

GUIDE FOR

DYNAMIC POSITIONING SYSTEMS NOVEMBER 2013

Guide to Color Coding Used in Online Version of the Guide

The following summarizes the colors corresponding to Rule Changes, Corrigenda items and editorial changes in the Guide files which are available for download.

Rule Changes:

Changes effective 1 November 2013

NOTICE NO. 1 – September 2015 (effective 1 September 2015)

Corrigenda:

CORRIGENDA/EDITORIALS – 1 July 2014

CORRIGENDA/EDITORIALS – 22 February 2016

Editorials:

Editorial Changes

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GUIDE FOR

DYNAMIC POSITIONING SYSTEMS

NOVEMBER 2013 (Updated February 2016 – see next page)

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Updates

February 2016 consolidation includes:

- September 2015 version plus Corrigenda/Editorials

September 2015 consolidation includes:

- July 2014 version plus Notice No. 1

July 2014 consolidation includes:

- November 2013 version plus Corrigenda/Editorials

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Foreword

The application of dynamic positioning (DP) systems has been expanded significantly not only in the number of DP vessels, but also in the range of applications and the advancement of DP technologies. In order to address this variety and the needs of industry, ABS undertook to develop an *ABS Guide for Dynamic Positioning Systems*. The Guide replaces ABS DP system requirements currently included in the *ABS Rules for Building and Classing Steel Vessels (Steel Vessel Rules)* and the *ABS Rules for Building and Classing Offshore Support Vessels (OSV Rules)*.

In addition to the current requirements, the Guide provides new optional notations and technical specifics that reflect current industry practice and DP technologies. The Guide covers ABS requirements for the design and testing of DP systems with the following new features:

- Enhanced system (EHS) notations to recognize design features beyond current DPS-series notations and to provide flexibility to owners and operators.
- Station keeping performance (SKP) notations to recognize DP capability and to encourage robust design of the DP system.
- Increased level of detail on the technical requirements to help less experienced users
- Details of vessel type specifics to reflect industry need
- Requirements for testing comparable with current industry practice.

The Guide is applicable to systems that are installed onboard vessels, offshore installations and facilities. It is applicable to new constructions.

This Guide becomes effective on **the first day of the month of publication**.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of this Guide is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.



GUIDE FOR DYNAMIC POSITIONING SYSTEMS

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SECTION 1 General

1 Introduction

The requirements contained in this Guide are for dynamic positioning systems for ships, mobile offshore drilling units, mobile offshore units and offshore support vessels. These requirements are to be used in conjunction with Part 4 of the *ABS Rules for Building and Classing Steel Vessels (Steel Vessel Rules)*, Parts 4, 6, and 7 of the *ABS Rules for Building and Classing Mobile Offshore Drilling Units (MODU Rules)* and the *ABS Rules for Survey After Construction (Part 7)*. The requirements in the following sections are particularly relevant.

ABS Rules for Building and Classing Steel Vessels

- i) Diesel Engines – Section 4-2-1
- ii) Gas Turbines – Section 4-2-3
- iii) Electric Motors and Motor Controllers – Section 4-8-3
- iv) Gears – Section 4-3-1
- v) Shafting – Section 4-3-2
- vi) Propellers – Section 4-3-3
- vii) Piping System – Chapter 4-6
- viii) Thrusters – 4-3-5/3 and 4-3-5/5
- ix) Control Equipment and Systems – Section 4-9-8

ABS Rules for Building and Classing Mobile Offshore Drilling Units

- i) Pumps and Piping Systems – Chapter 4-2
- ii) Electrical Installation – Chapter 4-3
- iii) Rules for Equipment and Machinery Certification – Part 6
- iv) Survey After Construction – Chapter 7-2

ABS Rules for Survey After Construction

- i) Machinery Surveys – Chapter 7-6
- ii) Shipboard Automatic and Remote-control Systems – Chapter 7-8
- iii) Survey Requirements for Additional Systems and Services – Chapter 7-9

3 Classification Notation

The dynamic positioning systems built and tested in compliance with the requirements in this Guide and relevant Rules may be assigned with different classification notations depending on the degree of redundancy built into the system as defined below. These notations are not a requirement for classification of the vessel and are to be assigned only on the specific request of the Owner.

DPS-0 For vessels, which are 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, which are fitted with a dynamic positioning system which 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, which are fitted with a dynamic positioning system which 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, which are fitted with a dynamic positioning system which 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 class of **1, 2 and 3**, respectively.

