from Platform supply vessels (PSVs) in being fitted with winches for towing and anchor handling, having an open stern to allow the decking of anchors, and having more power to increase the bollard pull.
- The machinery is specifically designed for anchor handling operations. They also have arrangements for quick anchor release, which is operable from the bridge or other normally manned location in direct communication with the bridge. The reference load used in the design and testing of the towing winch is twice the static bollard pull.

Anchor Handling Tug Supply (AHTS) vessels

- Even if AHTS-vessels are customized for anchor-handling and towing, they can also undertake, for example, ROV (remotely operated underwater vehicle) services, safety/rescue services, and supply duties between mainland and offshore installations.

Anchor Handling Tug Supply (AHTS) vessels

- It is common knowledge that oil rigs are located in the middle of the ocean or in the high seas. But just as this is easy to understand, the question arises that what type of vessels help such oil rigs reach the middle of the ocean? The anchor handling tug supply vessel (AHTS) is the answer to this question

Anchor Handling Tug Supply (AHTS) vessels

- The anchor handling tug is a naval vessel that is solely concerned with the objective of either tugging or towing an oil-rig or a ship. When it comes to oil rigs, these tugs form the most important necessity as without their help, it would be impossible to place oil rigs in the required sea and oceanic areas.

Design Aspects and Additional Features

- Anchor handling tug vessels or systems have a crane like equipment (known as the winch) that can be attached to the oil rigs and then propelled forth in the water. The “anchor supply “, mentioned as a part of the vessel’s name, is then allowed to be sunk into the seawater in order to keep the rigs steady.

Design Aspects and Additional Features

- AHTS vessels are a type of supply vessels that supply tugs and anchors to not just oil rigs but also to cargo-carrying barges. Technically, an AHTS is a very huge naval vessel, mainly because of the equipment's that it carries – tugs and anchors along with the winches. In order to transport such a heavy bulk in a manner that they are lost while the AHTS is moving, it is but natural that the design and construction of such ships has to be accommodating to fit such equipment's easily.

Design Aspects and Additional Features

- In addition to towing and tugging oil rigs, another major feature of such anchor handling vessels is that they also act as rescue vessels for other ships in times of some emergency. If a ship or a boat requires immediate anchor handling or towing or tugging, and if an anchor handling tug is in the oceanic vicinity, then they are a great source of help to such stranded vessels.

Increase in Usage of AHTS

- Since the AHTS provide a multi-utility facility, as naval vessels they are demanded in a higher coverage area. Also since in contemporary times, oil drilling from the oceanic areas has increased and is a regular activity, the increase in demand and usage of AHTS makes a lot of relevance and sense.

Increase in Usage of AHTS

- Although the knowledge about AHTS is not that common, among people whose routine work involves shipping and oil drilling, the concept of AHTS is not something that is new. The anchor handling tug and supply vessels have been an intrinsic part of the oil-drilling industry right from the time drilling oil from oceans as an option was raised

Increase in Usage of AHTS

- Also as a point to ponder, it can be mentioned that since such vessels involve anchor handling and are used for the purpose of rescue of other vehicles, they can be used as effective tools to prevent oil rig capsizing and other types of mishaps occurring in the high sea waters.

Increase in Usage of AHTS

- AHTS are one of those technological creations of the marine world that not only aid other technological developments’ with smooth progress but also help in preventing major mishaps at the sea.

SUPPLY VESSELS

- A **platform supply vessel** (**PSV**) is a ship specially designed to supply offshore oil and gas platforms.[1] These ships range from 50 to 100 metres (160 to 330 ft) in length and accomplish a variety of tasks. The primary function for most of these vessels is logistic support and transportation of goods, tools, equipment and personnel to and from offshore oil platforms and other offshore structures. In recent years, a new generation of platform supply vessels entered the market, usually equipped with Class 1 or Class 2 dynamic positioning system. Military applications are also under development as in the Status-6 Oceanic Multipurpose System.

Increase in Usage of AHTS

- They belong to the broad category of offshore vessels (OSVs) that include platform supply vessels (PSVs), crane vessels (CV) and well stimulation vessels (WSVs), anchor handling tug supply vessels (AHTSVs) and offshore construction vessels (OCVs). Larger offshore vessels have extensive sophisticated equipment including remotely operated underwater vehicles (ROVs) and tend to accommodate a larger number of people (more than 100)[2]

Cargo[

CARGO

- A primary function of a platform supply vessel is to transport supplies to the oil platform and return other cargoes to shore. Cargo tanks for drilling mud, pulverized cement, diesel fuel, potable and non-potable water, and chemicals used in the drilling process comprise the bulk of the cargo spaces. Fuel, water, and chemicals are almost always required by oil platforms. Certain other chemicals must be returned to shore for proper recycling or disposal, however, crude oil product from the rig is usually not a supply vessel cargo.

Support

- Common and specialty tools are carried on the large decks of these vessels. Most carry a combination of deck cargoes and bulk cargo in tanks below deck. Many ships are constructed (or re-fitted) to accomplish a particular job. Some of these vessels are equipped with a firefighting capability and fire monitors for fighting platform fires. Some vessels are equipped with oil containment and recovery equipment to assist in the cleanup of a spill at sea. Other vessels are equipped with tools, chemicals and personnel to "work-over" existing oil wells for the purpose of increasing the wells' production.

