SHUTTLE TANKER ADVISORY

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INTRODUCTION

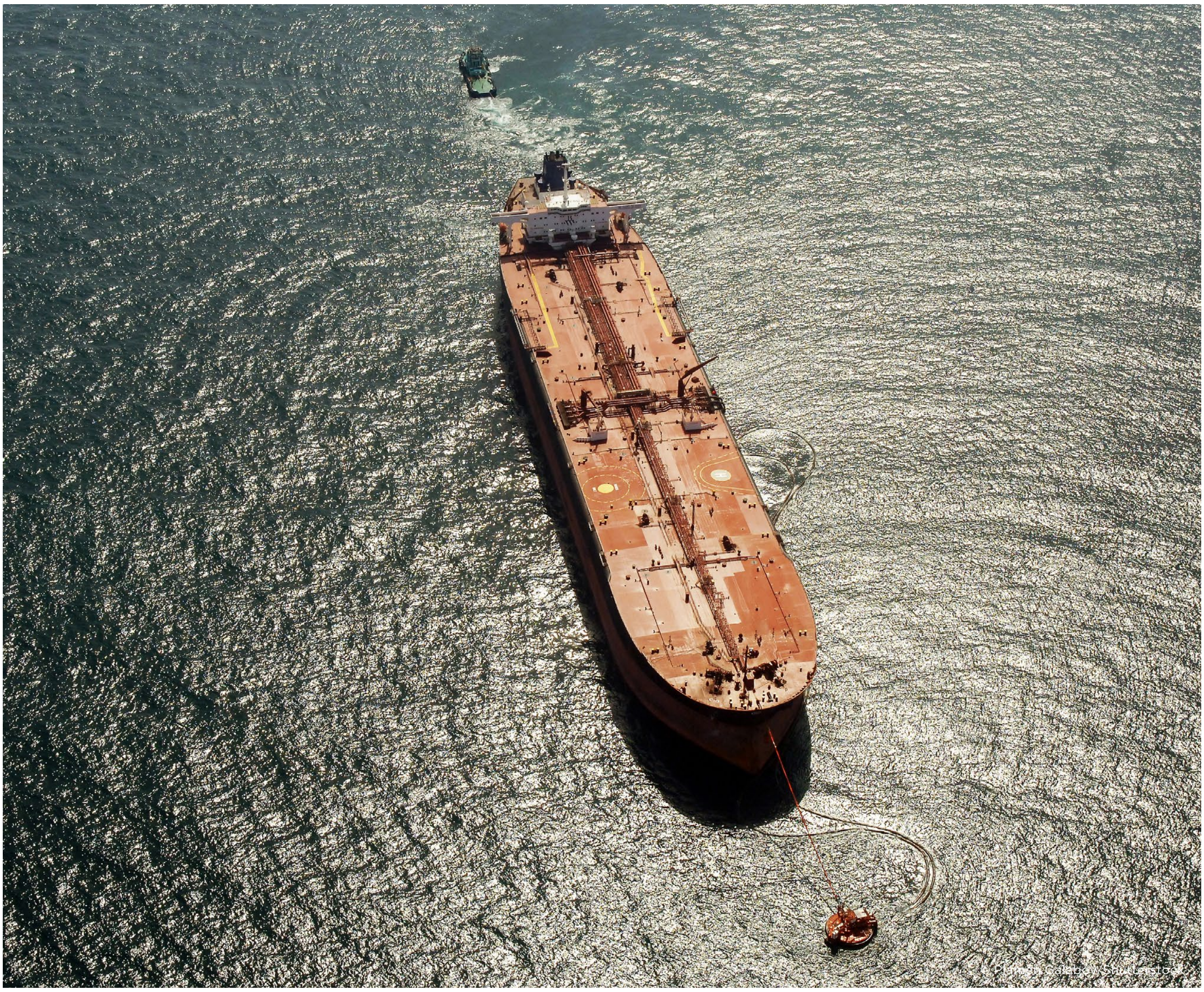
ABS is the Class leader in the tanker industry with over a quarter of the worldwide existing fleet and orderbook. ABS has extensive global experience in all sizes of tankers. Its safety record and leading Port State Control (PSC) ranking are a testament to ABS's commitment and focus on its mission.

ABS has a dedicated global workforce, with over 1,200 Surveyors and 500 Engineers positioned in 200 offices in 70 counties worldwide. ABS is looked upon as a trusted service provider not only for classification services but also for leading technology and research geared toward improving vessel performance.

Shuttle tankers are primarily employed in offshore oil and gas fields. As the Class leader in the offshore industry with a significant majority of Mobile Offshore Drilling Units (MODUs) currently under ABS class, our extensive network of experienced Surveyors and Engineers are well-positioned to support client operations. In a continually evolving market, ABS works alongside its partners to tackle the most pressing technical, operational, and regulatory challenges to help the industry operate safely, securely, and responsibly.

This Advisory provides an overview of shuttle tanker design and operation. It discusses regional considerations for shuttle tankers operating in Brazil, the North Sea, and the Gulf of Mexico. It explains how ABS optional notations complement class and statutory requirements to fulfill regional and operational requirements. We also identify requirements that are not covered by our class offerings that may be addressed by newbuild specifications or operational policies. We conclude by discussing new technologies that have already started to impact the shuttle tanker market.

SECTION 1 – OVERVIEW OF SHUTTLE TANKER OPERATIONS



Shuttle Tankers are a specialized type of tanker designed to load cargo from an offshore facility or a vessel of large size that cannot transit to the destination due to draft restrictions. Shuttle tankers are often used as an alternative to pipelines where harsh environments, remote location or water depth prevent a pipeline installation.

The offshore facility that a shuttle tanker loads from is typically a Single Point Mooring (SPM) buoy or a Floating (Production) Storage and Offloading (F(P)SO) unit. Some F(P)SOs are turret moored, which allows them to weathervane around the turret depending on current, wave, and wind direction. Some F(P)SOs are spread moored, which means that they have mooring lines off their bow and stern that maintain their heading despite current, wave, and wind patterns. A shuttle tanker must be able to safely moor and load cargo from these types of units.

All of this means that station keeping, cargo handling and communication between the shuttle tanker and offshore loading facility are vital to a shuttle tanker's safe operation.

STATION KEEPING

The Dynamic Positioning System is one of the most important or vital systems on a shuttle tanker. The shuttle tanker must maintain position during approach, loading, and departure, even in less than ideal weather conditions. To address station keeping requirements, ABS offers a full suite of Dynamic Positioning Notations.

Most shuttle tankers have a minimum of **DPS-2** dynamic positioning system. Additional complementary Notations, including Enhanced System Notation, Station Keeping Notation, and Athwartship Thruster Notations are also available and are discussed in Section 6.

To provide further propulsion safety, some shuttle tankers incorporate propulsion redundancy, with various combinations of multiple engines, engine rooms, and propellers. Propulsion redundancy is also discussed in Section 6.

CARGO HANDLING

SUBMERGED TURRET LOADING

Depending on the offshore field's infrastructure, shuttle tankers may need to accommodate different loading systems. Some shuttle tankers accommodate a Submerged Turret Loading (STL) system with a submerged buoy that connects through a cone-shaped turret in the keel of the shuttle tanker. This system is best suited for loading in areas with high sea states.

The buoy is spread moored to the seafloor and normally floats in a neutral position about 40 m below the surface. The mooring lines, risers, and umbilicals are connected to a turret nested inside the buoy. The turret is free to rotate inside the buoy, which allows the shuttle tanker to weathervane while connected to the buoy.

The following is a high-level overview of the loading operation using the STL:

1. The shuttle tanker locates the buoy using hydroacoustic transponders and TV cameras.
2. A messenger line from the shuttle tanker is connected to a messenger line connected to the submerged buoy, and the buoy is pulled up through the conical opening in the shuttle tanker bow.
3. The buoy is pulled into the hull and locked in place by hydraulic actuators.
4. The ship's loading manifold is lowered onto and connected to the buoy.
5. Loading of oil can begin.
6. Once loading has completed, the tanker releases the buoy, which sinks back down to the neutral position.

SINGLE POINT MOORING

A Single Point Mooring (SPM) Buoy consists of three components: the anchoring system, the buoy body, and the product transfer system. The buoy is spread moored to the seabed. A Pipeline End and Manifold (PLEM) on the seabed connects to the SPM through a riser. The buoy loading mechanism rotates to allow buoy and tanker movement relative to the PLEM. The cargo is transferred from the PLEM to the tanker using the buoy's product transfer system.

The following is a high-level overview of the mooring and loading operation using the SPM:

1. A small boat receives a messenger line from the shuttle tanker and connects it to a buoy messenger line. The buoy messenger line is connected to a mooring line and a short length of mooring chain.
2. The tanker hauls in the mooring line and engages the mooring chain in chain stoppers on the shuttle tanker. The tanker is now moored to the buoy.
3. A floating hose from the buoy is hauled in and connected to the taker's loading manifold.
4. Loading of oil can now begin.

BOW LOADING SYSTEM

Introduced in the 1980s, the Bow Loading System (BLS) is the most widely used system. This system has a small house located on the shuttle tanker's bow where the BLS equipment is located.

The following is a high-level overview of the loading operation using the BLS:

1. The shuttle tanker approaches the offloading facility, establishes contact, and maintains the minimum required distance from the loading facility.
2. The BLS house or the bow doors are opened.
3. The shuttle tanker receives a messenger line from the offloading facility. This messenger line is connected to a short length of mooring chain, followed by a mooring rope.

4. The messenger line is hauled in by the traction winch and stored in the onboard rope locker.
5. The mooring chain that was connected to the messenger line is engaged by the shuttle tanker chain stopper. Now the shuttle tanker is moored to the offloading facility.
6. A second messenger line is attached to the mooring line that was just hauled in and secured. This messenger line is connected to the export hose on the offloading facility. This messenger line is disconnected from the mooring line and fed to the hose handling winch.
7. The messenger line and export hose are hauled in by the shuttle tanker.
8. The export hose is clamped into the BLS manifold.
9. Once all connections have been verified, cargo loading from the offloading facility to the shuttle tanker can begin.

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COMMUNICATIONS

Communication between the shuttle tanker and the loading facility is vital for safe and successful loading operations. Redundant voice, telemetry, and Relative Position Reference Systems (RPRS) are typically required for all shuttle tankers. If personnel or sensors indicate that the minimum safe operating conditions are not being met, emergency shutdown and disconnection is initiated.

OTHER IMPORTANT CONSIDERATIONS

Vapor Emission Control – The filling levels of cargo tanks in shuttle tankers are always in flux, with tanks empty a significant amount of time. This means that a large amount of Volatile Organic Compounds (VOCs) are generated and must be dealt with. ABS addresses these needs through our Vapor Emission Control Notations, **VEC**, and **VEC-L**, discussed in Section 8.

Exhaust Emission Reduction – ABS has assisted several owners to develop a 2020 fuel strategy and evaluate available solutions. To assist in meeting exhaust gas emission requirements, ABS offers various notations for various types of exhaust emission abatement systems, which include SOx scrubbers, Selective Catalytic Reduction (SCR) systems, and Exhaust Gas Recirculation (EGR) arrangements, and are supported by Exhaust Emissions Monitoring Systems (EEMS). These are discussed in Section 10.

Ballast Water Capacity – To enhance stability and station keeping performance, a shuttle tanker's ballast water capacity may be increased.

Ballast Water Treatment – IMO has issued ballast water treatment guidance in the "International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004". Additionally, the USCG has issued separate requirements for type approval of Ballast Water Treatment Systems, which do not coincide with the IMO requirements. ABS can help owners and operators sort through these requirements and make sure that a BWT system is installed onboard that meets all local requirements. See Section 4 for more information on Ballast Water Treatment.

Ballast Water Exchange – When a system is installed during new construction, the vessel must also comply with the ABS Guide for Ballast Water Exchange if used as a contingency measure during situations when the ballast water treatment system needs repairs, is out of service, or unavailable. The use of ballast water exchange as a contingency measure is subject to approval from the flag Administration or the Port State Authority. The ballast water management plan includes instructions for the Master to seek permission from the port being visited prior to commencing ballast exchange as a contingency measure in case of the ballast water treatment system's inoperability.

Enhanced Fire Protection – In addition to the normal tanker fire protection requirements, a shuttle tanker must provide additional fire protection in the way of the bow loading system. Activation of these systems must be integrated into the emergency shutdown system. The ABS *Guide for the Class Notation Bow or Stern Loading and Unloading (BLU or SLU) for Oil. Carriers, Liquefied Gas Carriers, or Chemical Carriers*, discussed in Section 5, provides additional optional fire-fighting requirements for the bow loading system.

Human Factors – Providing a safe work environment is key to maintaining crew safety and morale. ABS offers Habitability, Ergonomic, Navigation Bridge Layout, and Means of Access Notations to keep a vessel's crew safe and efficient. Section 9 discusses safety and human factors Notations offered by ABS.

MANNING AND TRAINING

SHUTTLE TANKER

Shuttle Tanker Master
The Master should be familiar with all aspects of shuttle tanker operations for the vessel. When coming on board a new vessel, the Master typically completes a minimum number of loading cycles, ordinarily between two and six, supervised by a qualified Master, before he is eligible to conduct loading operations independently.

The Master also typically holds a valid Dynamic Positioning (DP) certificate applicable for the vessel type.

The Master is responsible for communications with the offshore facility and standby vessel. Normally, communications are established at 10 nautical miles from the offshore facility, and reports are given each hour during loading. Communications also occur when the shuttle tanker is ready to disconnect and when the shuttle tanker is clear of the loading facility.

Junior Officers
In addition to the Master, a minimum of two Deck or Junior officers normally hold appropriate DP certificates.

Engine Room Manning
During approach, loading, and departure, the engine room typically needs to be fully manned to meet flag State requirements. This generally includes one engineer and one rating.

Bridge Manning
DP Operator – The Master is not typically part of the DP watch team but is available to assist. The Senior DP certified officer on the watch, assisted by the Junior officers on watch, is normally responsible for DP operations.

VOC Operations
The crew members in charge of the VOC plant should be fully trained in the VOC equipment's operation.

BLS Deck Officer
The Deck Officer in charge of BLS operations should have undergone training provided by the equipment manufacturer. Any Deck Officer being trained in BLS operations should undergo a minimum number of loading cycles, normally three, supervised by a qualified officer, before being placed in charge of BLS operations.

Crane Operator
The crew members who perform crane lifts should be fully trained in the operation of the onboard crane(s).

Onboard Training
Many shuttle tankers are equipped with onboard training software. This software can simulate current trading patterns and a variety of field conditions. Most shuttle tanker operators require a minimum number of simulator hours for DP and BLS trained officers and crew.

