



Marine Safety Center Technical Note

MTN 02-11, CH 1
16710/Automation/DP
December 11, 2020

Subj: REVIEW OF VITAL SYSTEM AUTOMATION AND DYNAMIC POSITIONING
SYSTEM PLANS

- Ref:
- (a) Title 46 CFR Chapter I Subchapter F – Marine Engineering
 - (b) Title 46 CFR Chapter I Subchapter J – Electrical Engineering
 - (c) Navigation and Vessel Inspection Circular (NVIC) No. 2-95 Change 3, *The Alternate Compliance Program (ACP)*
 - (d) Use of Dynamic Positioning (DP) by Offshore Supply Vessels (OSVs) for Oil and Hazmat Transfers, Eighth Coast Guard District (D8(m)) Policy Letter 01-2003, 22 January 2003
 - (e) [Mobile Offshore Drilling Unit \(MODU\) Dynamic Positioning \(DP\) Guidance, Federal Register Notice 77 FR 26562, May 4, 2012, Coast Guard Commercial Regulations and Standards](#)

1. Purpose: This Marine Safety Center Technical Note (MTN) provides guidance for the preparation of shipboard vital system automation plans and dynamic positioning (DP) system plans submitted to the Marine Safety Center (MSC) for approval, or to an Authorized Classification Society (ACS) conducting review of these systems on behalf of the Coast Guard.

2. Discussion:

- a. References (a) and (b) establish the minimum requirements to ensure the safety of a vessel with automated vital systems is equivalent to that of a vessel with vital systems under direct manual control. ACSs use their respective rules and USCG Supplement when reviewing automated vital systems on behalf of the Coast Guard under reference (c). However, the MSC plan review requirements for these systems are not concisely discussed in any one document. As such, the guidelines provided in Enclosure (1) clarify existing plan review requirements for vital system automation plans.
- b. DP systems are considered to be a vital component of the propulsion control system. With diesel-electric and hybrid propulsion systems, the DP systems are fully integrated with the vessel's power management systems. DP systems are routinely used as the primary maneuvering system during critical operations, such as those involving close quarters hazardous cargo and personnel transfers, and station keeping during exploration, drilling, production, and oil transfer operations. The failure of primary or back-up power

Subj: MARINE SAFETY CENTER GUIDANCE FOR VITAL SYSTEM AUTOMATION
AND DYNAMIC POSITIONING SYSTEM PLANS

systems may cause the failure of DP systems, or a failure in the DP systems may negatively impact primary power systems. Accordingly, any review of vital system automation plans is expected to include a full review of the entire DP system. Guidelines for the preparation of DP system plans are provided in Enclosure (2).

- c. Shipboard machinery and electrical systems are becoming more automated. Shipboard vital automation systems have essentially become the nerve system for the entire vessel, monitoring and continuously adjusting all systems capable of remote operation. Programmable logic controllers for centralized machinery monitoring and control systems, power management systems, and propulsion control systems are integrated using multiple ship-wide communications networks. A failure of a single component previously viewed as a minor event may now result in an unforeseen power loss affecting vital systems. Although testing required by manufacturers, shipyards, ACSs, and owners is conducted prior to vessel delivery, these tests are usually operational in nature, completed at separate times, and often do not adequately cover failure modes. Because of this, and in light of several marine casualties involving vital system automation and/or DP systems, the Coast Guard has increased the level of technical review it performs on all plans and testing procedures associated with these systems. As a result, the Qualitative Failure Analysis (QFA), Design Verification Test Procedures (DVTP), and Periodic Safety Test Procedures (PSTP) required by reference (a) have become comprehensive documents which can be difficult to prepare, review, and approve. The guidelines for the preparation of these documents provided in both Enclosures (1) and (2) are intended to streamline plan review, testing, and approval of these systems.

3. Applicability: This MTN applies to all vital system automation and DP system plans submitted to the MSC for approval, or submitted to an ACS conducting plan review on behalf of the Coast Guard. Vessels that do not require vital system automation documentation, but have a DP system, must still meet the requirements outlined in Enclosure (2). These guidelines do not preclude the OCMI from deeming additional tests necessary to be assured of the safety and seaworthiness of the vessel.

4. Action: The MSC, or an ACS conducting plan review on behalf of the Coast Guard, will review vital system automation and DP system plans submitted for approval for compliance with the applicable regulations and requirements established by references (a) and (b), or if applicable, the respective ACS rules and USCG Supplement as described in reference (c). References (d) and (e) provide additional guidance that may support submission and review of plans. The plans should provide sufficient details to permit a complete review of all vital systems. Upon successful completion of this review, these documents will be considered satisfactory for shipboard testing, to be witnessed by the cognizant OCMI or designated ACS Surveyor. The applicable documents for automation systems include a QFA, DVTP, and PSTP; and for DP systems, the DP FMEA, DP Proving Trials, and the DP Operations Manual. The

Subj: MARINE SAFETY CENTER GUIDANCE FOR VITAL SYSTEM AUTOMATION
AND DYNAMIC POSITIONING SYSTEM PLANS

MSC, or ACS conducting plan review on behalf of the Coast Guard, will not stamp such plans “Approved” until after the completion of testing and after the incorporation of any necessary changes identified during testing by the OCMI or ACS. Any revisions to “Approved” documents must be resubmitted to the MSC or to an ACS conducting plan review on behalf of the Coast Guard, for review prior to conducting onboard testing. The scope of this review may be limited to the revisions if they are related to a minor equipment modification. A full review will be required where there are significant changes in vital automation such as a control system upgrade.