Vessel types

TYPES OF VESSELS

- Platform supply vessels (PSV): High capacity supply ship, either in deck or cargo hold.[3]
- Anchor handling tugs supply (AHTS): Similar to PSV, they can anchor and tow floating oil platforms (jack-ups and semi-submersible ones)
- Multi purpose supply vessels (MPSV): Universal vessels able to provide a large variety of maintenance services. They are most of the time equipped with a high capacity crane (100 tons and more). "Jumpers", particular MPSV who are equipped with ROV (remote operated vehicles) to upkeep submarine equipment like wellheads.[4]

TYPES OF VESSELS

- Fast Supply Intervention Vessels (FSIV): High-speed ships, (approximately 25 knots, 46 km/h, 29 mph) with a smaller deck capacity. They can nevertheless transport passengers. They essentially serve for urgent delivery or small shipment.
- Crew Boats: Those vessels are meant to shuttle back and forth oil platform workers between the sea installation and land. They can be high-speed craft (NGV). Smaller vessels are used for cross-sites transports. The helicopter is also widely used, especially when the weather is tough like in North Sea.

TYPES OF VESSELS

- Stand-by/Rescue vessels: Ships destined to security, they keep patrolling around the installation and must be ready to intervene in case of sea fall, evacuation or fire fighting. They are used mostly in northern seas.
- Line Handling Vessels (LH): Vessels used for handling spies (mooring lines).
- ROV Support Vessels (RSV): Support vessel specialized in ROV (Remote Operate Vehicle) operation.

TYPES OF VESSELS

- Tug Supply Vessels (TS): Vessels used as a tug and in the supply of platforms.
- Oil Spill Response Vessels (ORSV): Vessels dedicated to responding to offshore oil spills.
- Diving Support Vessels (DSV): Vessels used as a floating base for professional diving services

CREW

- Crew on these ships can number up to 36 crew members, depending on the size, working area, and whether DP equipped or not. Crane vessels and drill ships often have 100 to 200 people on board including a dedicated project team.

Daily operations

- Crews sign on to work and live aboard the ship an extended period of time, this is followed by similar period of time off. Depending on the ship's owner or operator the time aboard varies from 1 to 3 months with 1 month off. Work details on platform supply vessels, like many ships, are organized into shifts of up to 12 hours.

Daily operations

- Living aboard the ship, each crew member and worker will have at least a 12-hour shift, lasting some portion of a 24-hour day. Supply vessels are provided with a "bridge" area for navigating and operating the ship, machinery spaces, living quarters, and galley and mess room. Some have built-in work areas and common areas for entertainment. The large main deck area is sometimes utilized for portable housing.

Daily operations

- Living quarters consist of cabins, lockers, offices, and spaces for storing personal items. Living areas are provided with wash basins, showers, and toilets.
- The galley or cooking and eating areas aboard ship will be stocked with enough grocery items to last for the intended voyage but with the ability also to store provisions for months if required. A walk-in size cooler and freezer, a commercial stove and oven, deep sinks, storage and counter space will be available for the persons doing the cooking. The eating area will have coffee makers, toasters, microwave ovens, cafeteria-style seating, and other amenities needed to feed a hard-working crew.

PIPE LAYING VESSEL

- A **pipelaying ship** is a maritime vessel used in the construction of subsea infrastructure. It serves to connect oil production platforms with refineries on shore. To accomplish this goal a typical pipelaying vessel carries a heavy lift crane, used to install pumps and valves, and equipment to lay pipe between subsea structures.

PIPE LAYING VESSEL

- Lay methods consist of J-lay and S-lay and can be reel-lay or welded length by length. Pipelaying ships make use of dynamic positioning systems or anchor spreads to maintain the correct position and speed while laying pipe.
- Recent advances have been made, with pipe being laid in water depths of more than 2,500 metres.

PIPE LAYING VESSEL

- The term "pipelaying vessel" or "pipelayer" refers to all vessels capable of laying pipe on the ocean floor. It can also refer to "dual activity" ships. These vessels are capable of laying pipe on the ocean floor in addition to their primary job. Examples of dual activity pipelayers include barges, modified bulk carriers, modified drillships semi-immersible laying vessels among others.[1]
- A number of national oil companies own and operate pipe laying barges for offshore oil projects. HYSY 202 was the first pipe laying barge to be built in

LAYING VESSEL

- Commercial diving support vessels emerged during the 1960s and 1970s, when the need arose for offshore diving operations to be performed below and around oil production platforms and associated installations in open water in the North Sea and Gulf of Mexico. Until that point, most diving operations were from mobile oil drilling platforms, pipe-lay, or crane barges. The diving system tended to be modularised and craned on and off the vessels as a package.

LAYING VESSEL

- As permanent oil and gas production platforms emerged, the owners and operators were not keen to give over valuable deck space to diving systems because after they came on-line the expectation of continuing diving operations was low.

- However, equipment fails or gets damaged, and there was a regular if not continuous need for diving operations in and around oil fields. The solution was to put diving packages on ships. Initially these tended to be oilfield supply ships or fishing vessels; however, keeping this kind of ship 'on station', particularly during uncertain weather, made the diving dangerous, problematic and seasonal. Furthermore, seabed operations usually entailed the raising and lowering of heavy equipment, and most such vessels were not equipped for this task.

LAYING VESSEL

- This is when the dedicated commercial diving support vessel emerged. These were often built from scratch or heavily converted pipe carriers or other utility ships. The key components of the diving support vessel are:

Dynamic Positioning

- Dynamic Positioning –

- Controlled by a computer with input from position reference systems (DGPS, Transponders, Light Taut Wires or RadaScan), it will maintain the ship's position over a dive site by using multi-directional thrusters, other sensors would compensate for swell, tide and prevailing wind.

Saturation diving

- Saturation diving system – For diving operations below 50 m, a mixture of helium and oxygen (heliox) is required to eliminate the narcotic effect of nitrogen under pressure. For extended diving operations at depth, saturation diving is the preferred approach. A saturation system would be installed within the ship. A diving bell[2] would transport the divers between the saturation system and the work site lowered through a 'moon pool' in the bottom of the ship, usually with a support structure 'cursor' to support the diving bell through the turbulent waters near the surface. There are a number of support systems for the saturation system on a diving support vessel, usually including a remotely operated vehicle ROV and heavy lifting equipment.