At the Owner’s request, an enhanced system notation (**EHS**), as a supplement for 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 power system, thruster system and control system. The main objective of the enhanced system notation is to improve reliability, operability and maintainability. Section 8 of this Guide provides details for the enhanced system notations.

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

Section 11 of this Guide provides information about other optional notations that may apply to DP systems such as those for Integrated Software Quality Management (**ISQM**) and System Verification (**SV**).

5 Definitions

The following definitions of symbols and terms are to be understood (in the absence of other specifications) where they appear in the Guide.

5.1 General

Dynamically Positioned Vessel (DP Vessel): A unit or a vessel which automatically maintains its position (fixed location or predetermined track) by means of thruster force.

Industrial Mission: The industrial mission is the primary operational role of the vessel, typically applicable to MODUs and Project and Construction vessels (e.g., Pipe-lay/Heavy-lift). (Note: by definition the industrial mission for a Logistic Vessel is to support logistics).

Specified Maximum Environmental Conditions: The specified maximum environmental conditions are the specified wind speed, current and wave height under which the vessel is designed to carry out intended operations.

Specified Operating Envelope: The specified operating envelope is the area within which the vessel is required to stay in order to satisfactorily perform the intended operations under the specified maximum environmental conditions.

Worst Case Failure (WCF): The identified single fault in the DP system resulting in maximum effect on DP capability as determined through the FMEA study. This worst case failure is to be used in the consequence analysis.

Worst Case Failure Design Intent (WCFDI): The worst case failure design intent describes the minimum amount of propulsion and control equipment remaining operational following the worst case failure. The worst case failure design intent is used as the basis of design. This usually relates to the number of thrusters and generators that can simultaneously fail.

5.3 Equipment and Dynamic Positioning System (1 November 2013)

Active Component: Active components or systems are in particular: generators, thrusters, switchboards, DP control computers, sensors, remote controlled valves, compensators, etc.

Static Component: Static components are in particular: cables, pipes, manual valves, etc.

Dynamic Positioning System (DP System): The complete installation necessary for dynamically positioning a vessel comprises the following subsystems.

- i) Power system,
- ii) Thruster system, and
- iii) DP control system.

Power System: All components and systems necessary to supply the DP system with power, the power system includes:

- i) Prime movers with necessary auxiliary systems including piping,
- ii) Generators,
- iii) Switchboards,
- iv) Electrical distribution system (cabling and cable routing) and
- v) Power management if applicable.

Thruster System: All components and systems necessary to supply the DP system with thrust force and direction. The thruster system includes:

- i) Thrusters with drive units and necessary auxiliary systems including piping,
- ii) Main propellers and rudders if these are under the control of the DP system,
- iii) Thruster control electronics,
- iv) Manual thruster controls, and
- v) Associated cabling and cable routing.

DP Control System: All control components and systems, hardware and software necessary to dynamically position the vessel. The DP control system consists of the following:

- i) Computer system/joystick system,
- ii) Position reference systems,
- iii) **DP sensor system**
- iv) Display system (operator panels), and
- v) Associated cabling and cable routing.

Computer System: A system of one or more programmable electronic devices, associated software, peripherals and interfaces. Microprocessors, Programmable Logic Controller (PLC), Distributed Control Systems (DCS), PC or server-based computation systems are examples of computer-based systems."

Interface: A transfer point at which information is exchanged. Examples of interfaces include: input/output interface (for interconnection with sensors and actuators); communications interface (to enable serial communications/networking with other computers or peripherals).

Peripheral: A device performing an auxiliary function in the system (e.g., printer, data storage device).

Joystick System: A system for manual position control and with automatic heading control.

Position Reference System: All hardware, software and sensors that supply information necessary to give position references.

DP Sensor System: A system comprising devices that measure vessel heading (such as gyro compasses), vessel motions (such as motion reference units), and wind speed and direction.

Consequence Analyzer: A software function that issues an alarm if the vessel would not be able to keep position and heading after predefined worst case failure has occurred at current operation mode and weather conditions. Additionally, the consequence analyzer is to be able to perform calculations to verify that in the event of a single fault there will be sufficient thrust available to maintain position and heading.

Control Mode: Method used for station keeping. Control mode for a DP system may be:

- i) DP **control** mode (automatic position and heading control),
- ii) Manual position control mode (centralized manual position control with selectable automatic or manual heading control),
- iii) Auto track mode (considered as a variant of DP position control, with programmed movement of reference point),
- iv) Manual thruster control mode (individual control of thrust (pitch or speed), azimuth, start and stop of each thruster).

Manual Position Control System: A system with centralized manual position control and automatic heading control, referred to as a joystick system.