5. Disclaimer: While the guidance contained in this document may assist the industry, the public, the Coast Guard, and other Federal and State agencies in applying statutory and regulatory requirements, this guidance is not a substitute for the applicable legal requirements, nor is it in itself a regulation. It is not intended to, nor does it impose legally binding requirements on any party, including the Coast Guard, other Federal agencies, the States, or the regulated community.



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Encl: (1) Plan Submission Requirements for Vital System Automation
(2) Plan Submission Requirements for Dynamic Positioning (DP) Systems

Copy: Commandant (CG-521), Office of Design and Engineering Standards
Commandant (CG-522), Office of Operating & Environmental Standards
Commandant (CG-543), Office of Vessel Activities
Commandant (CG-546), Office of Quality Assurance and Traveling Inspection
Outer Continental Shelf National Center of Expertise (OCS NCOE)
American Bureau of Shipping (ABS, Houston)
DNV GL (Houston)
Lloyd’s Register of Shipping (LR, Houston)

PLAN SUBMISSION REQUIREMENTS FOR VITAL SYSTEM AUTOMATION

1. General. To streamline plan review and facilitate approval, it is best for a single point of contact to submit all the necessary plans in one single submittal. See 46 CFR 62.20 for plan submittal requirements. Plans submitted must be vessel-specific and provide sufficient detail to permit a complete review of all vital systems. Vital automation submittals should specify the desired machinery plant manning level (e.g. fully manned, minimally attended, periodically unattended) as this affects the 46 CFR Part 62 requirements applied in the review.

2. Vital System Automation QFA, DVTP and PSTP Submittals. For vital system automation, the Coast Guard and Authorized Classification Societies both require a failure analysis. Where the Coast Guard requires a Qualitative Failure Analysis (QFA), Classification Societies require a Failure Mode and Effects Analysis (FMEA). The Coast Guard will accept an FMEA as a QFA, but only if it meets the requirements of a QFA. The Design Verification Test Procedure (DVTP) and Periodic Safety Test Procedure (PSTP) required by 46 CFR 61.40 are unique to the Coast Guard, and are not required in classification society rules. For vessels enrolled in the Coast Guard Alternate Compliance Program under NVIC 02-95, CH-3, the DVTP and PSTP are required in the corresponding authorized classification society (ACS) U.S. Supplement. The DVTP and PSTP require extensive onboard testing beyond simple operational tests once the installation is complete. The general guidance provided below should assist designers and submitters in meeting MSC plan review requirements:

- a. Qualitative Failure Analysis (QFA) – As stated in 46 CFR 62.20-3, the QFA is intended to assist in evaluating the safety and reliability of the vital system automation design. The QFA is performed to determine the effects of individual component failures on vital system automation. The QFA should be performed in sufficient detail to confirm that single non-concurrent failures in control, alarm, or instrumentation systems will not prevent sustained or restored operation. The lowest level of component failure required to be included in the QFA is each easily replaceable component. Typically this includes electronic circuit boards, power supplies, microprocessors, memory boards, input/output modules, microcontrollers, network switches and hubs, communication modules, circuit drivers, and similar circuit boards containing solid state devices. Loss of vital input/output signals such as main engine or electric propulsion drive speed commands and speed feedback should be addressed in the QFA. Relays, terminal boards, indicator lights, switches, wiring, meters, and instruments do not have to be included in the QFA unless their failure would lead to an unacceptable failure mode (e.g. not fail-safe).
- b. Design Verification Test Procedure (DVTP) – As stated in 46 CFR 61.40-3, the DVTP is a detailed test procedure used to verify the assumptions made for each failure mode addressed in the QFA. Each test should include: (1) safety precautions, (2) equipment status prior to testing, (3) equipment required to perform the test, (4) control or alarm set-points, (5) test procedure to be followed, (6) expected results, and (7) space for the cognizant OCMI or ACS Surveyor to record results during testing. Testing should be performed with the controlled system in operation to verify the effect(s) of each failure.

- c. Periodic Safety Test Procedure (PSTP) – As stated in 46 CFR 61.40-6, the PSTP provides detailed test procedures for the Coast Guard to evaluate the operation and reliability of controls, alarms, safety features, and interlocks of automatically or remotely controlled or monitored vital systems. With fully automated propulsion plants, including installations approved for periodically unattended operation, the scope of the PSTP increases considerably. Furthermore, 46 CFR 61.40-6 states testing in the PSTP must demonstrate the proper operation of primary and alternate controls, vital automation power sources, transfer of control and transfer override arrangements, interlocks, and safety controls. The systems addressed in the PSTP must include fire detection and extinguishing systems, flooding safety, propulsion, maneuvering, steering gear control systems, electric power generation and distribution, alarm and monitoring systems, remote control systems, and emergency internal communications (e.g. sound powered telephones, EOT, dead man alarm, engineers' assistance needed alarm, etc.). As stated in 46 CFR 61.40-10, each test must be in a step-by-step or check-off list format and include: (1) safety precautions; (2) equipment status prior to testing; (3) test equipment required to perform the test; (4) safety control or alarm set-points; (5) test procedure to be followed; (6) expected results; and (7) to provide space for OCMI or ACS Surveyor to record results during testing.