Modern diving support vessels

Saturation diving

- The 2015 launched DSV Curtis Marshall

- Most of the vessels currently in the North Sea have been built in the 1980s. The semi-submersible fleet, the Uncle John and similar, have proven to be too expensive to maintain and too slow to move between fields.[citation needed] Therefore, most existing designs are monohull vessels with either a one or a twin bell dive system. There has been little innovation since the 1980s. However, driven by high oil prices since 2004, the market for subsea developments in the North Sea has grown significantly.[citation needed] This has led to a scarcity of diving support vessels and has driven the price up. Thus, contractors have ordered a number of newbuild vessels which are expected to enter the market in 2008.[citation needed

Saturation diving

- These vessels are built and designed nowadays not only to support diving activities, but they also support remotely operated vehicles (ROVs) operations with dedicated hangar and LARS for ROV's, support seismic survey operations, support cable-laying operations, etc. Owing to these nature of the modern-day vessels, they may have at any time 80 to 150 project personnel on board, including divers, diving supervisors and superintendents, dive technicians, life support technicians and supervisors, ROV pilots, ROV superintendents, survey team, clients personnel, etc. For all these personnel to carry out their contracted job with an oil and gas company, a professional crew navigate and operate the vessel as per the requirements and instructions of the diving or ROV or survey team superintendents

Saturation diving

- However, ultimate responsibility lies on the master of the vessel for the safety of every person on board. In expanding the utility of the vessel, just like liveaboard dive boats, these vessels in addition to the usual domestic facilities expected by hotel guests, the vessel will have specialised mix gas diving compressors and reclaim systems, gas storage and gas blending facilities, as well as purpose-built saturation chambers where the divers in compression live. These vessels are designed to be hired by diving service providing companies or directly by oil and gas contractors who then will also hire a diving or ROV or survey service-providing company, which will then utilize the vessel as platform to carry out their activities.

Diving from a DSV

- Diving from a DSV makes a wider range of operations possible, but the platform presents some inherent hazards, and equipment and procedures must be adopted to manage these hazards as well as the hazards of the environment and diving tasks.

Hazards[edit]

- Hazards of the positioning system
  - Anchor patterns
  - Thrusters

Equipment[edit]

- On board recompression facilities
- Equipment to transport the diver through high risk zones
- Equipment to limit access to known hazards
- Hyperbaric evacuation facilities

Procedures[edit]

- Use of stages and bells to transport the diver through the interface between air and water
- Surface-supplied diving with limited umbilical length
- Underwater umbilical tending

Saturation diving

- Dive boat – Boat used for the support of scuba diving operations
- Commercial offshore diving – Professional diving in support of the oil and gas industry
- Saturation diving – Diving for periods long enough to bring all tissues into equilibrium with the partial pressures of the inert components of the breathing gas
- Professional diving – Underwater diving where divers are paid for their work
- Dynamic positioning – Automatic ship station- and heading-holding systems
- Diving bell – Chamber for transporting divers vertically through the water

<u>**Objectives**</u>

<u>The objectives of this guide are to:</u>

- State examples of DP use on the Outer Continental Shelf.
- Describe the systems and components of a DP system.
- Explain how the system keeps station.
- Describe the Documents normally found on board DP vessels.
- Describe the Surveys and Tests done on DP Systems.
- Outline the applicable guidance and other references applicable to DP system

Uses of DP Systems on the OCS

DP SYSTEM

- A Dynamic Positioning System is a computer-controlled system used to automatically maintain a vessel’s heading and position without the use of mooring lines and/or anchors

DP SYSTEM

- Since it was first introduced in the 1960s, DP Systems have evolved to become the primary means of station keeping for vessels operating on the U.S. Outer Continental Shelf (OCS). DP Systems are often used on Mobile Offshore Drilling Units (MODUs), Floating Production Units (FPUs), Construction Vessels, Accommodation Vessels (Floatels), Dive Support Vessels and Offshore Supply Vessels (OSVs).

DP SYSTEM

- The DP system is used to maintain the vessel’s position in order
- to conduct critical activities such as
- drilling, diving operations,
- under water construction,
- and close quarter activities such as
- bulk cargo transfers, fuel transfers, deck cargo operations,
- personnel transfers, and ROV work.

DP System Explored

- A DP System is comprised of three sub-systems:
- • **Power System,**
- • **Thruster System, and**
- • **DP Control System**
- These three sub-systems work in unison to maintain the vessel's heading and position by controlling the horizontal movement of the vessel.

Power System

- The power system is comprised of all components and associated systems necessary to supply the DP system with power. The power system includes but is not limited to:
- prime movers;
- generators;
- switchboards;
- distribution systems (associated cabling and cable routing);
- uninterruptible power supplies (UPS) and batteries; and,
- power management system(s) (as appropriate).

Thruster System

- The thruster system is comprised of all components and associated systems
- necessary to supply the DP system with variable force and direction of thrust.
- The thruster system includes:
- thrusters with drive units and necessary auxiliary systems including piping,
- cooling, hydraulic and lubrication systems, etc;
- main propulsion systems; propellers and rudders, Z-drives, azipods, water jets, etc;
- auxiliary thrusters; tunnel thrusters, drop down thrusters, z-drives, etc;
- thruster control systems;
- manual thruster controls; and,
- associated cabling and cable routing

DP Control System

- The DP control system is comprised of all
- control components
- and associated systems,
- hardware and
- software necessary to
- coordinate with the other
- sub-systems to maintain position.