STANDBY VESSEL

The Standby Vessel Master typically:

- Makes sure that all crew members are familiar with the arrival, loading, and departure operations for the shuttle tanker and the offshore facility.
- Makes sure all crew members are trained in emergency procedures, including emergency towing procedures for the shuttle tanker.
- Monitors all communications between the shuttle tanker and offshore facility.
- Is prepared to provide emergency assistance in the event of:
    - Hawser/loading hose failure
    - Loss of power, propulsion, or maneuvering capability on the shuttle tanker
    - Collision
    - Fire/Explosion
    - Cargo Spill
    - Man Overboard

OFFSHORE FACILITY

The Offshore Facility Manager typically:

- Makes sure the crew involved with offloading operations are familiar with all offloading procedures during approach, offloading and shuttle tanker departure.
- Makes sure all mooring and offloading equipment is in good working condition.
- Establishes communications with the shuttle tanker before it is 10 nautical miles (nm) from the offshore facility.
- Notifies the shuttle tanker Master of any other vessels operating within the exclusion zone for the offshore facility.
- Reports each hour during the loading operation on the loading rate.
- Initiates oil transfer shutdown in emergencies.

OIL COMPANIES INTERNATIONAL MARINE FORUM (OCIMF) PUBLICATIONS

The Oil Companies International Marine Forum (OCIMF) has produced several excellent publications that address ship management and safety on shuttle tankers. Of particular interest is the OCIMF *Guidelines for Offshore Tanker Operations*.

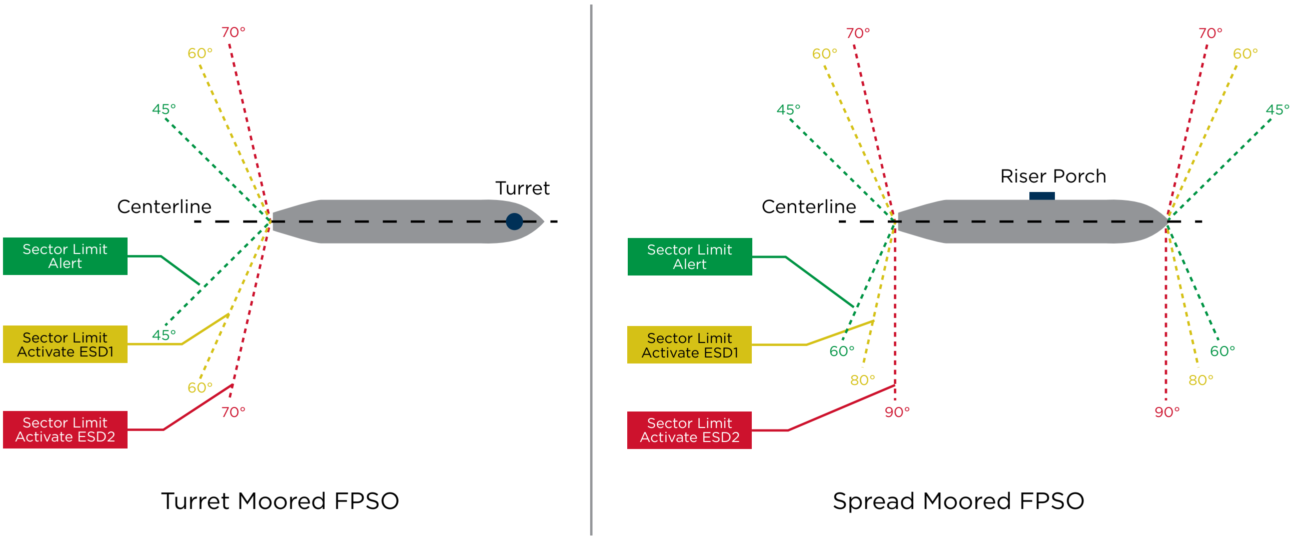
SECTION 2 – REGIONAL CONSIDERATIONS

BRAZIL

MAIN OPERATIONAL PARTICULARS

1. As most of F(P)SOs operating offshore Brazil are spread moored (versus turret moored), DP capabilities are vital for the shuttle tankers.
2. For the same reason, the operations sector is wider (see below diagram) than the one used for weathervaned operating conditions. This requires special attention on the DP control settings as well as customized training for the crew.
3. The above requires a very detailed operations procedure to cover the sequences for connection and disconnection.
4. The use of floating hoses for offloading may induce significant vibration in the Bow Loading System (BLS). Additional inspection and maintenance and affected parts may be required.

Figure 1. Sectors Definitions for Moored F(P)SOs



MAINTENANCE CHALLENGES

5. Difficulties in servicing thrusters while afloat.
6. Electrical problems with the sensors are not uncommon on BLS components.
7. Vigilance is required to keep the movable parts of BLS lubricated.
8. Critical components such as BLS, thrusters, and high voltage switchboards require special attention during overhaul periods.

BRAZILIAN FLAG CONSIDERATIONS

Shuttle tankers operating in Brazilian waters may require a percentage of the crew to be Brazilian nationals depending on the ship's service and time spent operating in Brazilian waters. It is recommended that local Brazilian officials be contacted before beginning shuttle tanker operations in Brazilian waters.

NORTH SEA

NORWEGIAN OIL AND GAS RECOMMENDED GUIDELINES FOR OFFSHORE LOADING SHUTTLE TANKERS, GUIDELINE NO. 140

Most shuttle tankers operating in the North Sea region are required by charterers to comply with the Norwegian Oil and Gas recommended Guidelines for Offshore Loading Shuttle Tankers, Guideline No. 140

This guideline is sponsored by the Norwegian Oil and Gas Association´s FPSO and Shuttle Tanker Network and recommended by the Norwegian Oil and Gas Operations Committee.

This guide contains information on:

- Hull Design and Structural Requirements
- Oil Spill Preventative Measures
- Machinery and Propulsion
- Cargo Vent and Ballast Systems
- Bow Loading Systems and Monitoring
- Dynamic Positioning
- Firefighting for Offshore Loading
- Safety Equipment
- Testing and Qualifications Requirements
- Competence and Manning

COLD CLIMATES

With many shuttle tankers operating in the North Sea, the Canadian east coast (offshore Newfoundland), and the Russian (Varandey, Caspian, Sakhalin, and Yamal) coast, there are specific considerations related to operating in cold climates that need to be considered. ABS offers Notations for Operation in Low-Temperature Environments and Ice Load Monitoring. We also provide a full suite of Ice Class Notations, including Polar Class, Enhanced Polar Class, First-year Ice Class, and Baltic Ice Class. See “Cold Climates” in Section 10 for more information.

U.S. GULF OF MEXICO

ALTERNATE COMPLIANCE PROGRAM

The Jones Act requires that vessels operating coastwise between U.S. ports or production facilities in the U.S. Gulf of Mexico and a U.S. port must be U.S. built and flagged. Traditionally, being U.S. flagged meant complying with all U.S. requirements in the Code of Federal Regulations (CFR). However, the U.S. Coast Guard has implemented Navigation and Vessel Inspection (NVIC) No. 2-95 Change 2, the U.S. Coast Guard’s Alternate Compliance Program (ACP). The ACP is an alternative to complying with vessel certification and inspection standards in Title 46 of the CFR and administered through inspections conducted by U.S. Coast guard personnel. The ACP does not supersede the Jones Act requirement that vessels trading coastwise between U.S. ports be U.S. built.

The ACP allows new or existing vessels to obtain U.S. flag by meeting applicable Statutory requirements, Class Rules, and additional requirements in a Supplement to the Class Rules. The Coast Guard considers the Statutory requirements plus Class Rules plus the Supplement requirements to provide an equivalent level of safety as that offered by meeting the full CFR requirements. ABS has USCG approved Supplements available on the Rules and Guides download page of our website, www.eagle.org.

Under the ACP, the USCG can also delegate authority to ABS to conduct plan reviews and surveys on behalf of the USCG. So, rather than dealing directly with the USCG, designers, shipyards, owners and operators can use ABS as a U.S. flag Recognized Organization (RO) for vessels that have been accepted into the ACP program. Please note that certain activities/functions, as specified in the NVIC 2-95, are retained by USCG and cannot be conducted by the Class Society.

SECTION 3 – DESIGN AND OPERATIONAL ISSUES

BRAZIL

WIND, WAVES, AND CURRENT (CAMPOS BASIN)

The Campos Basin is one of the 12 coastal sedimentary basins of Brazil. It spans both onshore and offshore parts of the South Atlantic with the onshore part near Rio de Janeiro. The Campos Basin is bounded on the south by the Cabo Frio High, separating the basin from the Santos Basin and the north by the Vitória High, forming the boundary with the Espírito Santo Basin. Campos Basin contains the Paraiba do Sul River delta.

The Campos Basin's environmental conditions are generally fair, with severe weather conditions limited from July to October each year.

1. **Wind** - Northeast winds prevail in Campos Basin with an average wind speed of 16.5 knots (8.5 m/s) but going as high as 40 knots (20.6 m/s). In autumn (March to May) and spring (September to November), sudden changes in wind direction (from NE to SW in less than one hour) and intensity (gusts up to 55 knots or 28.3 m/s) can occur. Shuttle tankers should be able to stay on station during these events.
2. **Waves** - Northeast waves prevail with significant wave heights (Hs) varying from 0.5 to 1.0 m. A one-year return period wave can have a height of up to 5.7 m, with a period of 13.7 seconds, and a 100-year return period can have a wave height of up to 7.8 m with a period of 15.3 seconds.

   When heavy winds and waves come from a specific direction, and the swell is reflected 90°, large roll motions in the shuttle tanker and F(P)SO may be induced.
3. **Current** - The "Brazil Stream" moves south along the Brazilian coast and exerts an influence in the Campos Basin area. Currents moving south with a speed of 0.8 m/s (1.5 knots) going up to 1.5 m/s (approx. 3.0 knots) have been recorded.

DYNAMIC POSITIONING SYSTEM

As shown in the above discussion of environmental conditions offshore Brazil, wind, waves, and currents are not always aligned and can rapidly shift. A minimum of DPS-2 is typically required for shuttle tankers operating off Brazil.

BOW LOADING SYSTEM (BLS)

All shuttle tankers in offshore Brazil service should be equipped with a Bow Loading System (BLS) for cargo loading. As discussed in Section 1, the Bow Loading System (BLS) should provide a system for connecting a shuttle tanker to an offshore loading terminal to offload crude oil from the terminal. The loading hose from the loading terminal should be connected to the BLS loading manifold on the ship a hydraulic coupler.

HIGH-PERFORMANCE RUDDER

Station keeping is key to successful operations offshore Brazil, and the rudder is part of that station keeping system. A high lift type, field-proven rudder integrated into the DP software, is typically required for shuttle tankers operating in Brazilian waters.

EQUIPMENT

The following equipment should be on board all shuttle tankers operating in Brazilian waters:

- **Traction Winch** - Must meet minimum pull-in speed for the offloading hose line and pull-in speed of the mooring system.
- **Chain Stopper** - A chain stopper for the mooring chafing chain with a hydraulic quick-release device adequate for the shuttle tanker size should be installed.
- **Emergency Towing Arrangements** - The shuttle tanker should be fitted with an emergency towing arrangement on the stern ready to be used, even in a blackout situation.
- **Pneumatic Line Throwers and Accessories** – The shuttle tanker should have a pneumatic line thrower and suitable tools for the Emergency Towing Arrangement on the poop deck, as well as a pneumatic line thrower and adequate tools for the transferring of the messengers on the forecastle deck.
- **Messenger Lines** - The shuttle tanker should be fitted with two (2) polypropylene messenger lines of the 10-inch circumference and 720 ft. length each and one (1) polypropylene messenger line of the 6-inch circumference and 720 ft. length. These lines are used for both mooring hawser and offloading hose line handling.
- **Personnel Transfer** – The shuttle tanker should be fitted with a proper crane to transfer personnel safely through a personnel basket transfer.
- **Telemetry System** – The shuttle tanker should be fitted with a radio signal-based telemetry system that verifies interlock and permits the pumping of oil during a transfer. Voice communication with the F(P)SO should also be included.
- **Relative Position Reference System (RPRS)** - There should be a minimum of three (3) RPRS installed. For "Full DP" operational mode, at least two (2) RPRS should be operational and in use during the approach, mooring, connection, loading, disconnection, and departure operations at F(P)SOs.
- **Hawser Tension Monitoring System** - The shuttle tanker should be provided with a hawser tension monitoring system.

USE OF TUG ASSIST

Normal Operations with a Dynamically Positioned Shuttle Tanker (DPST) do not require tug assist. If a Degraded Status exists, then tug assist may be necessary.

Degraded Status: The operational condition of a DP shuttle tanker in which a possibility of losing its safe operating capability has been detected. Normally, there will not be an imminent risk of positioning loss. Typically, failure, malfunction, or high load demand on essential DP equipment or systems (power generation, thrusters, computers, reference systems, sensors, etc.) causes a degradation of the vessel capability to operate within their rated DP capability. Generally, the degraded operational condition is related to redundancy loss.

It is important to note that "degraded status" does not necessarily mean that vessel operations must be stopped. However, all personnel in charge of the offloading operations must be informed to analyze the situation and take the appropriate course of action.

Brazil does not allow two (2) tugboats to operate simultaneously, supporting a shuttle tanker at any stage.

MINIMUM DISTANCE BETWEEN THE F(P)SO AND THE SHUTTLE TANKER

During the approach, the minimum distance between the F(P)SO and the shuttle tanker is not to be less than 50 m.

During operations, the minimum distance between the F(P)SO and the shuttle tanker is not to be less than 90 m.

TENSION ON THE MOORING HAWSER

During operations, the tension on the mooring hawser should not exceed 100 tons. If the tension exceeds 100 tons, the loading operation should be terminated, and disconnection should occur.

PRESSURE TEST

Connection Tightness Test – The tightness of the NSV (North Sea Valve) connection with the BLS (Bow Loading System) coupler should be tested before loading. The test must take place with an open Coupler Valve and closed Crude Valve or Inboarding Valve so that the test is limited to the bow piping (BLS area). The test should be carried out by the F(P)SO with a pressure of five bar for ten minutes. The shuttle tanker will monitor the pressure until the test has ended. The results of the test will be logged. After the conclusion, the system must be depressurized by the F(P)SO.

