Cruise Ship NCOE Recommended Practice

RP-06: Best Practice for Reduced Power in Ships with Azimuth Propulsion Systems

Revision Date: September 26, 2025

References:

74SOLAS 24 II-1/26.3
"Means shall be provided whereby normal operation of propulsion machinery can be sustained or restored even though one of the essential auxiliaries becomes inoperative….However, the Administration, having regard to overall safety considerations, may accept a partial reduction in propulsion capability, from normal operation.

74 SOLAS 24 II-1/28.3
"The stopping times, ship headings and distances recorded on trials, together with the results of the trials to determine the ability of ships having multiple propellers to navigate and maneuver with one or more propellers inoperative, shall be available on board for the use of the master or designated personnel."

74 SOLAS 24 II-1/31.1
"Main and auxiliary machinery essential for the propulsion and safety of the ship shall be provided with effective means of its operation and control"

46 CFR 4.05(a)(3), (4), & NVIC 01-15
"Immediately after the addressing of resultant safety concerns, the owner, agent, master, operator, or person in charge, shall notify the nearest Sector Office, Marine Inspection Office or Coast Guard Group Office whenever a vessel is involved in a marine casualty consisting in…

- A loss of main propulsion, primary steering, or any associated component or control system that reduces the maneuverability of the vessel
- An occurrence materially and adversely affecting the vessel's seaworthiness or fitness for service or route – (For foreign vessels the criteria is considered met if the occurrence requires temporary or permanent reduction or restriction in the vessel operating parameters or route as a condition of class or flag state requirement)

Background: The mid-1990s marked a historic shift in cruise vessel design and construction, with azimuth propulsion systems beginning to gain traction as a viable solution for propulsion and steerage. Fast forward to the present, and azimuth propulsion systems, commonly referred to as "podded propulsion", have become the standard arrangement in the cruise industry due to their efficiency in maneuverability, improved fuel consumption, and multiple layers of redundancy.

Port State Control Officers (PSCOs) may encounter a cruise ship entering their respective port with a malfunctioning azimuth propulsion system, which may require action from the Officer in Charge, Marine Inspection (OCMI) or Captain of the Port (COTP). In order to make the most appropriate decision, it is crucial to understand the main system components and their functions. In a standard cruise ship arrangement, there are two, or more, steering gear rooms, each containing an azimuth propulsion system. The most common types of azimuth propulsion systems are the fully electric type, which uses electric motors for propulsion and steering, and the electro-hydraulic type, which uses a combination of electric motors for propulsion and hydraulic pumps for steering. This recommended practice (RP) will discuss azimuth propulsion systems arrangements, special considerations and recommendations to COTPs.

In general, a typical azimuth propulsion system is comprised of:

- Steering Module
- Propulsion Module
- Associated Auxiliaries: steering drives, electric steering control unit, pumps, cooling air units, slip ring unit, etc.

The Steering Module includes four electric motors (fully electric type) driven by a steering frequency converter, and rated on average at 30 kW each, or a Hydraulic Power Unit containing two independent pumps each rated at 100% capacity, which actuate steering hydraulic motors (electro-hydraulic type). These motors are responsible for rotating the propulsion module. Generally, two-three motors are sufficient to rotate and hold the propulsion module to maintain safe steerage, however, during maneuvering mode, heavy seas, or high speeds additional motors may be required for optimal rotational speed of the propulsion module.

The Propulsion Module houses a large electric propeller motor with a rated output power average of 14-20 MW, the main shaft and bearings, and the fixed-pitch propeller.

In the fully electric type, there are two steering and propulsion drive cabinets for each pod that contain converters, commonly known as Converter A and Converter B. The converters control the power/frequency between the ship's generators and the steering/propulsion motors by converting constant-voltage, fixed-frequency electricity into controlled power. Pods can be operated using both converters for optimum performance and redundancy or the converters can be used independently, which reduces the output and redundancies. Similarly in an electro-hydraulically powered steering gear, one or two pumps can operate the pod. Below is a standard depiction of a power plant with an azimuth propulsion system:

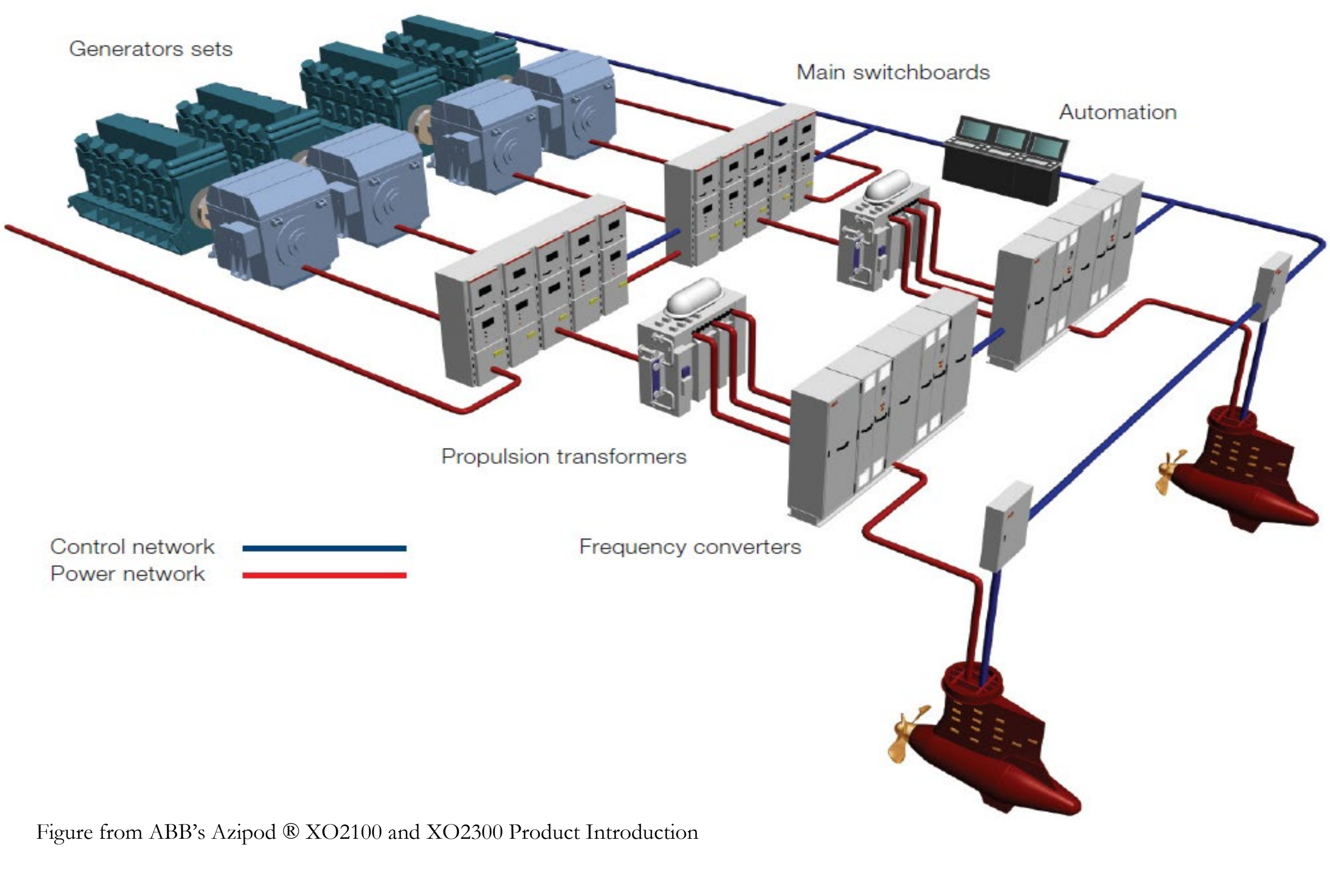

Figure from ABB's Azipod ® XO2100 and XO2300 Product Introduction

Redundancy: An azimuth propulsion system is generally designed with multiple levels of redundancy to ensure continuous propulsion and steering capabilities, even in the event of equipment failure.

- Multiple Generators: Provide continuous power. Even if one generator fails, the next generator in sequence will pick up the electrical load.
- Dual Frequency Converters: Each azimuth propulsion system can be fed by two parallel converter sections. If one fails, the second can maintain power for operation. These are usually configured in hot standby mode for fast switchover.
- Electric Steering Motors: Four motors, each with its own drive and power feed.
- Steering Control Units (SCU): Primary and backup SCUs running in parallel.
- Condition Monitoring and Fault Isolation: Faults are isolated, and backup systems are activated without requiring a full system shutdown.
- Manual and Local Control: Local control of the system in case of remote-control failure.

While azimuth propulsion systems offer multiple layers of redundancy, it is not uncommon for these systems to experience failures in some of their components. A few of the common casualties include, but are not limited to:

- Main Power Supply Failure (generators, switchboards, transformers)
- Frequency Converter Failures (control board failures, overheating, software sequencing)
- Electric Motor Failures (vibration, overheat, overload, loss of pressure, etc.)
- Steering System (steering motor failures, braking system malfunction)
- Bearing Damage (insufficient lubrication, overheating, corrosion, etc.)
- Control System / Programmable Logic Controller Power Loss (loss of control input, inability to control thrust or direction remotely or locally)
- Cooling System Failures (propulsion motors, steering drive cabinets)

Discussion: Any of the above casualties may cause a reduction or complete loss of power to the system, affecting the control and/or steerage in one or all the pods. If a pod is utilizing both converters in parallel, a malfunction in one will cause an automatic isolation via breakers or software interlocks and the remaining converter will take over the full load (if it has capacity) or can allow operation at a reduced maximum output. Even with one functioning pod, the ship may still be able to maintain a safe speed and complete its intended voyage. Therefore, operating with reduced power in one or both pods, or complete loss of a pod may not constitute a SOLAS non-compliance or reportable marine casualty, but may still warrant further inquiry to assess the risk of the vessel entering or departing port in its current condition.