DP Control System

- The DP control system includes:
- computer system;
- joystick system;
- sensor system(s);
- control stations and display system (operator panels);
- position reference system(s);
- associated cabling and cable routing; and,
- networks

Classes of DP Systems

- The IMO has categorized DP Systems into
- **3 Equipment Classes** based on
- **redundancy** and **protection**.
- The necessary redundancy level for the components
- and systems are determined by the consequence of the loss of vessel
- position and/or heading.
- The classes are stated below as defined in IMO MSC.1/Circ. 1580:

Classes of DP Systems

Class 1

• A loss of position and/or heading **may occur** in the event of a single fault.

- **Class 2**

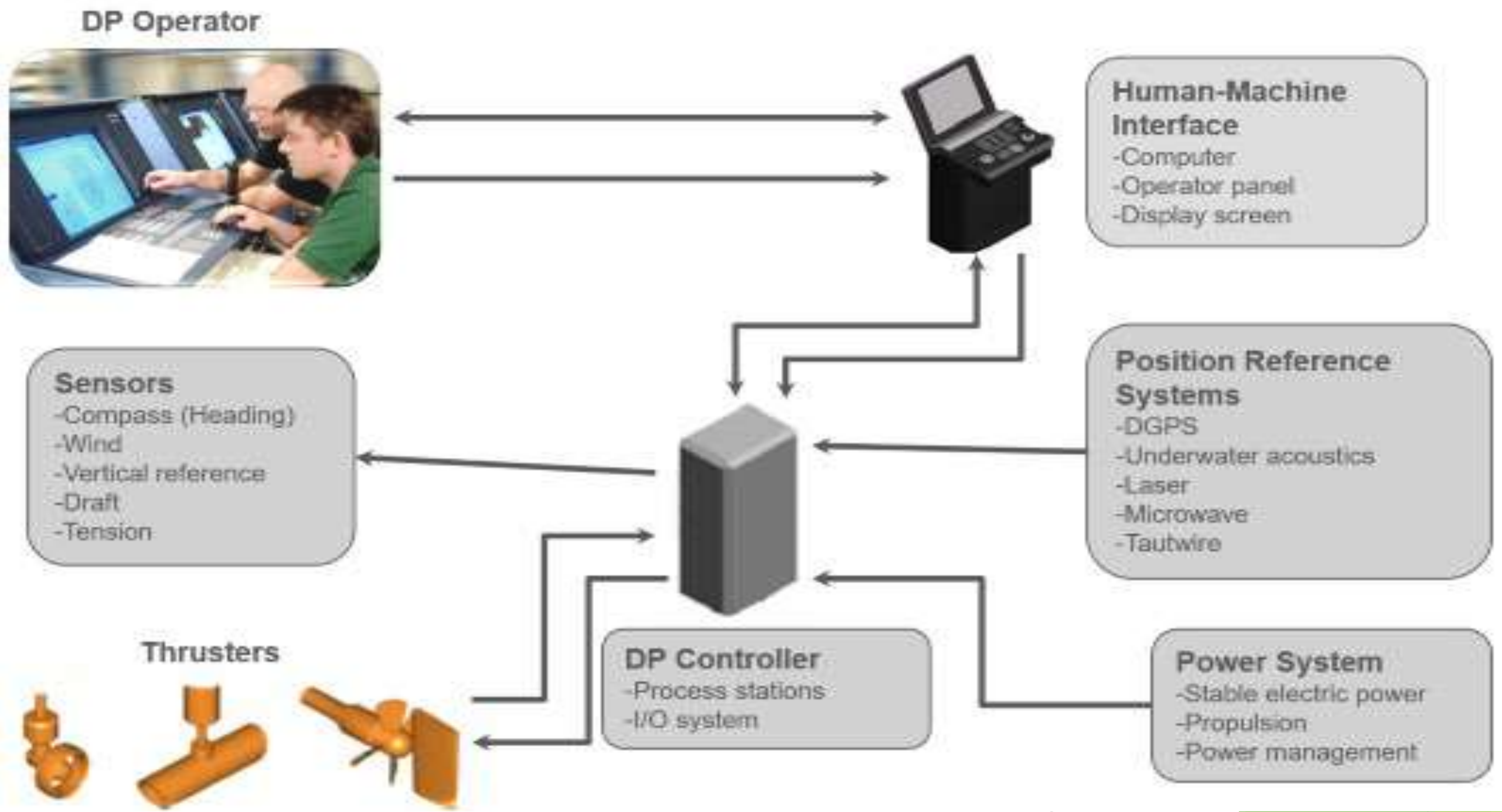
• A loss of position and/or heading **will not occur** in the event of a single fault in any active component or system.

- Single failure criteria include, but are not limited to:
- Any active component or system (generators, thrusters, switchboards, communication networks, remote-controlled valves, etc.); and,
- Any normally static component (cables, pipes, manual valves, etc.) that may immediately affect position keeping capabilities upon failure or is not properly documented with respect to protection.
- Common static components may be accepted in systems which will not immediately affect position keeping capabilities upon failure (e.g. ventilation and seawater systems not directly cooling running machinery).
- Normally such static components will not be considered to fail where adequate protection from damage is demonstrated to the satisfaction of the Administration

Classes of DP Systems

- **Class 3**
- • A loss of position and/or heading **will not occur** in the event of a single fault or failure.
- • A single failure includes:
- • Items listed above for class 2, and any normally static component assumed to fail;
- • All components in any one watertight compartment, from fire or flooding; and
- • All components in any one fire sub-division, from fire or flooding (for cables, see also paragraph 3.5.1 of IMO MSC.1/Circ. 1580).

Functionality of Systems



Functionality of Systems

- The DP System maintains a vessel's desired position and/or heading by use of the DP control computer which automates the control of vital power and propulsion systems in order to control 3 of 6 axes of a vessel's movement:
- surge (aft and forward),
- sway (side to side), and
- yaw (heading).