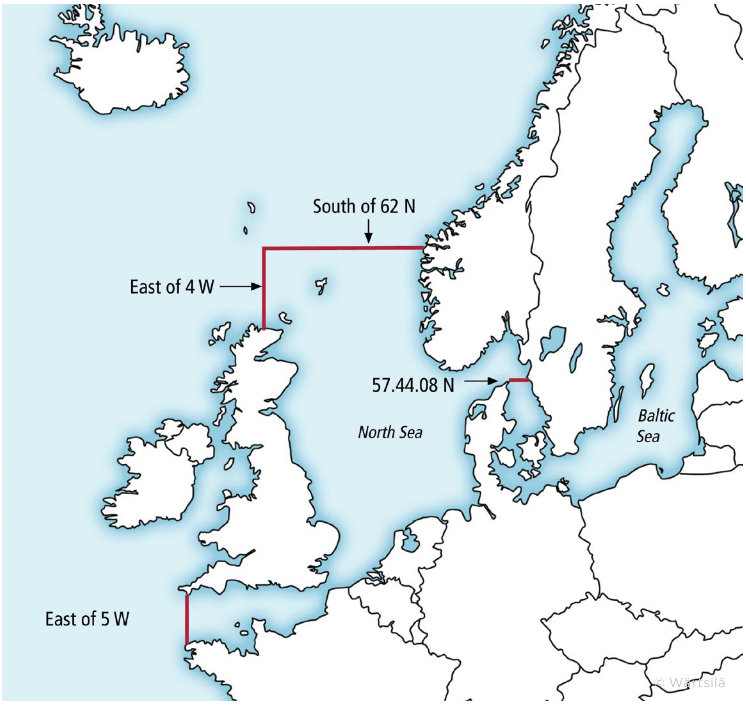
Hose Integrity Test – The pressure test for the verification of the hose integrity should be part of the inspection plan, following the international standard established by OCIMF (Guidelines for the handling, storage, inspection, and testing of hoses in the Field) in its last version.

Note: The Connection Tightness Test described above has the objective of testing the tightness between the NSV and the BLS. IT IS NOT a hose Integrity test nor an operational test. The pump pressure during the offloading operation IS NOT limited to 5 (five) BAR. The maximum pump pressure during the offloading n process is limited by the pressure used during the last hose integrity test.

NORTH SEA

The vessels operating in the North Sea, North Atlantic, and Norwegian Sea fields have traditionally been designed for considerably higher environmental loads and higher throughput compared to vessels operating in more benign waters. F(P)SOs operating in these areas typically have an internal turret in the bow or well forward of midships, with the transfer of pressurized production and injection streams going through piping systems in the turret. A Bow Loading System (BLS) is typically used on the shuttle tanker for loading from the F(P)SO or other offshore facilities.

To verify the robustness of the vessel for North Sea duty, ABS optional analyses such as Dynamic Loading Analysis (SH-DLA), Spectral Fatigue Analysis (SFA(years)), and Fatigue Life (FL(Years)) should be considered. See Section 7 for more information.



HULL DESIGN AND STRUCTURAL REQUIREMENTS

1. **Longitudinal Bulkheads** – Shuttle tankers should be equipped with a minimum of one solid longitudinal bulkhead throughout the cargo area.
2. **Structural Strength** – Cargo and ballast tanks should be designed for any degree of filling to avoid structural damage due to sloshing. Any shuttle tanker designed to the IACS Common Structural Rules (CSR) will meet this requirement.
3. **Internal Corrosion Protection of Cargo Tanks** – Cargo tanks should have corrosion protection using coatings that comply with the most current IMO requirements for cargo and ballast tanks. Anodes should be installed for the protection of suction wells.
4. **Helideck Arrangements** – All shuttle tankers should be equipped with a certified helideck.
5. **Securing of Anchors** – Stopper-bar or guillotine type anchor chain stoppers or equivalent means should be fitted to provide proper stowing of anchors.

PREVENTION OF OIL SPILLS

Coaming Arrangement – Oil spill coamings should be provided in the following areas:

1. The main deck between the bow and the midship manifold
2. From the midship manifold to the aft end of the main cargo tank deck
3. From the aft end of the main cargo tank deck to the accommodation
4. In the BLS area, the manifold room should have gutter bars for drainage to the main cargo deck. A forward coaming should also be provided.

Oil Spill Pumping System – For drainage of oil spills on deck, shuttle tankers should be equipped with permanently installed pumping or piping systems. The pump should be protected from freezing either by design or by operational procedures.

MACHINERY AND PROPULSION

The following general requirements are regarded as a minimum for a shuttle tanker in North Sea service:

1. The main and auxiliary engine(s) should have independent fuel systems (tanks, pumps, and piping systems).
2. Pumps, filters, strainers, etc., for the main and auxiliary engines, should be arranged in parallel.
3. Arrangement of instrumentation and alarms in the systems mentioned above should be documented.
4. All service tanks should be above the engines and boilers to provide gravity supply, or an equivalent system should be provided, so that fuel supply is maintained.

In addition:

1. Automatic de-sludging of filters should be provided.
2. A mixing tank should be provided so that the mixing of different fuels can be done before use in the engines.
3. Large electrical motors should be RPM controlled.

RUDDER AND THRUSTER TUNNEL GRATINGS

The shuttle tanker should be equipped with high-efficiency rudder(s)

All tunnel thrusters should have protective gratings.

CARGO, VENT, AND BALLAST SYSTEMS

Cargo Loading Capacity - To reduce risk, the time to load cargo should be minimized. The shuttle tanker's capacity to receive cargo should be optimized according to the shuttle tanker's total cargo tank volume.

Cargo Valves - Cargo valves should avoid pressure surges by having an appropriate closing time.

Cargo and Ballast Pump Monitoring – For shuttle tankers with a pump room, the pump's operating temperature should be monitored. Vibration monitoring of all cargo, stripping, and ballast pump bearings should be provided as well.

Cargo/ballast Monitoring - All cargo tanks should be provided with a radar type ullage gauging system. All ballast tanks and bunker tanks should be provided with automatic gauging systems. All gauging systems should provide input to a class-approved loading computer.

De-ballasting Capacity – A shuttle tanker should have at least two ballast pumps. The pumps should be able to de-ballast 100% ballast volume within 70% of the total loading time.

Explosive Atmosphere Monitoring – Ballast tanks and void spaces adjacent to cargo or slop tanks should be equipped with a fixed gas detection system.

Cargo/Slop Tank Venting System – Each cargo and slop tank should be provided with at least one high-velocity P/V-valve.

Vapor Emission Controls – Shuttle tankers should be equipped to meet the applicable Volatile Organic Compounds (VOC) emission requirements as stipulated by the VOC Industry Co-operation and enforced by the Norwegian Environment Agency.

BOW LOADING SYSTEM (BLS)

All shuttle tankers should be equipped with a Bow Loading System (BLS) for cargo loading.

A Failure Mode, Effect Analysis (FMEA) for the BLS and cargo loading system should be carried out for each shuttle tanker before the first offshore loading.

The BLS and cargo loading system should, as a minimum, be designed and verified according to these requirements:

1. A single failure in the cargo loading and storage system should not lead to a pressure rise exceeding the cargo loading and storage system's design pressure.
2. No single failure should cause a single-configured valve to close or open uncontrolled.
3. The vessel should, under all circumstances, be able to execute a controlled Emergency Shutdown operation.
4. Each active component should be designed with a fail-safe specification.

BLS Design Requirements

Remote control and monitoring of the following BLS equipment should be provided on the bridge:

1. Traction Winch
2. Chain Stopper
3. Coupler Valve
4. Inboard Valve
5. Inboard By-pass Valve
6. Hydraulic Pump Station

A control station on the forecastle deck should control the following:

1. Connection/disconnection of the Loading Hose
2. Bow Door
3. Loading Manifold
4. Hose Handling Winch
5. Forward/aft Movement of the Chain Stopper, or Adjustable Roller Rairlead

The following should be locally operated from the bow area:

1. Messenger Line Winch and Stowing Arrangement
2. Deck Crane

GREEN LINE CONTROL SYSTEM

The BLS and cargo loading system should be provided with a "green line" control system. When all the "green line" requirements are satisfied, the telemetry system should transmit a "loading permitted" signal to the offloading facility. Any interruption in the "green line" should automatically initiate an Emergency Shutdown on the shuttle tanker and the offloading facility.

TELEMETRY SYSTEM

A telemetry system should be a fail-to-safe design and capable of safely starting, controlling and stopping the cargo transfer. Duplicate telemetry systems operating in parallel and duplicate UHF radios with automatic changeover should be used.

DYNAMIC POSITIONING

The shuttle tanker should be capable of maintaining a safe position and heading during connection, loading, and disconnection by using a Dynamic Positioning System (DPS).

DP capability plots should be developed for the worst single failure according to the environmental conditions.

The intent of the capability plots is to identify each shuttle's DP capability. The plots will generally indicate a window of safe operation during connection and loading.

POSITION REFERENCE SYSTEM

The DP system should be equipped with redundant Position Reference Systems (PRSs). To reduce the risk of interference and shadow zones, the PRS sensors' location should be optimized.

FIRE-FIGHTING FOR OFFSHORE LOADING

A fire water system should be installed in the BLS area. The system should serve two purposes:

1. Supply of deluge (water only) to the BLS equipment and bow slot prevents any sparks that might cause a fire during emergency disconnection.
2. Supply of water for the foam fire-fighting system. The foam system should be operated from the fire-fighting panel on the bridge.

SAFETY EQUIPMENT

The following equipment should be provided:

1. Emergency towing arrangements
2. Pneumatic line throwing device (air gun)
3. Messenger line cutter
4. Safe walkways
5. Freefall Lifeboat
6. Fast Rescue Craft
7. Personal Protective Equipment

SECTION 4 – TYPICAL CLASS NOTATIONS

GENERAL

Shuttle tankers that comply with the requirements of the ABS Rules and which were surveyed by ABS during construction may be classed, for example, ✠ **A1, Oil Carrier, ESP, CSR, AB-CM,** Ⓔ, ✠ **AMS, ACCU, DPS-2+, BLU, EFP-M, TCM, NBLES(COS), UWILD, BWT, VEC-L, SPMA, CPS, IHM, ENVIRO, RRDA**.

The symbol Ⓔ is assigned if the vessel's anchor and chain comply with the Rules.

Shuttle tankers must also be enrolled in ABS's Enhanced Survey Program. Qualifying vessels are given the notation **ESP**.

Optional Notations typically awarded to Shuttle Tankers include **ENVIRO, BLU, SPMA, BWT, UWILD, TCM, VEC-L, NBLES(COS), POT, GFS(DFD, RELIQ, GCU), LNG Fuel Ready (S, FS, ME, AE), CRC, PMA, RW** and **HELIDK**.

All these Notations are widely accepted by the industry and are discussed in more detail later in this Advisory.

MACHINERY AND CONTROL SYSTEMS

The machinery, boilers, and systems of a shuttle tanker may be given the notation ✠ **AMS**.

ABS also offers notations for centralized control systems. The ✠ **ACC** notation signifies that a vessel has the means to control and monitor the propulsion-machinery space from a continuously manned centralized control and monitoring station instead of locally manning the propulsion machinery space. The ✠ **ACCU** notation means that the vessel is fitted with various degrees of automation and remote monitoring and control systems to enable the propulsion machinery space to be periodically unattended.

If the vessel's engines are designed to burn natural gas as fuel, optional notations typically assigned include **GFS (DFD, RELIQ, GCU, SGF)**. A vessel which is arranged to burn low flashpoint fuels other than natural gas, the **LFFS** notation may be assigned {e.g., **LFFS (DFD-Methanol)**}.

BALLAST WATER TREATMENT AND EXCHANGE

Currently, ABS has10 engineering offices with Ballast Water experience. One hundred and thirty systems have been design assessed by ABS. 140 Vendor systems are tracked by ABS and over 900 vessels are operating with the ABS **BWT** Notation.

BALLAST WATER EXCHANGE (BWE)

BWE – When a system is installed during new construction, the vessel is to also comply with the ABS *Guide for Ballast Water Exchange* if used as a contingency measure during situations when the ballast water treatment system needs repairs, is out of service, or unavailable. The use of ballast water exchange as a contingency measure is subject to approval from the flag Administration or the Port State Authority. The ballast water management plan is to include instructions for the Master to seek permission from the port being visited prior to commencing ballast exchange as a contingency measure in case of inoperability of the ballast water treatment system.

BALLAST WATER TREATMENT (BWT)

BWT – This notation is assigned to a vessel with a ballast water management system installed on board that has received a Type Approval Certificate issued by an IMO Member State. The system has been reviewed and installed in compliance with the ABS *Guide for Ballast Water Treatment* and serves to identify a level of compliance with the applicable regulations contained in the IMO "International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004", as well as those supporting IMO Guidelines referenced in the Convention addressing the ballast water management systems.

BWT+ – This notation is assigned to a vessel with a ballast water management system installed on board that, in addition to being type approved by an IMO Member State and evaluated for compliance with the requirements in the ABS *Guide for Ballast Water Treatment*, has been fabricated under survey at the manufacturing facility by an ABS Surveyor.

LIFTING APPLIANCES

A deck crane is standard equipment for a shuttle tanker equipped with a Bow Loading System (BLS). ABS offers a range of notations for lifting appliances, including shipboard cranes, special purpose cranes, personnel lifting cranes, and shipboard elevators.

As discussed further in the ABS *Guide for Certification of Lifting Appliances*, vessels may be assigned with the notation **CRC** if they have been issued an ABS Register of Lifting Appliances. ABS offers notations for several types of cranes, which include:

- **SC** for shipboard cranes
- **SP** for special purpose cranes (such as monorail hoists, engine room cranes, or provision cranes)

If these cranes may be used for personnel lifting, the **PL, PL+**, or **PL++** notations may also be given. These notations distinguish the level of emergency recovery capability of the crane.

For a shuttle tanker classed by ABS, having an installed shipboard elevator certified by ABS in accordance with requirements in the Lifting Appliance Guide, ABS offers the optional class notation **SELev** (shipboard elevator).