Safety of Navigation: If a cruise ship loses power, or experiences a partial power loss, the impact on speed and maneuverability may not be significant provided all other mechanical and electrical equipment are in good working order, i.e. bow and stern thrusters, and generators to meet power demand requirements. In one example, a cruise ship with two pods, each rated at 20 MW for propulsion, could lose 50% of total propulsion output if one pod is inoperable. The remaining pod may still be able to provide sufficient thrust, i.e. if the normal operating speed is 22 knots (not top speed), speed may drop to 12–15 knots. However, maneuverability **may** also be affected, with decreased turning radius and degraded yaw control, which can make situations of Restricted in the Ability to Maneuver and mooring more difficult in other than favorable conditions; where ships have thrusters, they may be used as a mitigation for any deficiency in total power output. Another likely scenario is when steering motors malfunction. If a ship loses two steering motors in one pod, it may affect the rotational speed of the propulsion module, but the remaining two motors may be able to maintain adequate steerage. COTPs are encouraged to determine and mitigate any possible risks before the ship enters or departs port by:

- Consult the local Pilot Association for a third-party opinion on the ship's ability to enter or depart port in its current condition.
- Assess weather conditions affecting visibility, wind, and current, etc.
- Determine the time of day (day or night entry/departure).
- Evaluate port characteristics, including vessel traffic, channel length, maneuvering complexity.
- Evaluate the details of the malfunction, subsequent troubleshooting, ability to isolate the failed component, ships consultation with OEM, Flag, Class, and performance testing following the failure.
- Obtain the Master's attestation regarding the vessel's ability to make way and maneuver in its current condition.
- Determine if the vessel has functioning bow and/or stern thrusters.
- Review the ship's documentation, e.g., maneuvering conditions specific to the vessel.
- Ships built after 2010: Ensure Flag/Class have addressed potential compliance issues regarding Safe Return to Port requirements if a full pod is inoperable.

Investigations: If the ship experienced a marine casualty that meets the requirements of 46 CFR 4.05 (within 12 NM), as detailed in NVIC 01-15 regarding loss of propulsion, steering power, or an occurrence negatively affecting the vessel's fitness for service, then a Marine Casualty investigation shall be conducted in accordance with existing Coast Guard policies. If the scenario is deemed to not meet these criteria (due to vessel location or determined to be a redundant system) no action is required.

Best Practice for Capturing Reduced Power in Azimuth Propulsion Systems: OCMI's should consider the above and understand that reduced power to a ship with two or more azimuth propulsion systems does not automatically constitute non-compliance (since SOLAS does not prescribe requirements for two or more pods), and issuance of a deficiency is not always granted. However, in the absence of a SOLAS non-compliance and considering any identified potential risks relating to safety of navigation, a best practice for COTPs **may** include issuing a COTP Order requiring conditions such as: tug assistance for arrival and/or departure, a repair plan to restore full operational capability, report from Class and/or OEM, risk analysis/mitigation, operational testing, and any other operational restrictions considering Safety of Navigation as detailed above. If the ship is unable to complete repairs while in port due to legitimate logistical challenges but can demonstrate an adequate level of safety with the reduction of one or both pods according to documentation required by 74 SOLAS 24 II-1/28.3, and with approval from Class and/or the Flag Administration, allowing the ship to return to sea should be considered. If the ship demonstrates evidence of non-compliance or fails to demonstrate an adequate level of safety in accordance with the references in this document, deficiencies should be documented accordingly.

Vessel System: 13 – Propulsion and Auxiliary Machinery
Vessel SubSystem: N/A – No Subsystem
Vessel Component: 13101 - Cite: 74 SOLAS 24 II-1/31.1
Example:

No.	Code	Description	Cite *(Convention)*
1	13101	Main and auxiliary machinery essential for the propulsion and safety of the ship shall be provided with effective means for its operation and control. The vessel experienced a loss of power to the port and starboard azimuth propulsion systems rendering the ship not able to make safe speed and maneuvering.	74 SOLAS 24 II-1/31.1

* *Action Taken: Per the Procedures for Port State Control, The OCMI and PSCO officer will exercise professional judgement in determining which action to take to ensure the deficiencies are rectified or to allow the ship to sail with certain deficiencies without reasonable danger to safety, health, or the environment, having also considered the circumstances of the intended voyage.*