- DP Systems are complex and rely on the harmonization of hardware, software, machinery and human interfaces to properly maintain the vessel in a fixed position. The failure of one or more of these systems could result in a potentially catastrophic event. To properly inspect the DP System, it is imperative that marine inspectors have knowledge and understanding of how the system works as a whole.

Power System

- The power supply should be reliable and adequate
- to provide continuous power to the DP control system,
- thrusters/propulsion systems and
- all of the vessel’s other operational loads or
- power demands so that the DP system
- can maintain the vessel’s desired position and heading.

Power System

- **DP Class 1**
- redundancy of power system is not required

- **DP Class 2 & 3**
- The power system should be divided into at least two or more systems so that in the event of failure of one system, there will be at least one other system in operation to maintain the vessel in position.

- At least one automatic power management system (PMS) should be provided and should have redundancy according to the equipment class and a blackout prevention function.

- There should be enough power available to maintain position after worst-case failure.

Power System

- Sudden load changes resulting from
- single faults or equipment failures should not create a blackout.
- The approved FMEA will illustrate the
- configuration of power generation systems

Control System Computers

- The control computers receive input from various sensors
- and reference systems to determine the vessel’s heading,
- position and the external forces being applied to the vessel.
- This information is then processed to determine the amount and
- direction of force that must be applied in order to
- counteract the external forces.
- The Power and Thrusts sub-system then
- execute the commands given from the
- control system and exerts the desired force
- needed to maintain the desired heading and position.

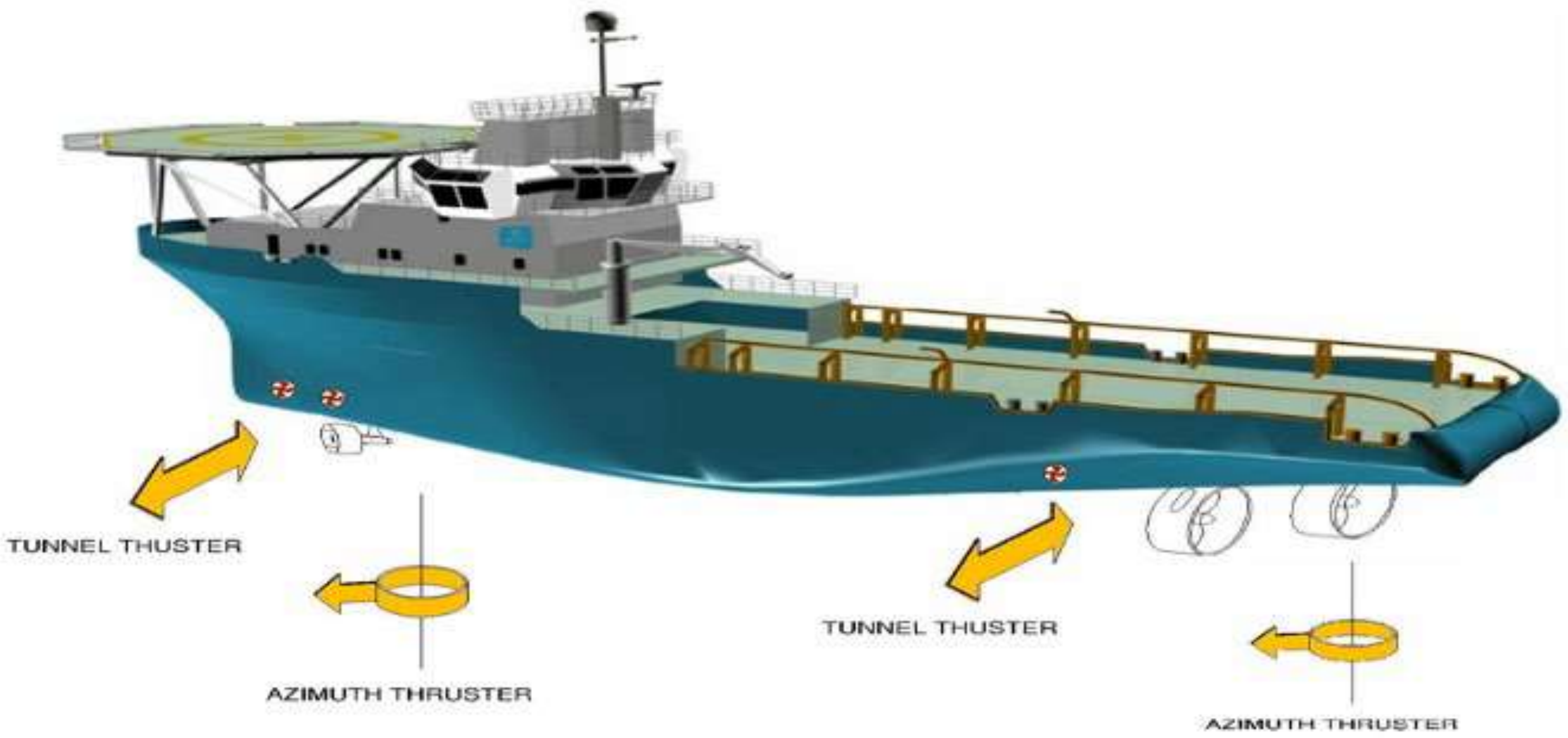
Control System Computers

- **DP Class 1**
- Redundancy of control system computers is not required.
- **DP Classes 2 & 3**
- The DP control system computers should consist of at least two computer systems so that, in case of any single failure, automatic position keeping ability will be maintained.
- There should be automatic transfer of control after a detected failure in one of the computer systems.
- The automatic transfer of control from one computer system to another should be smooth with no loss of position and/or heading.
- The DP control system computers should include a software function, normally known as "consequence analysis", which continuously verifies that the vessel will remain in position even if the worst-case failure occurs.