SECTION 5 – LOADING/UNLOADING SYSTEMS

ABS offers Notations for the following Loading/Unloading Systems:

BLU (BOW LOADING/UNLOADING) AND SLU (STERN LOADING AND UNLOADING) NOTATION

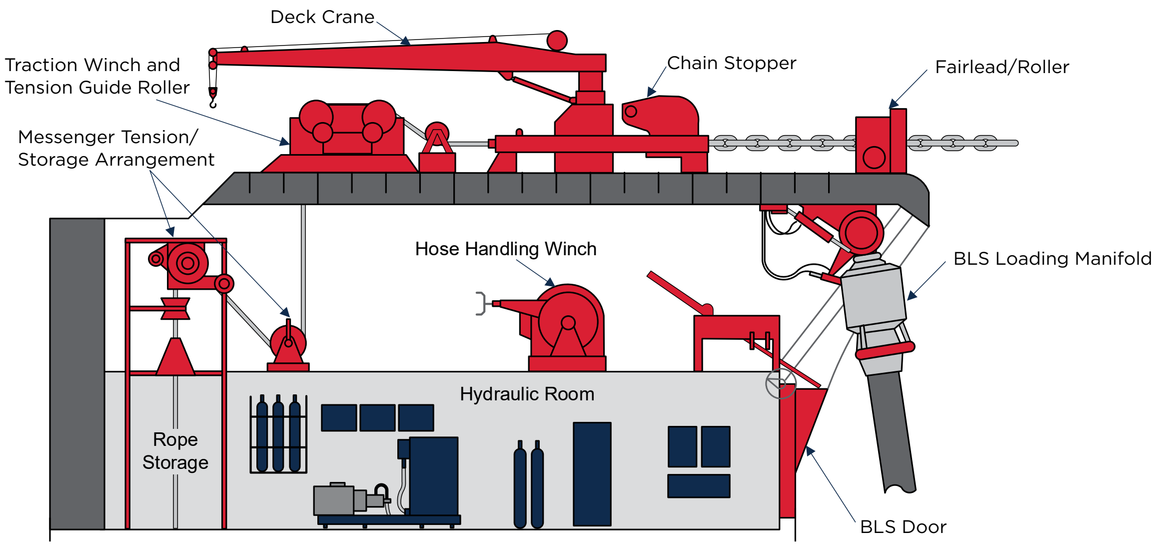
These Notations address arrangements where a shuttle tanker is provided with facilities to load or unload cargo with a piping manifold located at the vessel's bow or stern. Requirements for this Notation can be found in the ABS *Guide for the Class Notation Bow or Stern Loading and Unloading (BLU or SLU) for Oil Carriers, Liquefied Gas Carriers or Chemical Carriers*. The Guide has been recently updated to include requirements from the Norwegian Oil and Gas recommended Guidelines for Offshore Loading Shuttle Tankers, which are widely applied for the design of shuttle tankers operating in North Sea and Brazil.

This Guide gives minimum ABS requirements for:

1. Cargo Piping Systems
2. Hazardous Area and Electrical Systems
3. Communication Systems
4. Fire Extinguishing Arrangements
5. Mooring Arrangements
6. Emergency Quick Release System

See Figure 2 below for a profile view of a typical Bow Loading System (BLS).

Figure 2. Typical Bow Loading System



SINGLE POINT MOORING ARRANGEMENT

SPMA – This notation is assigned to a shuttle tanker provided with mooring arrangements in accordance with the requirements of Section 3-5-2 of the ABS *Rules for Building and Classing Marine Vessels (Mooring of Oil Carriers at Single Point Moorings)*. This Rule Section gives ABS requirements for:

1. Submission of Plans
2. Arrangements
3. Bow Chain Stoppers
4. Bow Fairleads
5. Pedestal Rollers
6. Winches or Capstan
7. Winch Storage Drum
8. Materials

SECTION 6 – DYNAMIC POSITIONING AND PROPULSION REDUNDANCY

The selection of propulsion solutions is mainly defined by Dynamic Positioning, redundancy, and the relevant operating profile of the vessel. Propulsion solutions affect the CAPEX as well as OPEX of the vessel. Certain recent propulsion solutions (affecting general machinery) with a more favorable environmental footprint (CO2 reduction) are using LNG as fuel as well as being able to handle/consume VOCs (Volatile Organic Compounds). Additionally, the hybrid propulsion concept has been developed to provide possible benefits (operating profile dependent) in OPEX (including reduced CO2) and CAPEX in certain cases.

- Typical propulsion solutions:
  - Twin main engine (2-stroke), twin screw
  - Diesel Electric (4-stroke), twin screw

Note: Single main engine, single screw, shuttle tankers exist as well.

- Recently developed propulsion solutions:
  - Twin main engine - Dual Fuel (2-stroke) – LNG
  - Diesel Electric – Dual Fuel (4-stroke) – LNG

Note: Above concepts may include Hybrid electric Propulsion with batteries.

DYNAMIC POSITIONING SYSTEMS

The Dynamic Positioning System is one of the most essential systems on a shuttle tanker. The shuttle tanker must maintain position during approach, loading, and departure, even in less than ideal weather conditions. Even though the full suite of ABS DPS notations is presented below, the minimum that should be considered for a shuttle tanker is **DPS-1+** or higher. Additional complementary Notations, including Enhanced System Notation, Station Keeping Notation, Athwartship Thruster Notation, and Propulsion Redundancy are also available and discussed below.

Dynamic positioning systems installed on shuttle tankers and built and tested in compliance with the requirements in the ABS *Guide for Dynamic Positioning Systems (DPS Guide)* and relevant Rules may be assigned different classification notations depending on the degree of redundancy built into the system as defined below. These notations are not a requirement for the vessel's classification and are to be assigned only on the specific request of the Owner. Certain flag States may have specific requirements for shuttle tankers operating in their waters (e.g., Brazil, North Sea).

- **DPS-0**: For vessels fitted with centralized manual position control and automatic heading control system to maintain the position and heading under the specified maximum environmental conditions.
- **DPS-1**: For vessels fitted with a dynamic positioning system that is capable of automatically maintaining the position and heading of the vessel under specified maximum environmental conditions having a manual position control system.
- **DPS-2**: For vessels fitted with a dynamic positioning system that is capable of automatically maintaining the position and heading of the vessel within a specified operating envelope under specified maximum environmental conditions during and following any single fault, excluding a loss of compartment or compartments.
- **DPS-3**: For vessels fitted with a dynamic positioning system that is capable of automatically maintaining the position and heading of the vessel within a specified operating envelope under specified maximum environmental conditions during and following any single fault, including complete loss of a compartment due to fire or flood.

DPS-1, DPS-2 and **DPS-3** classification notations are structured in line with the IMO MSC/Cir.645 "Guidelines for Vessels with Dynamic Positioning Systems." **DPS-1, DPS-2**, and **DPS-3** are in line with IMO equipment classes of 1, 2, and 3.

The symbol **+** for the **DPS**-series notations may be assigned, indicating additional requirements are met for station keeping capability and failure modes for static components that may affect position keeping capabilities upon failure as described in section 2 of the Guide. For **DPS-1+, DPS-2+** or **DPS-3+** notations, transverse thrust force, and yaw moment are not to be based on a combination of the conventional propeller and rudder arrangements only.

For **DPS-1+** notation, a thruster configuration arrangement is available to provide transverse force and yaw moment for station keeping.

For vessels with **DPS-2+** or **DPS-3+** notation, the vessel is to have thrusters in number and capacity sufficient to maintain position and heading, in the event of any single fault, under the specified maximum environmental conditions. This includes the failure of any one or more thrusters. A combination of propellers and rudders as redundancy for transverse thrust force and yaw moment is not acceptable.

An enhanced system notation (**EHS**), as a supplement to **DPS**-series notations, may be assigned. The notation provides the basis for the measurement of the enhancement of critical components of the DP system, including the power system, thruster system, and control system. The main objective of the enhanced system notation is to improve reliability, operability, and maintainability. Additional information on the **EHS** Notations is provided below, and Section 8 of the *DPS Guide* provides details for the enhanced system notations.

Also, a station keeping performance notation (**SKP**), as a supplement to the **DPS**-series notations, may be assigned to the vessel. The station's objective keeping performance notation is to recognize the DP capability and encourage robust design of DP systems. See below for additional information. Section 9 of the *DPS Guide* provides details for station keeping performance requirements.

To meet the requirements for a **DPS**-series notation, the minimum number of subsystems and components and the redundancy requirements for the power system, thruster system, and DP control system are provided in the following summary:

Subsystem or Component	Equipment		Minimum Requirements for Each Classification Notation			
			DPS-0	DPS-1[1]	DPS-2[2]	DPS-3[3]
Power System	Generators and Prime Movers		Non-redundant	Non-redundant	Non-redundant	Redundant, in separate compartments
	Main Switchboard		1	1	1 with bus-tie	2 with bus-ties, in separate compartments
	Bus-tie Breaker		0	0	1	2
	Distribution System		Non-redundant	Non-redundant	Redundant	Redundant, in separate compartments
	Power Management		No	No	Yes	Yes
Thrusters	Arrangement of Thrusters		Non-redundant	Non-redundant	Redundant	Redundant, in separate compartments
Control System	DP Control: Number of Control Computers		0	1	2	2 + 1 in backup control station
	Manual Position Control: Joystick with Auto Heading		Yes	Yes	Yes	Yes
	Manual Thruster Control		Yes	Yes	Yes	Yes
	Position Reference Systems		1	2	3	2 + 1 in backup control station
	Sensors	Wind	1	2	3	2 + 1 in backup control station
		Motion Reference Unit (MRU)	0	1	3	2 + 1 in backup control station
		Vessel Hading	1	2	3	2 + 1 in backup control station
	Uninterruptible Power Supply (UPS) System		0	1	2	2 + 1 in separate compartment
Backup Control Station for Backup Unit			N/A	N/A	N/A	Yes
Consequence Analyzer			No	No	Yes	Yes
FMEA			No	No	Yes	Yes
IMO Class Equivalent			No	1	2	3

1 DPS-1+ notation may be assigned for DP system meeting DPS-1 requirements plus 1 stern thruster
2 DPS-2+ notation may be assigned for DP system meeting DPS-2 requirements plus 2 stern thrusters and redundancy of static components
3 DPS-3+ notation may be assigned for DP system meeting DPS-3 requirements plus 2 stern thrusters

ENHANCED SYSTEM NOTATIONS

Enhanced system notations (EHS-series) are complementary to the corresponding DPS-series notations. The requirements for the DPS-series notations given in the above Table are to be complied with. Additionally, the following are to be complied with for the Enhanced System notations (EHS-series).

Three separate enhanced notations are offered as detailed below:

1. **Enhanced Power and Thruster System (EHS-P)**: This notation covers the power system requirements and thrusters beyond those for the **DPS**-series notations.
2. **Enhanced Control System: (EHS-C)**: This notation covers the requirements on the DP control systems, including control computers, position reference systems, and sensors, which are beyond the minimum requirements for **DPS**-series notations.
3. **Fire and Flood Protection System (EHS-F)**: This notation covers fire and flood protection requirements considering the risk level of the areas. This is a supplement for a **DPS-2** system. It is not necessary for a **DPS-3** system since a **DPS-3** system has a higher requirement in this regard.

EHS-P	EHS-C	EHS-F
Autonomous Generator Set	2 +1 backup DP control computers and controllers	**Generators and Prime Movers** Separate compartments, A60 for high fire risk area. Watertight below damage waterline
Bus-tie Breaker Redundantly configured between each bus segment	Wind Sensors 3 + 1 in back up control station	
Enhanced Generator Protection	Vessel heading sensor 3 + 1 in backup control station	**Power Distribution System** A0 between redundant groups. Watertight below damage waterline
Enhanced Power Management	Motion Reference Unit (MRU) 3 + 1 in backup control station	**Thruster System** A0 between redundant groups. Watertight below damage waterline
Autonomous Thruster Set	Position reference systems 3 + 1 in backup control station	**Controller Space** A0 between redundant groups

SKP (STATION KEEPING PERFORMANCE) NOTATION

SKP is an optional notation addressing the station keeping performance for specified limiting environmental conditions, such as wind speed and direction, wave height and frequency, current speed and direction. In general, the limiting environments are to be applied to intact (all thrusters running) and damaged (worst case failure) conditions unless the limiting environmental conditions for post-failure cases are also specified. The directions for wind, waves, and current can be different and are specified by the Owner.

APS (ATHWARTSHIP THRUSTER) NOTATION

Shuttle tankers, were fitted with thrusters capable of producing thrusts primarily in the athwartship direction and intended to assist in maneuvering the vessel, at the discretion of the owners, may comply with 4-1-1/1.5 and 4-3-5/1.3.1 of the ABS *Rules for Building and Classing Marine Vessels* and upon verification of compliance, may be assigned the class notation **APS**.

PROPULSION REDUNDANCY

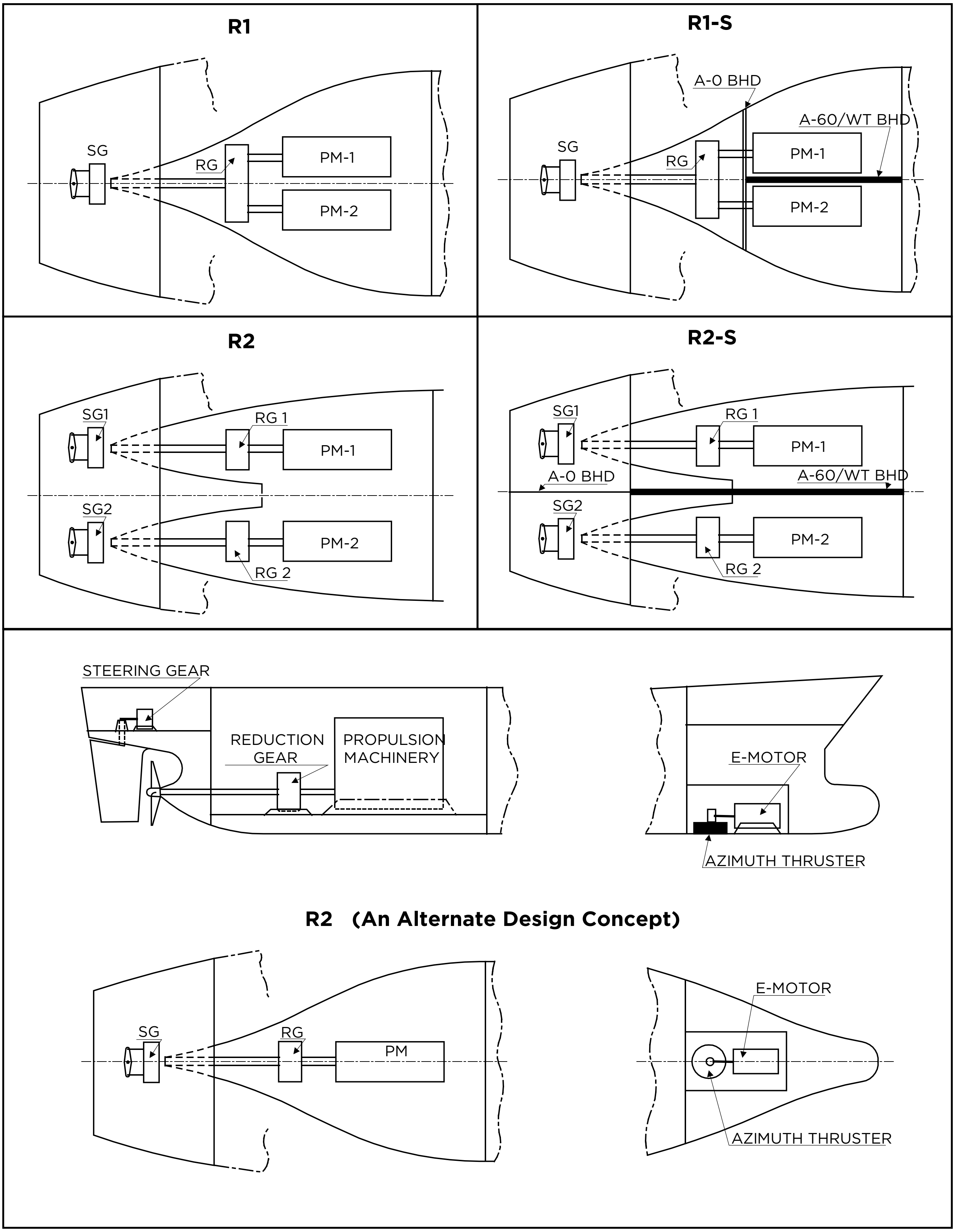
Requested by the Owner, propulsion, and steering installations are found to comply with the requirements specified in the ABS *Rules for Building and Classing Marine Vessels* and have been constructed and installed under survey by the ABS Surveyor may be assigned with the following class notations, as appropriate.