For further guidance on preparing QFA, DVTP and PSTP documents, see the Marine Safety Center website available as a featured link at www.dco.uscg.mil/msc. Once on the MSC website, click on Plan Review Guidelines under the "References" section. The Plan Review Guidelines titled "[E2-01 Vital System Automation](#)," "[E2-05 Design Verification Test Procedures](#)," "[E2-17 Periodic Safety Test Procedures](#)," and "[E2-18 Qualitative Failure Analysis](#)" will assist with preparing vital automation system plans and QFA, DVTP, and PSTP documents. If you have further questions or comments, please contact the MSC Electrical Branch at 202-795-6729 or email msc@uscg.mil.

PLAN SUBMISSION REQUIREMENTS FOR DYNAMIC POSITIONING (DP) SYSTEMS

1. General. To streamline plan review and facilitate final approval, it is best for a single point of contact to prepare and submit all the necessary plans in one single submittal. To facilitate the plan review process, submitters may submit plans using IMO MSC.1/Circ. 1580 Guidelines for Vessels and Units with Dynamic Positioning (DP) Systems as the baseline for the design, or cite the relevant classification society rules used in the design. Plans are to be vessel-specific, and submissions should include:

- a. DP Control System
- b. Automated Power Management System
- c. Power Generation and Distribution
- d. Thruster Control System
- e. DP System Failure Mode and Effects Analysis (FMEA)
- f. DP System Proving Trial Test Procedure
- g. DP Operations Manual

2. DP System Plan Review. Plan review for DP Systems is performed under 46 CFR Part 62 since this system is considered vital system automation. General guidance to assist with DP System design and plan review is provided below:

- a. DP Control System plans should include information for (1) required redundancy, (2) operator interface, (3) alarms and warnings, (4) position reference systems, (5) vessel sensors, (6) networks, (7) independent joystick controls, and (8) interface to Vessel Management System(s), including Automated Power Management Systems.
- b. Automated Power Management (APM) System plans should demonstrate capability to maintain continuity of power while responding to worst case (e.g. loss of an online generator) DP System power demands.
- c. Power Generation and Distribution plans should demonstrate the required redundancy.
- d. Thruster Control System plans should demonstrate required redundancy for (1) thruster auxiliaries, (2) emergency shutdown circuitry, and (3) manual controls.
- e. DP System Failure Mode and Effects Analysis (DP FMEA) will be reviewed for required system redundancy and ability of the system to maintain station-keeping capability following any single point failure.
- f. Dynamic Positioning System Proving Trial Test Procedure should ensure all failure modes identified in the FMEA are tested and the methods for testing will realistically replicate the failure.
- g. DP Operations Manuals should be vessel-specific and contain, the checklists, test procedures, trials, and instructions identified in paragraph 4.6 of IMO.1/Circ.1580.

Note: use of open bus architecture is preferred unless it can be tested and proven that closed bus operation will not degrade the safety, redundancy, or reliability of the system. Use of closed bus configuration may require additional testing; for additional context, see the applicable documents listed on the Dynamic Positioning (DP) Committee website of

the Marine Technology Society (MTS), available as a featured link at <https://dynamic-positioning.com>. Once on the website, click on Guidance and Standards under the “Documents” section.

3. DP Systems on Mobile Offshore Drilling Units (MODUs). On May 4, 2012, the Coast Guard published [Mobile Offshore Drilling Unit Dynamic Positioning Guidance](#). This guidance states:

“Until the Coast Guard publishes a DP Rule, the Coast Guard recommends owners and operators of dynamically positioned MODUs (not leaseholders who contract MODUs) operating on the U.S. Outer Continental Shelf (OCS) voluntarily follow guidance provided in the DP Operations Guidance prepared through the Dynamic Positioning Committee of the Marine Technology Society to aid in the safe and effective management of DP Operations. It is particularly important they identify the DP System’s Critical Activity Mode of Operation (CAMO) and ensure Well Specific Operating Guideline (WSOGs) are developed for operations at every well and location. A MODU attached to the seafloor of the U.S. OCS should be operated in accordance with the appropriate WSOG.”

4. Additional Information. For further guidance in preparing DP system submittals, please go to the Marine Safety Center website available as a featured link at [Marine Safety Center](#). Once on the MSC website, click on Plan Review Guidelines under the “References” section. The Plan Review Guideline titled “[E2-24 Dynamic Positioning Systems](#)” will assist with preparing a DP system plan submittal. If you have additional questions or comments, please contact the MSC Electrical Branch at 202-795-6729 or email mec@uscg.mil.