Control System Computers

- **DP Class 3**,
- • An additional backup DP control
- system computer should be in a room
- separated by an A-60 class division from the main DP control station.
-

Thruster System



Thruster System

- The thruster system shall be arranged as to provide the vessel with adequate maneuverability under all operating conditions. Also, the thruster system should be able to provide adequate thrust to control surge, sway and yawing.
- Thruster systems should be arranged so that the failure of any part of the system including pitch, azimuth or speed control should not increase the thrust magnitude or direction.
- Individual thruster emergency stop systems should be arranged in the DP control station.

Position Reference Systems

- **DP Class 1**
- Redundancy of thrusters system is not required.

- **DP Classes 2 and 3**
- The thruster emergency stop system should have closed loop monitoring to detect any faults.

- **DP Class 3**
- The effects of fire and flooding should be considered.

Position Reference Systems

- In order for the DP System to keep
- a vessel in a desired position, it must utilize a Position Reference System (PRS).
- The PRS identifies the vessel’s current position.
- This position will either be an **Absolute Position** (geographic position) or a **Relative Position** (relative to a target).

Position Reference Systems

- There are several systems, which utilize either absolute or relative positions. Some of these systems and some common brand names are:
- **Relative PRS** **Absolute PRS**
- Laser (Cyscan®, Fanbeam®) Satellite (DGPS, DGNSS)
- Microwave (Radascan®) Underwater Acoustics (HPR)*
- Tautwire**
- An acoustic absolute system can be used as a relative system if attached to a non-fixed target.
- **A relative system can be used as an absolute system if installed on a point that is a fixed geographical position.

Position Reference Systems

- **DP Class 1**
- • At least two position references systems should be available during operations.
-
- **DP Classes 2 & 3**
- • At least three position reference systems should be available during operations.
-
- **DP Class 3**
- • At least one of the position reference systems should be connected directly to the backup control system and separated by an A-60 class division from the other position reference systems.
-

Position Reference Systems

- When two or more position reference systems are used or required, they **should not be** of the same type, and **should be** based on different principles and suitable for the operating conditions.
- The approved FMEA will illustrate the types PRS on board.
- **Environmental & Motion Sensors**
- Vessel should be equipped with sensors to measure **heading, vessel motion** and the **wind speed and direction**. These sensors include

Position Reference Systems

- **Gyros:**
- ➢ The gyrocompass constantly provides the DP computer with the vessel's current heading data in order to maintain and/or control vessel's heading.
- **Wind:**
- ➢ Input from wind sensors are needed for the controller to measure the effects of the wind on the sail area of the vessel.
- **Motion Sensors:**
- ➢ These sensors measure the 3 of the 6 degree of motions that are not controlled, but must be accounted for to improve accuracy of the position reference systems.
- ➢ Pitch (rock fore and aft),
- ➢ Roll (rock side to side)
- ➢ Heave (lift up and down)

Position Reference Systems

- Sensors for the same purpose which are connected to redundant systems should be arranged independently so that failure of one will not affect the others. Example: the 3 gyrocompasses that are providing input data into the 2 DP computers should be arranged that failure of one gyrocompass shall not affect the remaining 2.

Position Reference Systems

- **DP Class 1**
- Redundancy of these systems are not required.

- **DP Classes 2 & 3**
- There should be three sensor available for the same purpose (3 wind sensors, 3 Gyros, 3 motion sensors).

- **DP Class 3**
- One of each type of sensor should be connected directly to the backup DP control system, and separated by an A-60 class division from the other sensors.

- If the data from these sensors are passed to the main DP control system, this system should be arranged so that a failure in the main DP control system cannot affect the integrity of the sensor’s data to the backup DP control system

Operator Control Stations

Operator Control Stations

- The DP operator station should display information from the power system, thruster system and control system to ensure that these systems are functioning correctly. Information necessary to safely operate the DP system should be visible at all times. Other information should be available upon the operator's request.
- The operator’s station should be located where the operator has good visibility of the exterior and surrounding arears.

Operator Control Stations

- The operator’s station should allow for easy accessibility of the control mode, i.e. manual joystick, or automatic DP control of thrusters, propellers and rudders, if part of the thruster system. The active control mode should be clearly displayed.
- The operator’s stations should be fitted with visual and audible alarms and warnings for failures in all systems interfaced to and/or controlled by the control system should be audible and visual. There should be a record of their occurrence and of status changes and should be provided together with any necessary explanations.

Operator Control Stations

- **DP Classes 2 & 3**
- • Two operator stations should be provided.

- **DP Class 3**
- • An additional backup control system should be available in an A-60 class division.

- **DP Classes 2 and 3**
- • The operator controls should be designed so that no single inadvertent act on the operator's panel can lead to a loss of position and/or heading.

Human Element (DP Operator)

- **The DP operator should be:**
- • A navigational watch officer
- • Trained and experienced
- • Knowledgeable and familiar with the DP system and vessel's characteristics
- • Responsible for the input of the desired position and heading into the DP computer
- • Responsible for monitoring all systems to ensure safe, effective and efficient DP Operations, including:
- • weather
- • positioning capability
- • DP control systems
- • power systems
- • thrusters systems
- • any other systems relevant to DP Operations

Surveys, Tests & DPVAD
DP FMEA

- Required for DP **Classes 2 & 3**.
- • Should be carried out to demonstrate that no single failure will cause a loss of position or heading and should also verify worst-case failure design intent.
- • The DP components and systems on board the vessel should match the components and systems that are listed in the approved FMEA.
- • Should be kept on board and should be kept updated so that it remains current.
- • Should be approved by flag state or their recognized ACS/RO.
- • For U.S. Flagged vessels, the FMEA will be approved by the Marine Safety Center or an ACS/RO.