- **R1** - A vessel fitted with multiple propulsion machines but only a single propulsor and steering system will be assigned the class notation **R1**.
- **R2** - A vessel fitted with multiple propulsion machines and multiple propulsors and steering systems (hence, multiple propulsion systems) will be assigned the class notation **R2**.

- **R1–S** - A vessel fitted with only a single propulsor but having the propulsion machines arranged in separate spaces such that a fire or flood in one space would not affect the propulsion machine(s) in the other space(s) will be assigned the class notation **R1–S**.
- **R2–S** - A vessel fitted with multiple propulsors (hence, multiple propulsion systems) which has the propulsion machines and propulsors, and associated steering systems arranged in separate spaces (propulsion machinery space and steering gear flat) such that a fire or flood in one space would not affect the propulsion machine(s) and propulsor(s), and associated steering systems in the other space(s) will be assigned the class notation **R2–S**.

+ (Plus Symbol) The mark **+** will be affixed to the end of any of the above class notations (e.g., **R1+, R2–S+**) to denote that the vessel's propulsion capability is such that, upon a single failure, propulsive power can be maintained or immediately restored to the extent necessary to withstand adverse weather conditions without drifting, following the ABS *Rules for Building and Classing Marine Vessels.*

Figure 1. Arrangement of Propulsion Redundancy



SECTION 7 – HULL CONSTRUCTION AND EQUIPMENT

STRUCTURES

Most shuttle tankers have the same structural configurations as oil tankers, as defined in the IACS *Common Structural Rules for Bulk Carriers and Oil Tankers (CSR)*. The **CSR AB-CM** notation indicates compliance with the CSR requirements and the ABS Construction Monitoring Program. If instead, the vessel was designed and built to comply with the tanker requirements in Part 5C of the ABS *Rules for Building and Classing Marine Vessels*, it may be given the **SH-SHCM** notation.

Oil Carriers may also receive the optional **FL(years)** notation if the design fatigue life of the vessel is greater than 20 years (e.g., **FL(30)**). Shuttle tankers designed for dedicated service in a harsh environment should consider this notation.

STRUCTURAL ANALYSES

Vessels operating in a harsh environment such as the North Sea may want to consider additional structural analysis beyond that offered by the **CSR** Notation. Advanced structural analysis techniques may be employed in the hull design of a shuttle tanker. ABS recognizes the use of these methods with several notations.

The SafeHull-Dynamic Loading Approach uses an enhanced structural analysis procedure and criteria for calculating and evaluating hull structures' behavior under dynamic loading conditions. The Dynamic Load Analysis uses a full ship model to investigate global and local structural responses. Shuttle tankers built to plans approved based on the results of such an analysis may be assigned the **SH-DLA** notation as described in the ABS *Guide for 'SafeHull-Dynamic Loading Approach' for Vessels*.

The Spectral Fatigue Analysis assists in obtaining fatigue lives greater than the minimum 20-year requirement. If the vessel is built to plans approved based on Spectral Fatigue Analysis results, the **SFA(years)** notation may be assigned. Please refer to the ABS *Guide for Spectral-Based Fatigue Analysis for Vessels*. As with the fatigue life notation, "years" denotes that the vessel's fatigue life is greater than 20 years.

ANCHORING

In addition to the Ⓔ symbol, ABS offers notations to recognize special anchoring equipment or arrangements. Shuttle tankers that are 150 meters or more in length may receive the **DWA** notation if their anchor, chain, windlass, and support structure are designed for temporary mooring in unsheltered water up to 120 m with 3 knots current and wind and waves corresponding to Beaufort 6.

If a shuttle tanker has anchors of proven superior holding ability, the **RW** notation may be assigned.

HELICOPTER DECKS

Helicopter decks are not required by Class for tankers, but helicopter decks are usually required by shuttle tanker charterers in both Brazil and the North Sea. ABS offers the **HELIDK** notation for vessels fitted with helidecks. The **HELIDK** notation is assigned to helicopter decks intended for landing with no provisions for storage or refueling. For more information, see the ABS *Guide for the Class Notation Helicopter Decks and Facilities (HELIDK and HELIDK(SRF))*.

HULL CONDITION MONITORING

More and more equipment is becoming available for the monitoring of both hull and machinery. ABS is fully committed to working with designers, shipyards, and owners to help implement and use these systems to maximize operational efficiency.

Hull monitoring systems are fitted to acquire, display, and/or record information and then use that information for decision making to improve operational efficiency and/or safety. ABS recognizes the enhanced safety aspects that can be obtained by the correct use of monitoring systems and will assign appropriate notations to any vessel fitted with such system that complies with the requirements of the ABS *Guide for Hull Condition Monitoring Systems*.

ABS offers the following optional notations for hull condition monitoring:

Notations	Descriptive Notations	Optional Descriptive Notations*
HM1 Motion Monitoring	Slam Warning	ACS, PT, LS
	Green Seas Warning	---
	Ship Motion	ACS, MOT
	Sea State	ST
	Sloshing Monitoring	PT, LS
HM2 Stress Monitoring	Hull Girder Stress	HS
	Local Load Monitoring	LS
	Fatigue Monitor	---
	Structural Temperature Monitoring	TEMP
	LC	---
HM3 Voyage Data Monitoring	VDR	---
	Enhanced VDR	---
	Navigation	---
	Wind	WD
	Shaft Monitoring	TM, RC
	SL	---

Optional descriptive notations are followed by a digit specifying the number of sensors (or devices) installed.

A **+R** notation may be assigned where the shuttle tanker has provisions for recording the data for later evaluation.

SECTION 8 – OTHER MACHINERY AND SYSTEMS

In addition to the machinery systems already discussed in Section 4, "Typical Class Notations." ABS also offers the following machinery related Notations for shuttle tankers.

VAPOR EMISSION CONTROL (VEC AND VEC-L)

The filling level of cargo tanks in shuttle tankers is always in flux, with tanks empty a significant amount of time. This means that a large amount of Volatile Organic Compounds is generated and must be dealt with. ABS addresses these needs through our Vapor Emission Control Notations, **VEC** and **VEC-L**, discussed below.

Vapor Emission Control (VEC) – The notation **VEC** is assigned to indicate that an oil carrier is fitted with a vapor emission control system; and that the system is in accordance with 5C-1-7/1.1.2 and 5C-1-7/21 of the ABS *Rules for Building and Marine Vessels.*

Vapor Emission Control-Lightering (VEC-L) – The notation **VEC-L** is assigned to indicate that an oil carrier is fitted with a vapor emission control system that is also suitable for use during lightering operations; and that the system is in accordance with the applicable requirements of 5C-1-7/1.1.2 and 5C-1-7/21 of the ABS *Rules for Building and Classing Marine Vessels.* It is common for shuttle tankers to receive the **VEC-L** notation since the services are similar.

ENHANCED SHAFT ALIGNMENT

This notation is assigned to shuttle tankers designed, constructed, and operated according to the shaft alignment procedures in ABS *Guide for Enhanced Shaft Alignment.*

The Guide's intention is to address shafting arrangements, such as installations with no forward stern tube bearing, that may particularly benefit from a more detailed analysis and a more accurate and structured procedure to optimize the shaft alignment and improve the service life of the vessel's powertrain.

Assignment of the **ESA** notation requires the review of plans and calculations by an ABS Engineering Office in accordance with the ABS *Guide for Enhanced Shaft Alignment*.

Assignment of the **ESA+** notation requires the review of plans and calculations by an ABS Engineering Office and compliance with the installation, measurements, and sea trial requirements, following the ABS *Guide for Enhanced Shaft Alignment*. In addition, the **ESA+** notation requires the attendance of an ABS Surveyor during shaft alignment efforts, which are in addition to regular Rule requirements, as explained in the Guide.

HIGH VOLTAGE SHORE CONNECTION SYSTEM

Some shuttle tankers now utilize a High Voltage Shore Connection System (**HVSC**) to provide ship's power while in port to improve their carbon signature. ABS offers the HVSC notation to shuttle tankers equipped with an HVSC system designed to power the vessel with shore power alone, enabling the shipboard generators to be shut down while in port. Details can be found in the ABS *Guide for High Voltage Shore Connection*.

TAILSHAFT CONDITION MONITORING

The Tailshaft Condition Monitoring (**TCM**) notation is assigned to vessels with tailshafts specifically arranged with oil-lubricated stern tube bearings, complying with the requirements of 4-3-2/13 of the ABS *Rules for Building and Classing Marine Vessels.*

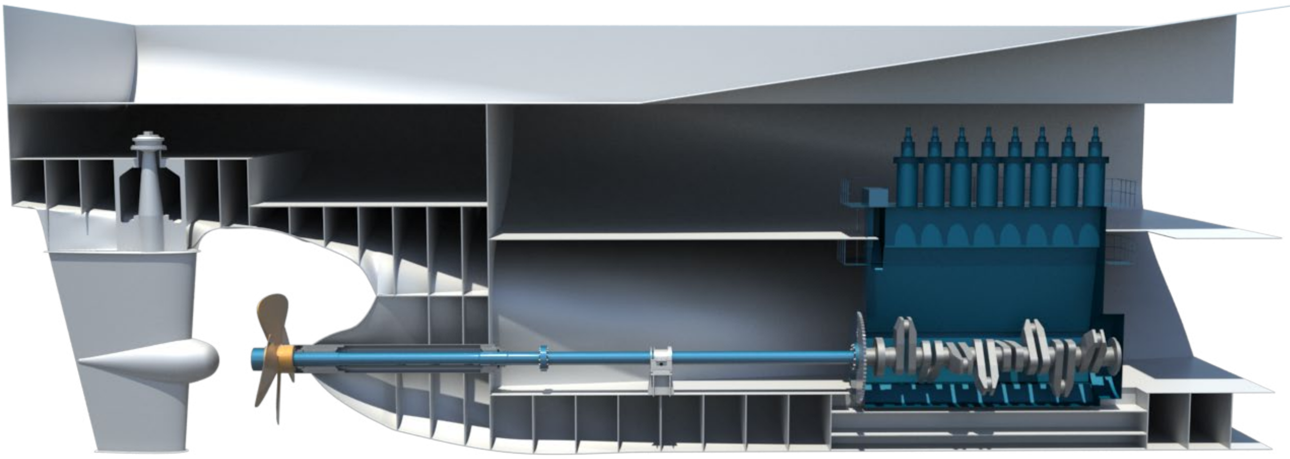
This Rule Section gives requirements for:

1. Temperature Monitoring and Alarm
2. Oil Seal Design
3. Bearing Wear Down Measurement
4. Management of Monitored Data
5. Surveys

The Tailshaft Condition Monitoring – Water Lubricated (**TCM-W**) notation is assigned to vessels with tailshafts specifically arranged with closed or opened type water-lubricated stern tube bearings, complying with the requirements of 4-3-2/15 of the ABS *Rules for Building and Classing Marine Vessels*.

This Rule Section gives requirements for:

1. Bearing Material
2. Corrosion Protection
3. Pumps and Piping
4. Control and Instruments
5. Management of Monitored Data
6. Wear Down Measurement
7. Bearing Operating Condition
8. Lubricant Operating Condition
9. Surveys



SECTION 9 – SAFETY AND HUMAN FACTORS

ABS has a strong commitment to safety and human factors. For more than 150 years, ABS has been promoting the security of life and property and preserving the natural environment.

SAFETY

ABS-ISGOTT - This notation is assigned to Oil Carriers, which are provided with the supplementary equipment and arrangements specified in the ABS *Guide for Implementation of International Safety Guide for Oil Tankers* (ISGOTT). The requirements and notation identified in this Guide are optional for classification.

This Guide provides requirements for:

1. Cargo and Ballast Systems
2. Gas Testing Equipment
3. Enclosed Spaces
4. Shipboard Operations
5. Surveys After Construction

ENHANCED FIRE PROTECTION

ABS offers a full suite of Enhanced Fire Protection Notations. The Enhanced Fire Protection notations available for shuttle tankers are **EFP-A** for accommodation areas, **EFP-M** for machinery spaces, and **EFP-C** for cargo areas. Individual or combinations of the above notations can be provided.

EFP-A - This notation is assigned to shuttle tankers that have accommodation areas designed, constructed and equipped according to the requirements in Chapter 1 and Chapter 2, Sections 1 through 5 of the ABS *Guide for Enhanced Fire Protection Arrangements*.

EFP-C - This notation is assigned to shuttle tankers and other vessel types identified in Chapter 4 of the *EFP Guide* that have the cargo areas designed, constructed and equipped according to Chapters 1 and 4 of the ABS *Guide for Enhanced Fire Protection Arrangements*.

EFP-M - This notation is assigned to shuttle tankers that have the machinery spaces designed, constructed and equipped according to the requirements in Chapters 1 and 3 of the ABS *Guide for Enhanced Fire Protection Arrangements*.

EFP-AMC - Meets EFP-A, M, and C requirements

HUMAN FACTORS

Recognizing that security of life starts with improving the safety and well-being of personnel with a clear understanding of their capabilities and limitations, ABS offers Habitability, Ergonomic, Navigation Bridge Layout ,and Means of Access Notations to keep your crew safe and efficient.

