# U.S. COAST GUARD MARINE SAFETY CENTER PLAN REVIEW GUIDELINE

## REVIEW OF DESIGN VERIFICATION TEST PROCEDURES

Procedure Number: E2-05
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**Purpose**

This Plan Review Guideline (PRG) explains the requirements for plan submittal for Design Verification Test Procedures of various shipboard automation systems in accordance with the references below. This PRG should be used as a guide for an automated vital system.

**Contact Information**

If you have any questions or comments concerning this document, please contact the Marine Safety Center (MSC) by e-mail or phone. Please refer to Procedure Number E2-05.

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# Table of Contents

## 1. Applicability

PRG is applicable to self-propelled vessels that are 500 gross regulatory tons (GRT) and over and certificated under subchapters D, I, or U, self-propelled vessels that are 100 GRT and over certificated under subchapter H, and OSVs of at least 6,000 GT ITC (500 GRT if GT ITC is not assigned) as defined in 46 CFR 125.160 certificated under subchapter L. Please refer to 46 CFR 62.01-5(a).

## 2. References

Title 46 CFR Subchapter F, Marine Engineering
Title 46 CFR Subchapter J, Electrical Engineering
Navigation and Inspection Circular (NVIC) 2-89, "Guide for Electrical Installations on Merchant Vessels and Mobile Offshore Drilling Units"
Safety of Life at Sea (SOLAS), Consolidated Edition, 2014: Chapter II-1, Part D
MSC Plan Review Guideline, E2-01, Review of Vital System Automation
MSC Plan Review Guideline, E2-17, Periodic Safety Test Procedures
MSC Plan Review Guideline, E2-18, Qualitative Failure Analysis
MSC Plan Review Guideline, E2-24, Dynamic Positioning Systems
MTN 2-11, Vital System Automation & Dynamic Position System
CG-ENG-Policy Letter No. 02-19 "Design Guidance for Lithium-Ion Battery Installations Onboard Commercial Vessels"
CG-ENG-Policy Letter No. 01-12, CH-1 "Equivalency Determination-Design Criteria for Natural Gas Fuel Systems"

## 3. Definitions

*Easily replaceable component*- using the submitted vital automation console or enclosure internal component layout plan and bill of materials, easily replaceable components are control system components that can be replaced. The Quality Failure Analysis (QFA) does not typically consider terminal boards, indicator lights, push-buttons, relays, and similar devices where the failure modes of the components are well understood. The focus should be on electronic circuit boards, power supplies, redundancy modules, processors, memory boards, input/output modules, microcontrollers, communications modules, network switches, signal converters, and similar devices. Using the applicable QFA procedures in the 46 CFR 62.20-3 (Note), the above easily replaceable components should be evaluated to:

a. An acceptable failure effects (failsafe)
b. Failure detection (audible and visual alarms) by the crew in the appropriate locations. IE: navigating bridge, ECC, machinery spaces and engineers' accommodations, as required.
c. Control or other alternatives available to the crew

## 4. Content

a. The Design Verification Test Procedure (DVTP) is to test all the assumptions and failures identified in the QFA. The DVTP is used to verify that automated vital system installations are designed, constructed, and operate in accordance with all applicable requirements. The DVTP must be based on the required QFA. See 46 CFR 61.40-3(a) and Part 62.20-3.

b. For vessels equipped with Dynamic Positioning System refer to MTN 2-11, CH 1 and MSC Plan Review Guideline E2-24.

c. For vessels equipped with Lithium-Ion Battery Systems, a DVTP is required per CG-ENG Policy Letter No. 02-19. Please use this MSC Plan Review Guideline to develop the Lithium-Ion Battery DVTP. Please note that this applies to all commercial vessels including 46 CFR subchapter T and K vessels.

d. For vessels using Liquefied Natural Gas (LNG) as fuel please see CG-ENG-Policy Letter No. 01-12, CH-1 "Equivalency Determination-Design Criteria for Natural Gas Fuel Systems".

e. Using the DVTP, tests must be performed immediately after installation of automated equipment or before issuance of an initial Certificate of Inspection (COI). The final approval of this document is by MSC and is contingent upon satisfactory completion of onboard tests to the satisfaction of the Officer in Charge, Marine Inspection (OCMI) and final review of the completed DVTP (OCMI mark-up) by MSC. See 46 CFR 61.40-1(c) and 61.40-3(b).

f. The DVTP may be combined with the QFA. Please see MSC Plan Review Guideline E2-18.

g. The DVTP must be a separate document from the PSTP. The DVTP document should be in a step-by-step or check-off list instruction format that when printed for testing onboard is legible to the OCMI. Each test in the DVTP is required to specify the following per 46 CFR 61.40-10(a):