DP Proving Trials

- A survey and proving trials should be conducted to confirm the expected effects of the failure modes found in the FMEA desktop analysis.
- • Required for DP **Classes 2 &3**.
- • Should test the interface of the different systems and equipment of the different vendors.
- • Proving Trials test to confirm that no single fault will cause a loss of position or heading and will also verify worst-case failure analysis.
- • The test procedures and the results of the DP proving trials should be kept on board.
- • Should be approved by the flag state or their recognized ACS/RO. For U.S. Flagged vessels, the Proving Trials will be approved by the Marine Safety Center or an ACS/RO.
- • These tests are comparable to the U.S. Regulatory requirements for Design Verification Test Procedures.

DP Periodic Trials

- A survey and periodic trials should be completed every 5 years using similar test procedures as the DP Proving Trials.
- • Required for DP **Classes 2 &3**.
- • Tests should confirm that system continues to operate as designed and no single fault will cause a loss of position or heading and will also verify worst-case failure analysis.
- • The test procedures and the results of the periodic trials should be kept on board.

DP Annual Trials

- The annual survey and tests of the DP system and components should be completed within 3 months before or after the anniversary date of the DPVAD or initial survey.
- • Required for **DP Classes 2 &3**.
- • Verifies that the DP system is able to function as designed and also validates the FMEA and operations manual.
- • Annual Trials are usually more limited in scope and are comparative to that of the Regulatory requirements of the Periodic Safety Test Procedures.
- • The test procedures and the results of the annual trials should be kept on board.

Special Trials

- Either a general or partial survey and test, depending on the circumstances, should be carried out each time a defect is discovered and corrected or after an accident occurs which affects the safety of the DP vessel, or whenever any significant repairs or alterations are made.
- • Any changes, upgrades, or modifications (excluding in-kind changes) to components or systems listed in the FMEA, including software changes, must be resubmitted to the Marine Safety Center and/or an ACS/RO for approval and be tested.
- • The tests procedures and the results of the special trials should be kept on board.
- • Should be approved by flag state or their recognized ACS/RO.
- • For U.S. Flagged vessels, these tests will be approved by the Marine Safety Center or an ACS/RO.

DP Verification Acceptance Document (DPVAD)

- This document should be issued by the Flag State or RO to vessels that comply with the IMO DP guidance (IMO 645 or IMO 1580), as applicable.
- • Should be issued for a period not to exceed 5 years
- • Should cease to be valid if significant alterations have been made to the DP system or components without Administration or RO approval.

- **Note:** Because the U.S. Coast Guard does not have any regulations regarding DP systems, DPVADs are not normally found on U.S. Flagged vessels. Verification of DP systems would be found on the appropriate Classification Certificate.

Operations

DP Operations Manual

- A DP Operations Manual is required as part of the plan review and approval. The DP Operations Manual should be vessel specific and located near the DP Operator's Station, readily available to the DPO for quick reference during DP Operations. DP operations should be conducted in accordance with the approved DP Operations Manual.
- DP Operations may be considered "Key Shipboard Operations" as stated in Regulation 7 of ISM. Therefore, the DP Operations Manual may also be part of the vessel's SMS.
- The requirement for the vessel specific DP Operations Manual is in addition to the manufacturer's Owner's or Operator's Manual.
- The requirements for the contents of the DP Operations Manual differ depending on the approving authority. However, most DP Operations Manual will normally include the items listed below:

DP Operations Manual

- **Vessel Specific DP Operation Instructions:** The manual should be representative of the way the vessel is operated in DP. It may also include Company Specific Policies and Procedures regarding Operations and Reporting.
- • **On-site Location and Watch-keeping Checklists:** Checklists specific to the on-site location as well as watch-keeping should be included in the DP Operation’s Manual. These checklist usually include both bridge and engine room checklists.
- • **DP Personnel Training and Competence Requirements:** The Operations Manual should provide requirements for training and competence of all DP personnel. This may include: on board familiarization, training certifications, checklists and assessments.

DP Operations Manual

- □ **Weather and Operation Limitations:** The DP Operations Manual should include information related to the limitation of DP Operations with regards to; weather, power systems, thrusters, proximity to other vessels/MODUs/structures, draft, Simultaneous operations, PMS, etc.
- • **Capability Plots:** The DP Operations Manual may also include Capability Plots which are calculated 360 degree envelopes of current and wind speeds that the vessel can theoretically be able to maintain position in certain scenarios. These scenarios would include; intact power and thrusters, loss of most effective thrusters, and following a worst case failure (WCF).
- Although, capability plots may be included in the approved DP Operations Manual, they may also be in a separate folder for quicker access during DP Operations.

DP Operations Manual

- **Foot Print Plots:** Foot Print Plots are actually taken onboard, to measure the vessel's performance while on DP within an established time period. The DP Operations Manual should include instructions on when these plots should be taken and include a sample form. These plots are normally completed manually, but may be done electronically if the DP Operator Station has the capability.
- • **Incident/Accident Reporting:** Incident/Accident reporting requirements should be included in the DP Operations Manual. There may also be instructions for reporting requirements for change of status when using an ASOG/WSOG or CAMO.
- • **Record Keeping:** The DP Operations Manual should also contain instructions for record keeping. DP related records should be maintained onboard and, where appropriate, at the company's office.

DP Operations Manual

- □ **Record Keeping:** The DP Operations Manual should also contain instructions for record keeping. DP related records should be maintained onboard and, where appropriate, at the company's office.
- • **Operational Planning**: The DP Operations Manual should include specific guidance in the form of an ASOG/WSOG and CAMOs for specific DP activities and missions, as appropriate. The DP Operations Manual should also give the configuration arrangement of the vessel's DP system for TAMs, and CAMs.
- • **List of Critical Components**: A list of critical components should be identified and listed in the DP Operations Manual.
- • **Blackout Recovery:** There should be blackout recovery procedures in the DP Operations Manual to provide guidance for recovery in the event of a blackout.