HABITABILITY

As discussed in the ABS *Guide for Crew Habitability on Ships*, the Habitability series of notations focuses on five (5) categories of habitability criteria that can affect task performance and can be controlled, measured, and assessed in crew work, rest, and recreation areas of ships. These categories are accommodation area, whole-body vibration (separate criteria for accommodation areas and workspaces), noise, indoor climate, and lighting.

- The **HAB** notation indicates that a vessel meets the basic criteria for these categories.
- The **HAB+** notation invokes a more stringent accommodation area, whole-body vibration, and noise criteria aimed at increasing crew comfort and safety.
- The **HAB++** notation applies even more stringent accommodation areas, whole-body vibration, noise, and indoor climate criteria.

In addition to the **HAB** notation assignment, at the Owner's request, ABS may review the accommodation area design for compliance with ILO Maritime Labour Convention (MLC), 2006 Title 3 requirements, and assign the **MLC-ACCOM** notation. For more information, see the ABS *Guide for Compliance with the ILO Maritime Labour Convention, 2006 Title 3 Requirements*.

ERGONOMICS

With the objective of promoting ergonomically focused design and construction, ABS offers the following ergonomic notations:

- The **ERGO ES** notation is directed at assessing the human fit and compatibility of areas inside the vessel's skin on or below the main deck. These include interior ramps, passageways, ramps hatches and scuttles, and other crew safety and job performance structures.
- The **ERGO VALVE** notation is directed at assessing the access and use of operating and maintaining valves with regard to accessibility and ease of identification and use.
- The **ERGO MAINT** notation is directed at assessing the safety and ease of access to maintenance areas (maintenance platforms, access aids such as ladders, and the size of the maintenance workspace).

See the ABS *Guide for Ergonomic Notations* for more detailed information.

NAVIGATION BRIDGE

The requirements for the functionality of the bridge design and layout, and the navigational equipment/systems are provided in the ABS *Guide for Bridge Design and Navigational Equipment/Systems*. The requirements are intended to improve and optimize the work environment within the bridge area and enhance the navigational capabilities and safety of a vessel. The requirements for vessels fitted with an integrated bridge system for navigational purposes are also included in this Guide.

NBL - Navigational Bridge Layout (NBL) – This notation is assigned to vessels having bridges found to comply with the requirements in Sections 1 and 2 of the ABS *Guide for Bridge Design and Navigational Equipment/Systems*, as applicable, and which have been constructed and installed under ABS survey.

NBLES - Navigational Bridge Layout and Equipment/Systems (NBLES) – This notation is assigned to vessels having bridges found to comply with the requirements in Sections 1 through 3, with equipment listed in Section 3, Table 1, of the ABS *Guide for Bridge Design and Navigational Equipment/Systems*, as applicable, and which have been constructed and installed under ABS survey.

NBLES+ - Navigational Bridge Layout and Equipment/Systems Plus (NBLES+) – This notation is assigned to vessels having bridges found to comply with the requirements in Sections 1 through 3, with equipment listed in Section 3, Table 1 and 2, of the ABS *Guide for Bridge Design and Navigational Equipment/Systems*, as applicable, and which have been constructed and installed under ABS survey.

NBLES (COS) – Navigational Bridge Layout and Equipment/Systems for Coastal and Offshore Service (NBLES (COS)) – It is an optional notation assigned to vessels that typically operate in coastal and narrow waters provided they meet enhanced requirements of the ABS *Guide for Bridge Design and Navigational Equipment/Systems* for bridge design, configuration, workstation arrangements and bridge instrumentation including detailed documentation of the vessel's maneuvering characteristics based on sea trials. The **NBLES (COS)** Notation is well suited for the shuttle tanker vessels.

NIBS - Navigational Integrated Bridge System (NIBS) – This notation is assigned to vessels which are fitted with an integrated bridge system (IBS) for the navigational purpose, and are found to comply with the requirements in Sections 1 and 5 of the ABS *Guide for Bridge Design and Navigational Equipment/Systems*, and which have been constructed and installed under ABS survey

MEANS OF ACCESS

To enable physical surveys, inspections, and maintenance activities to be conducted effectively, consideration needs to be given to means of access arrangements. The ABS *Guide for Means of Access to Tanks and Holds for Inspection* discusses how the effectiveness of the design of means of access can be maximized through the application of ergonomics to the vessel's structural designs and arrangements. ABS offers two notations:

- The **PMA** notation indicates compliance with IMO Resolutions MSC.151(78) and MSC.158(78), as well as IACS Unified Interpretation (UI) SC 191.
- The **PMA+** notation may be assigned to meeting the **PMA** notation requirements plus additional ergonomic considerations specified by ABS.

SECTION 10 – ENVIRONMENT

COLD CLIMATES

With many shuttle tankers operating in the North Sea, the Canadian east coast (offshore Newfoundland), and the Russian (Varandey, Caspian, Sakhalin, and Yamal) coast, there are specific considerations related to operating in cold climates that need to be considered. ABS offers Notations for Operation in Low-Temperature Environments and Ice Load Monitoring. ABS also offers a full suite of Ice Class Notations, including Polar Class, Enhanced Polar Class, First-year Ice Class, and Baltic Ice Class. See below for more information.

ICE CLASSES

ABS offers four series of Ice Class notations, as follows:

Polar Class	Polar Class, Enhanced	First-year Ice Class	Baltic Class
PC1	PC1, Enhanced		
PC2	PC2, Enhanced		
PC3	PC3, Enhanced		
PC4	PC4, Enhanced		
PC5	PC5, Enhanced		
PC6	PC6, Enhanced		I AA
PC7	PC7, Enhanced	A0	I A
		B0	I B
		C0	I C
		D0	
		E0	

Polar Class (Part 6-1-1 to 6-1-4 of the Marine Vessel Rules)
The Polar Class notations (**PC1-PC7**) indicate that the vessel is suitable for navigating independently in ice-covered Polar waters.

The Enhanced Polar Class notations (**PC1-PC7**) indicate that the vessel is suitable for navigating independently in ice-covered Polar waters and complies with ABS' additional requirements.

Vessels with the Polar Class notations or Enhanced Polar Class notations are eligible for **Ice Breaker** Class notation.

First-year Ice (Part 6-1-5 of the Marine Vessel Rules)
Ice Classes **A0** through **E0** indicate that the vessel is suitable for navigating independently in first-year ice.

Baltic Ice Class (Part 6-1-6 of the Marine Vessel Rules)
Ice Classes **I AA** through **I C** indicate that the vessel is suitable for navigating the Northern Baltic waters in winter. The requirements for these notations agree with the Finnish-Swedish Ice Class Rules.

OPERATION IN LOW-TEMPERATURE ENVIRONMENTS

ABS also offers notations for other aspects of low temperature operation that are not typically covered by the ice class Rules. These notations are covered by the ABS *Guide for Vessels Operating in Low Temperature Environments.* Low temperature environments present numerous challenges related to the operation of equipment, systems, structure, vessel maintenance, safety equipment, and crew performance. Vessels designed and constructed without addressing the effects of low temperatures may experience increased structural and equipment failures and nonfunctioning systems. The effects of low temperatures will typically reduce personnel performance.

The following notations recognize vessels that have been designed and equipped to operate in a low temperature environment:

- **CCO (TDST, TMAT)** is a basic notation for vessels operating in a low temperature designed, constructed, and surveyed with consideration to materials, hull construction, vessel systems and machinery, safety systems, and any specific vessel requirements.

  The "**TDST, TMAT**" in the parentheses refer to the design service temperature and the minimum anticipated temperature in °C for which the vessel's structure and exposed machinery are designed, respectively.
- **CCO-POLAR (TDST, TMAT)** is a notation available for those vessels intended to operate in Polar Regions on a frequent basis. The service temperature will be stated on the Polar Ship Certificate for ships operating in defined polar waters.
- **(HR *HOURS*)** notation can be appended to the **CCO-POLAR (TDST, TMAT)** notation to indicate that a vessel is equipped and provided with emergency power arrangements in excess of the minimum 18 hours specified within Regulation II-1/43 of the 1974 Safety of Life at Sea Convention (SOLAS).
- **DE-ICE** is a notation available for vessels that occasionally operate in low temperatures subject to ice accretion.

Vessels receiving either the **CCO** or the **CCO-POLAR** notation will also be required to obtain the Class notation **POT** for protection of fuel and lubricating oil tanks.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ICE LOADS MONITORING

As discussed in the ABS *Guide for Ice Loads Monitoring Systems,* shuttle tankers may be assigned the following notations if they are equipped with an ice loads monitoring system intended to:

- Provide the bridge near real-time information of the measured data while transiting in ice.
- Warn the vessel's personnel that near-real-time parameters are approaching permissible levels to take corrective actions.
- Warn the vessel's personnel that during the voyage, the value(s) of these parameters could be equal to or higher than corresponding permissible level(s) in the near future based on recent impacts.

Notation	Definition
ILM	Basic Ice loads Monitoring System that monitors the local ice belt stresses
(*n*)	Number of additional strain gauge locations (e.g., 2, 4 etc.)
+T (Turning Ice Loads)	System with the additional purpose of monitoring the ice loads induced at the quarters of the vessel due to turning in ice
+G (Hull Girder Loads due to Ice Impact)	System for hull girder bending and shear monitoring due to operation in ice, typically ramming loads
+L (Recording)	System with the additional purpose of recording the stresses for analysis of ice loads
+P (Pressure Measurement and Recording)	System with the additional purpose of measuring and recording local impact pressures

EMISSIONS AND POLLUTION CONTROL

In keeping with ABS' mission of preserving the natural environment, several notations recognize a commitment to environmental protection and pollution control.

EXHAUST EMISSION REDUCTION

With increased legislation regulating air pollution, ABS offers notations for various types of exhaust emission abatement systems, including SOx scrubbers, Selective Catalytic Reduction (SCR) systems, and Exhaust Gas Recirculation (EGR) arrangements, as well as Exhaust Emissions Monitoring Systems (EEMS). ABS has helped multiple owners develop a 2020 fuel strategy and shortlist and evaluate available scrubber solutions.

The requirements for these systems are presented in the ABS *Guide for Exhaust Emission Abatement*.

- The **EGC-SOx** notation may be assigned to a vessel with an exhaust gas cleaning system that uses exhaust gas scrubbing to reduce SOx emissions.
- The **EGC-SCR** notation may be assigned to a vessel with an exhaust gas cleaning system that uses Selective Catalytic Reduction to reduce NOx emissions.
- The **EGC-EGR** notation may be assigned to a vessel with an exhaust gas cleaning system separate from the engine that uses exhaust gas recirculation to reduce NOx emissions.
- The **EEMS** notation may be assigned to a vessel with a permanently installed exhaust emission monitoring system. The vessel may or may not also be fitted with an exhaust emission abatement system.

If a shuttle tanker is built with design features that permit installation of a SOx scrubber system at a future date, the **SOx Scrubber Ready** notation may be assigned according to the ABS *Guide for SOx Scrubber Ready Vessels*. Once the vessel has undergone a complete retrofitting to install a SOx scrubber system, the **EGC-SOx** notation may be assigned.

ENERGY EFFICIENCY DESIGN INDEX (EEDI) AND THE IMO GHG STRATEGY

The regulatory requirements of MARPOL Annex VI for the Energy Efficiency Design Index (EEDI) mandate that new vessel designs achieve a minimum level of efficiency and reduction of carbon dioxide (CO2) emissions depending on their ship type and size segment.

Compliance with the strengthened EEDI requirements has been up to now successful for specific ship types. Concerns through, have been raised on the challenges for vessel designs (particularly those built using conventional technology and fuel) to meet the upcoming EEDI Phase 2 and Phase 3 levels. Furthermore, with the IMO GHG Strategy adoption in 2018, vessels are expected to meet the more ambitious CO2 and GHG reduction targets set for 2030 and 2050, some of which lie beyond the reach of current technology.

ABS' thorough knowledge of international regulations coupled with industry recognized leadership on sustainability can assist ship owners, builders and designers in addressing compliance requirements while examining different technology alternatives. Comprehensive project assessments can include sensitivity studies to support the client's investment strategy and decision-making process.

The IMO Calculation Guidelines allow the use of a power correction factor, fj equal to 0.77 for shuttle tankers that:

a. Have DWT between 80000 MT and 160000 MT
b. Are fitted with 2 main engines and 2 propellers to meet the dynamic positioning requirements under their assigned class notation.

With the above requirement, the IMO allows a mitigating adjustment to the vessel's attained EEDI when the installed main engine MCR needs to be increased for purposes of maneuvering and dynamic positioning. However, thruster systems and their corresponding powering systems are excluded from EEDI regulations and, therefore, not accounted for in the calculation of attained EEDI.

Based on MARPOL ANNEX VI, Regulation 19, Para 3, Regulations 20 and 21 of MARPOL Annex VI for Attained EEDI and Required EEDI shall not apply to shuttle tankers which have diesel-electric propulsion, turbine propulsion, or hybrid propulsion systems.

EU MRV (MONITORING, REPORTING, AND VERIFICATION) OF FUEL CONSUMPTION AND IMO DCS (DATA COLLECTION SYSTEM)

ABS was a participant in the IMO Working and Correspondence Groups during the development of the IMO DCS. More than 120 shipping companies chose ABS to assess and verify EU MRV Monitoring Plans, with ABS performing EU Verification Services for more than 4,000 vessels.

- ABS can verify that our clients' CO2 emissions inventory is in line with EU MRV and IMO DCS regulations.
- Through its easy-to-use template, ABS assists owners to quickly fill in the gaps between EU MRV and IMO DCS compliance.
- ABS offers additional support through its software platform, ABS Nautical Systems (NS).

ENVIRONMENTAL PROTECTION

As presented in the ABS *Guide for the Environmental Protection Notations for Vessels*, ABS also has notations to promote environmentally focused design, construction, and operation of ABS-classed vessels and prevent pollution.

- The **ENVIRO** notation indicates compliance with the applicable requirements of Annexes I, II, IV, V, and VI to the International Convention for the Prevention of Pollution from Ships, MARPOL 73/78, as amended, as well as additional requirements in Section 2 of the ABS *Guide for the Environmental Protection Notations for Vessels*.
- For the **ENVIRO+** notation, there are more stringent criteria for design characteristics, management and support systems, sea discharges, and air discharges. These additional requirements are seen in Section 3 of the ABS *Guide for the Environmental Protection Notations for Vessels*.
- The optional notation **LEV** recognizes that the specified internal combustion engines installed on a vessel meet stricter gaseous and particulate pollutant limits than regulated by MARPOL Annex VI. These additional requirements are seen in Section 4 of the ABS *Guide for the Environmental Protection Notations for Vessels*. The **LEV** notation recognizes that engine emissions meet the corresponding levels for engine size, power, and application regulated by other regional, national or local regulatory instruments, for example EU for equivalent marine, heavy-duty, or non-road mobile machinery applications. Typically, these regulatory instruments regulate NOx emissions, as does MARPOL Annex VI Regulation 13, but in addition, set limits for CO, HC, PM, and PN. The benchmark emissions limits for the ABS **LEV** notation are EU Tier V, for example, EU Regulation 2016/1628.