(1) Equipment status.
(2) Apparatus (test equipment) needed to perform the test.
(3) Safety precautions.
(4) Safety control and alarm set-points.
(5) Procedure to be followed.
(6) Expected test results

**Note:** See Enclosure (1) for a sample DVTP format.

h. The DVTP should be performed with the vital system in operation so that the effects of the failures on system operation may be observed. This should be clearly identified in the "equipment status" provided for each test. See 46 CFR 61.40-1(a).

i. After successfully completing the DVTP, programmable control or alarm system logic must not be altered without the approval of the cognizant OCMI. This comment should be included in the MSC DVTP final approval letter, where appropriate. See CFR 62.25-25(a).

j. DVTP test instructions must adequately simulate the failure of the component considered in the QFA. For example, testing the failure of a control cabinet internal component by loss of power to the entire control cabinet would not be acceptable. However a programmable logic controller (PLC) power supply module failure could be tested by loss of power (e.g., removing the fuse) to the power supply module. A central processor unit (CPU) fed from the power supply module, however, should not be tested using the same power supply fuse removal procedure since the power supply module would remain energized with the failure of the CPU. See 46 CFR 61.40-10(b).

k. Where components are considered in the QFA but not tested in the DVTP, an explanation must be provided as to why the component cannot be tested. All components that can be safely tested without damaging the component should be tested in the DVTP. Any exceptions will be granted by MSC on a case-by-case basis.

l. Failsafe states of equipment and systems shall be in compliance with applicable regulations. Typical failsafe states is provided in Table 46 CFR 62.10-1(a).

m. Based on the automated machinery normally tested in the DVTP, the following applicable Plan Review Guidelines might be useful during the development and submittal of the DVTP:

(1) E2-04: Overcurrent Protection Coordination
(2) E2-06: Load Analysis
(3) E2-07: One-line Electrical Diagrams
(4) E2-20: Steering Gear Control and Alarm Circuits

Encl: (1) Sample DVTP Format

## 5. Disclaimer

This guidance is not a substitute for applicable legal requirements, nor is it itself a rule. It is not intended to nor does it impose legally-binding requirements on any party. It represents the Coast Guard's current thinking on this topic and may assist industry, mariners, the general public, and the Coast Guard, as well as other federal and state regulators, in applying statutory and regulatory requirements. You can use an alternative approach for complying with these requirements if the approach satisfies the requirements of the applicable statutes and regulations. If you want to discuss an alternative, you may contact MSC, the unit responsible for implementing this guidance.

**Test 34 - Remote Propulsion Control System Motor Speed Command Failure**

***Equipment Status:*** Propulsion system operating normally with pilothouse in control and shaft speed of >5 rpms ahead.
***Test Apparatus:*** Phillips screwdriver Size No.4, anti-static wrist strap
***Safety Precautions:*** Testing may cause a sudden increase in shaft speed. Emergency stop should be attended and test performed while underway or with lines doubled or being closely monitored.
***Safety/Alarm Set-Points:*** Out of Range Detection (<4mA or >20mA)
***Reference Plans:*** 252-4379476, Rev (-), Remote Propulsion Control System Elementary Wiring Diagram

| TEST STEP | COMPONENT | PROCEDURE | EXPECTED RESULTS | ALTERNATIVES AVAILABLE TO CREW | AUDIBLE ALARM & INDICATION | | | | OCMI |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | PH | ECC | LCL | ALARM TEXT | |
| 1 | Remote Propulsion Control System - (PCS) 4-20mA Propulsion Motor Speed Command Drive | 1. Lift wire from PCS controller PLC analog output module 2, terminal TB1-1<br>2. Acknowledge alarms at respective console | 1. Loss of remote propulsion control system. Propulsion fails to last ordered speed (as-is)<br>2. Alarms visually and audibly annunciate until manually silenced | 1. Control can be restored using local manual alternate control<br>2. Activate emergency stop | X | X | | PCS SPEED COMMAND FAILURE | |
| | | | | | X | X | | PCS FAILURE | |
| | | | | | | | | | |
| | | | | | | | | | |
| 2 | | 1. Activate PH Emergency Stop<br>2. Acknowledge alarms at respective console | 1. Main propulsion motor trip<br>2. Alarms visually and audibly annunciate until manually silenced | | X | X | | EMERGENCY STOP ACTIVATED PILOTHOUSE | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| 3 | | 1. Reinstate lifted wire to PCS controller PLC analog output module 2, terminal TB1-1<br>2. Start main propulsion and transfer control to PH | Remote propulsion speed control restored | | | | | | |
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