Maintenance Records

- Each DP vessel should have a structured planned maintenance system that specifically addresses maintenance of the vessel’s DP System and Components. Includes all components of the DP system to include the power, thruster and control systems.
- Should address all systems and components that may affect the safety of the DP operations and station keeping capabilities.
- **Note:** Service Reports for DP system should also be kept on board.

Records of Warnings and Alarms

- Records of system warnings and alarms
- should be kept by means of an electronic
- DP data log, or a dedicated printer readout
- Records relating to a DP
- incident should be permanently
- stored in retrievable archives.

Table of Subsystems & Equipment per DP Class

- **DP Class Equipment Requirements**
- **Subsystem or Component   Minimum Requirements for each DP Class**
- **Class 1   Class2   Class 3**
- **Power** Generators & Prime Movers Non-Redundant Redundant Redundant, with separate A-60 compartments
- Main Switch Board   1   1 w/Bus Tie   2, with 1 in separate A-60 compartment
- Bus Tie Breaker   0   1   2
- Distribution System   Non-Redundant   Redundant   Redundant, with 1 in separate A-60 compartment
- Power Management System   Optional   Yes Yes
- **Thrusters**
- **/Propulsion**   Arrangement   Non-Redundant   Redundant   **Redundant**

Table of Subsystems & Equipment per DP Class

Controls			
DP Computer Systems	1	2	2 + 1 in A-60 backup control station
Manual Control – Joystick	Yes	Yes	Yes
Single Levers for each thruster	Yes	Yes	Yes
Operator Control Station	1	2	2 + 1 in A-60 backup control station
Consequence Analysis	No	Yes	Yes
Position Reference Systems	2	3	2 + 1 in A-60 backup control station
Sensors Wind	1	3	2 + 1 in A-60 backup control station
Motion	1	3	2 + 1 in A-60 backup control station

Definitions

- The following are definitions for the purpose of this guide.
- **Absolute Reference System:** A position reference system that provides geographical position information.
- **Activity Specific Operating Guidelines:** Tabulated guidelines for the operational, environmental and equipment performance limits for a specific activity and location. The table also sets out various levels of DPO's actions should any situation changes.
- **Bus-Tie:** A device for connecting/disconnecting multiple switchboards.
- **Company:** The person, organization or charterer who has assumed the responsibility of operation of the vessel. This would normally be the same as the Company as stated on the vessel's SMC.

Definitions

- **Consequence Analysis:** A software function built-in for DP 2 & 3 class systems, which continuously monitors the system and environmental impacts, verifying that the vessel will remain in position even if a worst-case failure occurs.
- **Critical Activity Mode of Operations:** A tabulated table presentation of the CAM which also sets out the DPO’s action should the required configuration not be met.
- **Critical Activity Mode:** The configuration of the DP system should be setup and operated in so as to deliver the intent of the vessel’s DP class notation.
- **DP Capability:** A vessel’s ability to maintain position or station keeping while using the DP system (on DP).
- **DP Control Station:** DPO workstation where the DPO can monitor and control all systems and components of the DP System.

Definitions

- **DP Control Systems:** All control components and systems, hardware and software including; computer systems, sensors, display systems, PRS, and associated cable and routing, necessary to dynamically position the vessel.
- **DP Incident**: A major system failure, environmental or human factor which has resulted in loss of DP capability and/or station keeping.
- **DP Operation:** When the DP system controls at least 2 degrees of freedom in the horizontal plane.
- **DP Operations Manual:** A vessel specific operations manual to provide the DPO with guidance and procedures for carrying out DP operations.
- **DP Personnel:** All personnel involved with DP operations, including the DPO.
- **DP Undesired Event**: A system failure, environmental or human factor which has caused a loss of redundancy and/or compromised DP capability and/or station keeping.
- **DPO:** A member of the navigation watch team that has been delegated to operating of the DP system.

Definitions

- **Drift Off:** a loss of position caused by a partial or total loss of thrust leading the DP vessel/installation to drift.
- **Drive Off**: a loss of position caused by an improper and undesired force applied by the DP system or a DP control system instability leading the DP vessel/installation to move in an undesired direction (yaw, surge and/or sway).
- **Dynamic Positioning Vessel:** A vessel maintaining position and heading or following a target automatically by means of the DP System.
- **Fail Safe Condition:** The system is returned to a safe state in the case of a failure or malfunction.
- **Loss of Position:** The vessel's position is outside the limits set for conducting a desired task or activity.
- **Position Keeping:** The act of maintaining a desired position within the limits set for conducting a desired task or activity under defined environmental conditions.
- **Redundancy:** The ability of a system or component to maintain or restore its function when a single fault has occurred.

Definitions

- **Redundant Groups (Subsystems):** Two or more component groups each of which is capable of individually and independently performing a specific function.
- **Relative Reference Systems:** A position reference system that gives the vessel's position relative to a non-fixed reference.
- **Station or Position Keeping:** Maintaining a desired position within the normal excursions of the control system and under the defined environmental conditions.
- **Task Appropriate Mode:** the appropriate configuration of the DP system and operational procedures when CAM is not required. For example, TAM configuration can be used where determined that the risks from loss position are not critical.
- **Well Specific Operational Guide:** The MODU version of the ASOG.
- **Worst Case Failure Design Intent:** Is the single failure with the maximum consequences that has been the basis of the design and operational conditions. This usually relates to a number of thrusters and generators that can simultaneously fail.
- **Worst Case Failure:** The identified single fault in the DP system resulting in maximum DP capability as determined through the FMEA study. The WCF is used in consequence analysis.