- The notation **NOx-Tier III** indicates that all marine diesel engines with a power output greater than 130 kW, other than those exempted as per Para 1.2 of Regulation 13 of Annex VI of the MARPOL 73/78 Regulations, as applicable, have been certified for compliance with Para 5.1 of Regulation 13 of Annex VI of MARPOL 73/78, and provided with an approved NOx Technical File and Engine International Air Pollution (EIAPP) certification. Engines using Selective Catalytic Reduction (SCR) or Exhaust Gas Recirculation (EGR) equipment to meet the Tier III NOx limits, and which have not applied the applicable optional notations of the ABS *Guide for Exhaust Emissions Abatement* (ABS EEA Guide), are to comply with the minimum requirements of that guide, as prescribed in 1/15 Table 1 of the ABS EEA Guide, for assignment of the **NOx-Tier III** notation. For more details, see Section 2/37 of the ABS *Guide for the Environmental Protection Notations for Vessels*.

HAZARDOUS MATERIALS

As discussed in the ABS *Guide for the Inventory of Hazardous Materials*, the **IHM** notation may be assigned to a vessel for which an inventory detailing the type, amount, and location of hazardous materials used in a vessel's construction and operations has been reviewed and verified by ABS. Obtaining this notation assists owners and operators in complying with Regulations 4, 5, and 10 of the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 (SR/CONF/45).

PROTECTION OF FUEL AND LUBRICATING OIL TANKS

The Protection of Fuel and Lubricating Oil Tanks (**POT**) notation is assigned to shuttle tankers having an aggregate fuel oil capacity of 600 m^3 (21,190 ft^3) and lubricating oil tanks with a capacity greater than 30 m^3 (1060 ft^3) [other than tanks for lubricating oil under main engines] and above with fuel oil and lubricating oil tanks arranged in accordance with the requirements specified in 4-6-4/17.5 of the ABS *Rules for Building and Classing Marine Vessels*.

NOISE CONTROL

Recent regulatory initiatives have been aimed at reducing of underwater radiated noise from ships to address concerns about the underwater noise pollution affecting marine life and habitats. ABS supports these efforts by offering the **UWN (T), UWN (Q), UWN+ (T)**, and **UWN+ (Q)** notations. The **UWN+ (T)** and **UWN+ (Q)** notations require compliance with stricter sound pressure level limits. **T** indicates Transit condition, and **Q** indicates Quiet Operation condition, which is a low-speed operation condition for a vessel operating in environmentally sensitive areas. See the ABS *Guide for the Classification Notation Underwater Noise* for more information.

SECTION 11 – ADDITIONAL SURVEY AND INSPECTION CONSIDERATIONS

HULL INSPECTION

The **HIMP** (Hull Inspection and Maintenance Program) notation signifies that the vessel is enrolled in the Hull Inspection and Maintenance Program following the ABS *Guide for Hull Inspection and Maintenance Program*.

UNDERWATER INSPECTION IN LIEU OF DRYDOCKING

The **UWILD** (Under Water Inspection in Lieu of Drydocking) notation signifies that the vessel follows Appendix 7-A1-1 of the ABS *Rules for Survey After Construction (Part 7)* and the Owner may request Underwater Inspection as an alternative to Drydocking Inspection. This notation does not apply to vessels 15 years of age or over and subject to the Enhanced Survey Program (ESP).

CONDITION ASSESSMENT PROGRAM (CAP)

CAP is a voluntary program, initially developed by the oil industry, to assess older ships' continued fitness to carry their cargo safely. CAP involves a detailed survey, including gauging the vessel's structure and a sophisticated strength and fatigue engineering analysis. It also includes extensive testing of the vessel's machinery, equipment, and cargo systems. A CAP rating is assigned to the vessel. Most charterers require a CAP 1 (Very Good) or CAP 2 (Good) rating. Both of these ratings suggest that the vessel has been maintained to a standard in excess of Classification Society and Statutory minimums. CAP is very common for tankers aged 15 years and above.

PROCESS

CAP involves a detailed survey, including:

- Gauging of the vessel's structure
- Strength and fatigue engineering analysis
- Testing of the vessel's machinery, equipment, and cargo systems

BENEFITS

- Less time off-hire
- Close-up survey of cargo and ballast spaces
- Targeted maintenance and lower life cycle repair costs
- Comprehensive, cost-effective fatigue and strength assessment
- Projected structural performance for up to five years
- Comprehensive management of structural failure risk through identification of critical areas
- Recommendations for enhancement of critical areas
- More effective identification of required steel replacements through dynamic-based structural evaluation, including fatigue assessment

PREVENTATIVE MAINTENANCE PROGRAM (PMP)

The intent of the Preventative Maintenance Program (PMP) and related Guides and Guidance Notes (see 7-A1-14/1.1) is to provide requirements for Owners to achieve alternative survey crediting of machinery applying preventative maintenance practices. To support operational activities, ABS requirements have been developed to consider various processes that can be used to develop an in-service maintenance plan. This should take into consideration OEM recommendations, vessel service history, Owner Maintenance Philosophy, risk-based processes, and reliability analyses.

The notations below provide alternatives to the traditional "open and inspect" survey regime and are assigned to vessels that follow the requirements for the Preventative Maintenance Program in the ABS *Rules for Survey After Construction (Part 7)*.

To qualify for a notation assigned under the Preventative Maintenance Program requirements, a vessel is required to be assigned with a **PMP** notation. In addition, any notation (e.g., **PMP, PMP-CBM**, etc.) with "**+**" appended (e.g., **PMP+**) indicates more than 50% of all equipment subject to CMS are enrolled into the program.

Plan	Definition	ABS Notation
Preventative Maintenance Program (PMP) (see 7-A1-14)	A program that consists of Planned Maintenance and/or Condition Monitoring. • **Planned Maintenance (PM)** –A time-based maintenance plan incorporating inspection, part replacement and/or overhauls to reduce the likelihood of equipment failures. Timing can be based on calendar days, a number of cycles, equipment running hours, fuel consumption, or alternate periodic trigger. Such schedules are generally established by the machinery manufacturer and include lubrication servicing, filter, bearing, and seal replacements, as well as major overhaul. • **Condition Monitoring (CM)** – The use of various technologies to determine equipment condition at a specific moment in time, using minimal or non-invasive means. Common approaches applied in condition monitoring are temperature monitoring, dynamic analysis (vibration monitoring), oil analysis, corrosion monitoring, nondestructive testing (ultrasonic analyses, acoustic emissions), electrical testing, observation and surveillance, performance trending, engine, and system performance trending, and diagnostics. Maintenance intervals and tasks follow OEM recommendations or documented operator experience.	**PMP** or **PMP+**
Condition Based Maintenance (CBM) (see 7-A1-14/5)	Maintenance is performed based on the results of condition monitoring activities performed and trended or analyzed to determine when part replacement or other corrective action is required. Periodic or real-time condition monitoring activities can support this.	**PMP-CBM** or **PMP-CBM+**
Design for Reliability (DFR)	Design for reliability (DFR) utilizes reliability/risk analysis tools so that future reliability-related performance meets expectations. It also provides a structure for applying these reliability/ risk analysis tools throughout the design process to provide the designers information to make more informed design decisions. See ABS *Guide for Surveys based on Machinery Reliability and Maintenance Techniques (MRM Guide)*. DFR requires the addition of a reliability-based or reliability centered maintenance program.	**PMP-RBMD** or **PMP-RBMD+** and **PMP-RCMD** or **PMP-RCMD+**
Reliability Based Maintenance (RBM) (see *MRM Guide*)	A maintenance development process that will act as the foundation for applying selective reliability techniques, choosing and deploying a maintenance plan, and creating an effective reliability strategy to support an efficient maintenance environment.	**PMP-RBM** or **PMP-RBM+**
Reliability Centered Maintenance (RCM) (see *MRM Guide*)	A systematic process coupling risk and reliability principles to create a maintenance plan, consisting of planned maintenance tasks, condition based maintenance tasks, or run-to-failure strategies, taking into consideration equipment criticality, functional definitions with applicable failure management analysis and OEM recommendations. To support the resulting maintenance plan/activities, RCM also deploys a risk-based analysis of spare parts holding and a sustainment plan.	**PMP-RCM** or **PMP-RCM+**

REMOTE SURVEYS

The ABS Remote Survey program augments the traditional survey process by transferring digital documentation for verification of select surveys without physical Surveyor attendance.

Existing clients can order all eligible surveys remotely through a user-friendly, web-based platform. They then have the option to interact within a mobile-friendly environment to easily capture and transmit all required videos, images and documentation while on board in both a connected and disconnected environment that sync seamlessly or they can choose to use the web-based platform to submit all required documentation from an office environment.

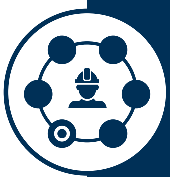
Inputs include:

- Documentation/reports
- Images
- Video
- Near Real-time Video Feeds

For shuttle tankers, the following Surveys are eligible for the program :

STATUTORY SURVEYS

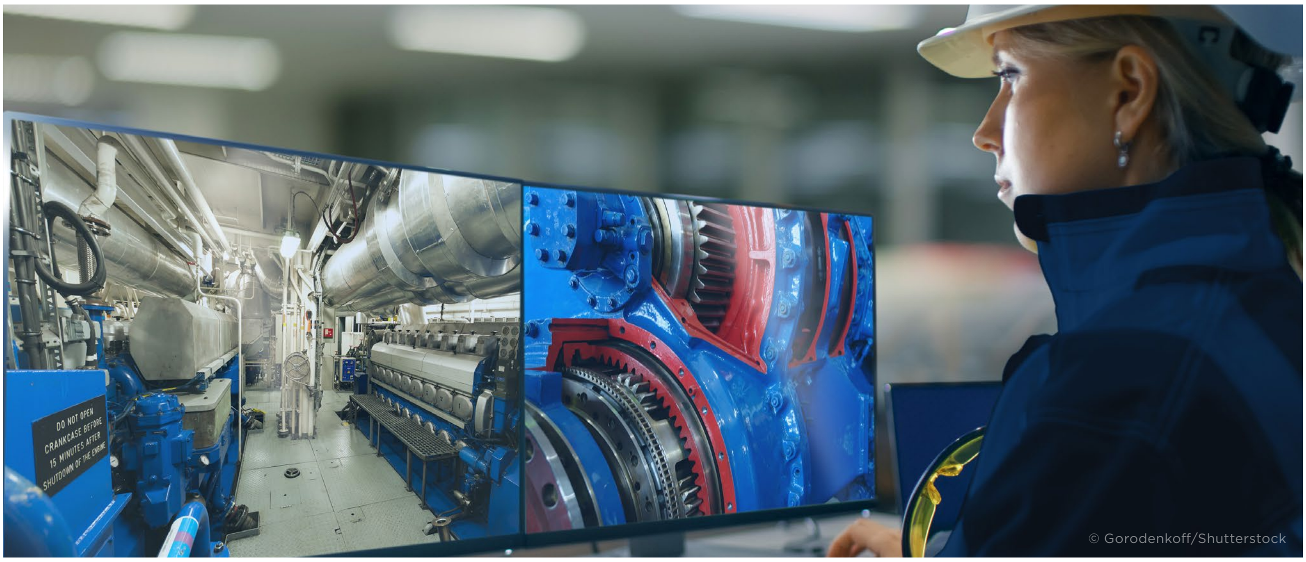
- Inventory of Hazardous Materials (IHM) Surveys
- Safety Radio Surveys



OCCASIONAL SURVEYS

- Continuous Machinery Survey
- Drydock Extension Survey
- Concurrent Load Line
- Boiler Three-Month Extension
- Condition of Class and Statutory Condition
- Tail Shaft or Tube Shaft Survey
- Minor Damage Survey

The latest information on this rapidly evolving program can be found on the ABS website.



SECTION 12 – NEW TECHNOLOGIES

LOW CARBON SHIPPING OUTLOOK

The ABS publication, *Setting the Course to Low Carbon Shipping – 2030 Outlook | 2050 Vision*, illuminates potential pathways to low-carbon shipping. Its purpose is to inform by concisely organizing current knowledge on the technologies and issues that could help to reduce greenhouse gas (GHG) emissions from shipping.

A better understanding of existing technologies and strategies can help the maritime industry reach the International Maritime Organization's (IMO) GHG targets for 2030. The even more ambitious emissions goals set for 2050, however, lie beyond the reach of current technology. New technology (including fuels) will need to be developed to achieve those goals, with the main thrust of research and innovation occurring before 2030, giving any new products and ideas time to develop and mature.

Another ABS publication, *Setting the Course to Low Carbon Shipping – Pathways to Sustainable Shipping*, examines how global trade development will impact global emissions. Furthermore, it identifies the three main fuel pathways on the course to meet the IMO's emission reduction targets for 2050 and beyond: light gas fuels, heavy gas fuels and, bio/synthetic fuels. It also examines the possible capacity demand and related emissions output trends on a global basis to envision the environments in which those targets may need to be achieved.

RELIQUEFACTION OF VOLATILE ORGANIC COMPOUNDS (VOC)

During the loading of cargo on shuttle tankers, a large quantity of lighter components evaporates from the oil, which is known as Volatile Organic Compounds (VOC). The VOC generation also leads to increased tank pressure, which needs to be vented to the atmosphere to maintain safer pressure inside the cargo tanks. While doing so, a significant amount of energy is wasted in the form of VOC, and air pollution. Since VOC is an energy source, the same can be used as fuel for the vessel's engines or boilers in conjunction with diesel or heavy fuel oil. New technologies are available to reliquefy the VOC and hold it in a storage tank to be used as fuel in the engines or boilers.

GAS AND OTHER LOW FLASHPOINT FUELS

The marine industry faces many substantive challenges, mostly driven by increasingly strict gaseous air emission and global warming legislation, and from the shift in global energy markets towards renewable energy. The ABS *Advisory on Gas and Other Low Flashpoint Fuels* focuses on LNG and other low flashpoint fuels that can provide solutions to the fuel sulfur regulations in the short and mid-term, and in some cases viable solutions for the longer-term transition to low and zero carbon fuels. Information is provided on the regulatory background for the use of LNG and other low flashpoint fuels, and an overview of the technologies and operational impacts is also given that can support the decision-making process for future ship propulsion arrangements and fuel strategies. The ABS *Guide for Gas and Other Low-Flashpoint Fuel Ready Vessels* considers additional fuels.

HYBRID POWER SYSTEMS

The ABS *Advisory on Hybrid Electric Power Systems* discusses electric propulsion systems as an alternative to traditional diesel propulsion systems. An electric propulsion system allows for the vessel's propulsion capability l to be provided by electric propulsion motors. These propulsion motors may be supplied by a common set of generators that also supply the vessel hotel loads.

One of the main benefits of electric propulsion systems is the ability to optimize the loading of the prime movers for the generators (diesel engines, gas turbines, etc.) to obtain maximum efficiency and reduce fuel consumption. This is especially beneficial in vessels with a diverse operational profile (such as DP vessels where a typical operational profile is divided between transit and station keeping operations). Generators and electric motors for propulsion offer greater flexibility in the utilization of onboard space than main engines.

FUEL CELL POWER SYSTEMS

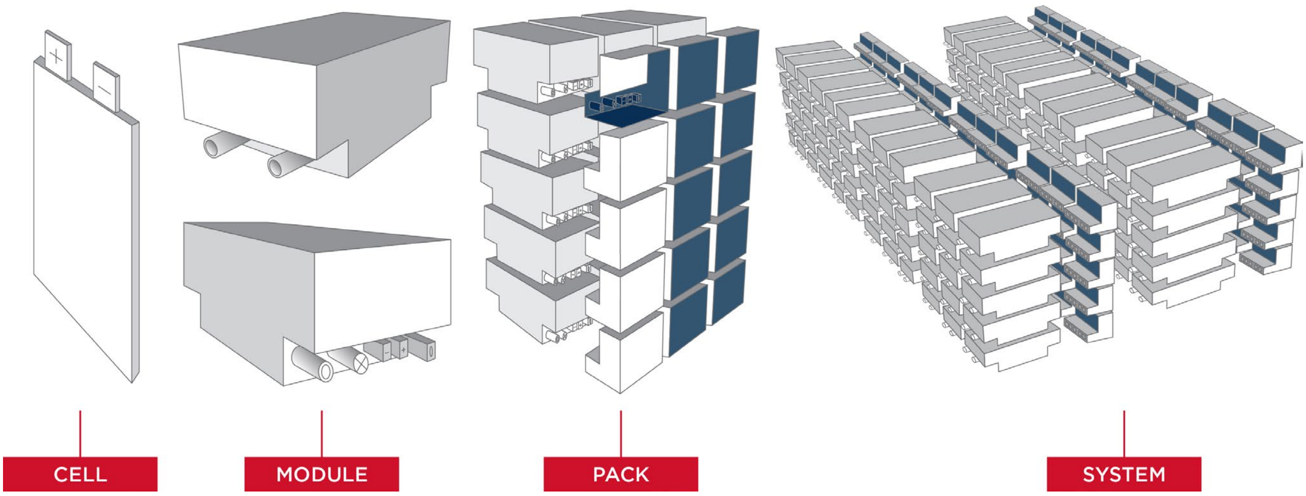
FC-E – Where a vessel is arranged to use the fuel cell power system for essential services (primary and secondary) or emergency services, the system is to be designed, constructed, and tested in accordance with the ABS *Guide for Fuel Cell Power Systems for Marine and Offshore Applications*.

FC-NE – Where a vessel is arranged to use the fuel cell power system for non-essential services, the system is to be designed, constructed, and tested in accordance with the ABS *Guide for Fuel Cell Power Systems for Marine and Offshore Applications* except the requirements as per 2/5.2 of the Guide are not applicable.

ENERGY STORAGE SYSTEMS

ESS-LiBATTERY - This notation is assigned to vessels designed, constructed, or retrofitted with a lithium battery system used as an additional source of power with a capacity greater than 25 kWh. The optional notation **ESS-LiBattery** may be granted to those vessels once the battery installation has complied with the requirements of the ABS *Guide for Use of Lithium Batteries in the Marine and Offshore Industries*.

ESS-SC - This notation is assigned to vessels designed, constructed, or retrofitted with a supercapacitor system used as an additional source of power with a capacity greater than 50 Wh. The optional notation **ESS-SC** may be granted once the supercapacitor installation has complied with the requirements of the ABS *Guide for the Use of Supercapacitors in the Marine and Offshore Industries*.



DC POWER DISTRIBUTION

LVDC-DIST - An optional notation applicable to vessels designed, constructed, or retrofitted with a DC power distribution system, where electrical power sources, major vessel loads, and/or energy storage systems are connected to the DC bus directly or via power electronic converters. The optional notation **LVDC-DIST** may be granted to those vessels that comply with the requirements of the ABS *Guide for Direct Current (DC) Power Distribution Systems for Marine and Offshore Applications*.

CYBERSAFETY

With the increasing digitization and automation in marine applications, new cyber-related threats and vulnerabilities are being exposed. The ABS CyberSafety® program and capability development model provides a method for shuttle tanker owners and operators to assess their relative risk, understand potentially unmet security requirements, and define a Cybersecurity Management System (CMS) outline that addresses risk and security requirements.

The ABS *Guide for Cybersecurity Implementation for the Marine and Offshore Industries – ABS CyberSafety® Volume 2* is available for all classed vessels complying with the IMO International Safety Management (ISM) Code. ABS CyberSafety® verification addresses systems critical to human, vessel, system, or environmental safety. This Guide allows both shipyard and owner to better understand their cyber management role, and the **CS-Ready** Notation helps guide the hand-off from shipyard to owner.

SOFTWARE SYSTEMS

SQM, ISQM - Classification notations indicating compliance with the procedures and criteria given in the ABS *Guide for Integrated Software Quality Management (ISQM)* for control system software development from the concept phase or Design Group to the end of the Verification, Validation, and Transition phase, subsequently leading to the beginning of operation of the affected system.

ISQM is for integrated control systems, and **SQM** is for non-integrated control systems.

SSV - This notation is assigned to ABS classed vessels with standalone or integrated computer-based control systems complying with the procedures and criteria of the ABS *Guide for Software Systems Verification – ABS CyberSafety® Volume 4*. The **SSV** Notation applies only to the software of the equipment's control system included in the ABS reviewed Verification Plan. The connected control systems and functions of the connected equipment are not included in the notation unless detailed in the verification plan.

SMART VESSELS

Smart Functions, which provide crew and support personnel with crucial information to aid in decision-making, are becoming increasingly common on board vessels. Common Smart Functions include structural and machinery health monitoring, asset efficiency monitoring, operational performance management and crew assistance and augmentation to support vessel operations.

Smart Functions are enabled via a data infrastructure and supported by robust software integrity and cybersecurity that facilitate the use of aggregated data from sensors and other sources, data analytics, and data synthesis for reporting, decision-making, and actions.

ABS recently introduced the *Guide for Smart Functions for Marine Vessels and Offshore Units* to provide the industry with technical and survey requirements for vessels fitted with Smart Functions. Compliance with the requirements given in this Guide may result in the granting of optional class notations **SMART (INF)** covering the data infrastructure, as well as **SMART (SHM**) and/or **SMART (MHM)** covering the Smart Functions for health monitoring of structures or machinery.

This Guide further describes the ABS process to approve technology and services offered in support of Smart Function implementation. Approval by ABS of external service providers includes third-party organizations that support Smart Function implementation, Original Equipment Manufacturers (OEMs), shipyards, owners, and operators. The Product Design Assessment (PDA) option may also be offered to any party providing hardware and software meet the requirements within this Guide.

This Guide allows for the use of the data and decision-making support provided by the Smart Functions to assist Surveyors in performing onboard activities.

This Guide is meant to be used together with the ABS *Guidance Notes on Smart Function Implementation*, which provides ABS clients with the procedures for setting goals and deciding on the Smart Functions needed to achieve these goals, as well as the Rules and Guides issued by ABS and other recognized International, National, and Industry Regulations and Standards.

DIGITAL SOLUTIONS

ABS' Digital Solutions portfolio provides a framework for enhanced data management for better operation and maintenance management through the steps Connect, Improve, Evolve, and Transform. "Connect" offers tools for easy visualization of performance, providing predictive insights and critical information to allow users to make more informed decisions on structural health and maintenance opportunities. "Improve" offers several tools to improve the depth of analysis used to make decisions on operational and maintenance planning for a longer service life. Lastly, by using a hull sensor package, "Evolve" offers a tool for direct measurement of hull fatigue in critical areas, providing the most accurate measurement of hull condition where it matters most. "Transform" empowers customers to solve physical issues faster by detecting them sooner, design and build better products, and ultimately, better serve their clients.

DIGITAL INNOVATIONS

The fast-paced growth of technology means there are many opportunities for growth and improvements in efficiency. Some of the areas ABS is continuing to explore are AI-driven inspections, new inspection technologies, and autonomous vessels.

ABS' completion of a pilot project applying AI on corrosion and coating breakdown identification leads the way to reducing the need for physical attendance, increased accuracy, and increased efficiency during surveys.

Additionally, unmanned aerial vehicles, crawlers, remotely operated vehicles, and wearable technologies are areas ABS is looking into to provide a more predictive survey process. With increased digitalization, ABS works towards a new, data-driven lifecycle approach to better enhance survey efficiency and effectiveness.

As the journey towards autonomous vessels continues, ABS collaborates with members, industry, and regulators on autonomous vessel design, risk management, and implementation to support increased safety, operation cost reduction, and emission reduction.

Connected Assets	Data Analytics	Digital Applications
• Nautical Systems • Freedom	Cloud and AI Platform • Analytics Platform • Orchestration Managers • Data Layer	• Anomaly Detection • Spare Parts Optimization • Predictive Maintenance • Condition-Based Maintenance • Vessel Performance

NEXT-GENERATION MARINE FLEET MANAGEMENT SERVICES

For 30 years, ABS Nautical Systems has provided hundreds of maritime clients with innovative fleet management software to improve their shipping operations' reliability and performance. Today, ABS is a recognized leader in maritime fleet management software, supporting digital transformation across marine assets, and providing robust business intelligence solutions for a complex world. ABS reliability-based software and compliance management solutions support faster, more accurate decision-making to help the marine and offshore industries improve efficiency, ensure safety, and drive performance.

Nautical Systems is the leading fleet management software provider. Learn more about ABS Nautical Systems software modules and enterprise asset management services to achieve operational efficiency and maintain compliance.

ROLE BASED CONTROLS

Role based controls enforce process and approvals.

WORK OFFLINE

The offline capability allows work to be done anytime with automatic syncing to the office when connectivity is available.

SHIP AND SHORE COLLABORATION

Replication to enable real-time visibility to every vessel, as well as the entire fleet.

KEY PERFORMANCE INDICATORS

KPIs enable one-click quick access to critical tasks and management actions.

CUSTOM FORMS AND QUESTIONNAIRES

Flexible questionnaires and custom forms capture customized data sets for trending and analysis.

NS CLOUD

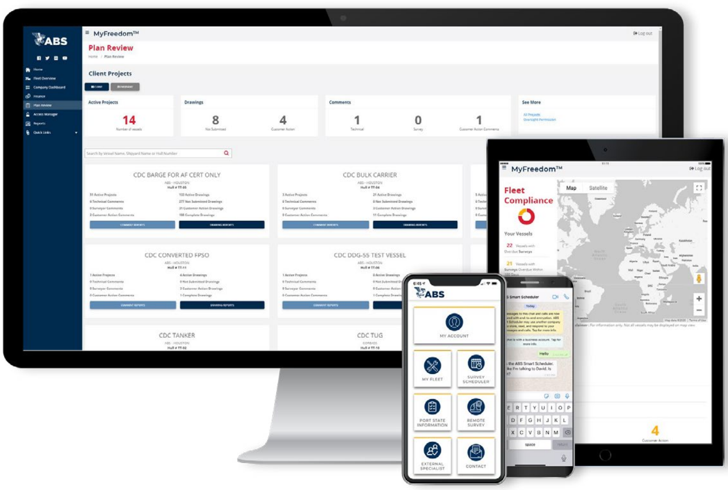
An easy and cost-effective option for implementation, deployment, and management of the Nautical Systems software.

IOT DATA INTERFACE

Improve accuracy with:

- Real-time data capture directly from ship automation systems and sensors
- Secure marine-grade appliances
- Improved accuracy of logged data
- Automated import of data to NS systems

FREEDOM



The new ABS MyFreedom™ Client Portal is a suite of fleet management and vessel compliance services powered by smart functionality and advanced analytics. It is designed to help the user make informed decisions, manage risk, operate efficiently, and plan proactively.

ABS MyFreedom does this by providing the user with smart scheduling, customized port state control analytics, top ISM findings by vessel, comparisons of estimated survey fees, direct connections to port specific external specialists, and remote survey options. ABS MyFreedom gives the user control anytime, anywhere, and anyway by providing online and offline options through the ABS app, SMS text, or WhatsApp. ABS MyFreedom will also provide the user with automatic reminders for survey and certification renewal as well as custom pre-arrival port checklists.

APPENDIX A - REFERENCES

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8. ABS Guide for Hull Condition Monitoring Systems (Pub# 73)
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CONTACT INFORMATION

NORTH AMERICA REGION
1701 City Plaza Dr.
Spring, Texas 77389, USA
Tel: +1-281-877-6000
Email: ABS-Amer@eagle.org

SOUTH AMERICA REGION
Rua Acre, nº 15 - 11º floor, Centro
Rio de Janeiro 20081-000, Brazil
Tel: +55 21 2276-3535
Email: ABSRio@eagle.org

EUROPE REGION
111 Old Broad Street
London EC2N 1AP, UK
Tel: +44-20-7247-3255
Email: ABS-Eur@eagle.org

AFRICA AND MIDDLE EAST REGION
Al Joud Center, 1st floor, Suite # 111
Sheikh Zayed Road
P.O. Box 24860, Dubai, UAE
Tel: +971 4 330 6000
Email: ABSDubai@eagle.org

GREATER CHINA REGION
World Trade Tower, 29F, Room 2906
500 Guangdong Road, Huangpu District,
Shanghai, China 200000
Tel: +86 21 23270888
Email: ABSGreaterChina@eagle.org

NORTH PACIFIC REGION
11th Floor, Kyobo Life Insurance Bldg.
7, Chungjang-daero, Jung-Gu
Busan 48939, Republic of Korea
Tel: +82 51 460 4197
Email: ABSNorthPacific@eagle.org

SOUTH PACIFIC REGION
438 Alexandra Road
#08-00 Alexandra Point, Singapore 119958
Tel: +65 6276 8700
Email: ABS-Pac@eagle.org

ABS

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