Manual Thruster Control System: A system provides an individual control **lever** for each thruster.

Phase back: A method utilized to temporarily reduce power consumption following an event, to stabilize the power plant and avoid a black-out.

5.5 Redundancy Design

Autonomous System: An autonomous system is a system that can control and operate itself, independently of any control system or auxiliary systems not directly connected to it.

Closed Bus: Closed bus often describes an operational configuration where all or most sections and all or most switchboards are connected together, that is, the bus-tie breakers between switchboards are closed. The alternative to closed bus is open bus, sometimes called split bus or split ring. Closed bus is also called joined bus, tied bus or closed-ring.

Common Mode Failure: A common mode failure occurs when events are not statistically independent, when one event causes multiple systems to fail.

Critical Redundancy: Equipment provided to support the worst case failure design intent.

Differentiation: Differentiation is a method to avoid common mode failures by introducing a change of producer of redundant systems based on the same principle.

Fail Safe Condition: The system is to return to a safe state in the case of a failure or malfunction.

Hidden Failure: a failure that is not immediately evident to operations and maintenance personnel, such as protective functions on which redundancy depends.

Independence: An independent system is a system that can operate without the assistance of central control or other systems or subsystems. In this Guide it is mainly in reference to main machinery such as generators and thrusters. Auxiliary and control functions are to be provided in a manner that makes the machinery as independent as practical to minimize the number of failures that can lead to the loss of more than one main item of machinery.

Non-critical Redundancy: Equipment provided over and above that required to support the worst case failure design intent. Its purpose is to improve the reliability and availability of systems.

Physical Separation: With reference to DPS-3 vessels, fire and watertight subdivisions required to support the worst case failure design intent in respect of DPS-3 failure criteria.

Redundancy: Ability of a component or system to maintain or restore its function, when a single fault has occurred. Redundancy can be achieved for instance by installation of multiple components, systems or alternative means of performing a function.

Redundancy Concept: The means by which the worst case failure design intent is achieved. It is to be documented as part of the preliminary design process.

Redundant Groups (Subsystems): Two or more component groups each of which is capable of individually and independently performing a specific function.

Separation: (Redundant systems) Separation is to reduce the number of connections between systems to reduce the risk that failure effects may propagate from one redundant system to another.

Single Fault: The single fault is an occurrence of the termination of the ability to perform a required function of a component or a subsystem in the DP system. For vessels with **DPS-3** notation, the loss of any single compartment is also to be considered a single fault.

Single Fault Tolerance: The ability of a system to continue its function, following a single fault, without unacceptable interruption.

5.7 Performance and Operation (1 November 2013)

Availability: (IEC 191-02-05) Availability is the ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided. This ability depends on the combined aspects of the reliability performance, the maintainability performance and the maintenance support performance.

Loss of Position: The vessel's position is outside the limits set for carrying out the industrial activity in progress.

DP Capability/Station Keeping Analysis: A theoretical calculation of the vessel's capability to maintain position under particular conditions of wind, waves and current from different directions. It is to be determined for different thruster combinations, (e.g., all thrusters, loss of most effective thrusters, WCF).

Maintainability: (IEC 191-02-07): The ability of an item under given conditions of use, to be retained in, or restored to, a state in which it can perform a required function, when maintenance is performed under given conditions and using stated procedures and resources within a stated time.

Operability: Service operability performance (IEC 191-19-06): The ability of a service to be successfully and easily operated by a user.

Spinning Reserve: The difference between the total capacity of the running generators and the consumed power.

Station Keeping: Maintaining a desired position within the normal excursions of the control system and under the defined environmental conditions.

System Flexibility: The ability of a system to adapt to internal or external changes to allow its primary mission to be satisfied.

Time to Terminate: This time is calculated as the amount of time required in an emergency to physically free the DP vessel from its operational activity following a DP abort status and allowing it to be maneuvered clear and to proceed to safety.

7 Documentation

Where one of the classification notations described in Subsection 1/3 is requested, the following plans, data and documentations are to be submitted for review as applicable. These documentation requirements are in addition to the requirements for the vessel's mandatory classification notations. The requirements on the extent of the documents are given in the related Sections of this Guide. The following symbols are used in this Section for the type of review of the documents

R: Documents to be reviewed

I: Documentation for information and verification for consistency with related review.

OB: Documentation which needs to be kept onboard

7.1 Dynamic Positioning System

Documents listed in this section are mainly related to the global functionality, performance and characteristics of an integrated DP system.

- i) DP Operations Manual (**R, OB**)
- ii) System description including a block diagram showing how the various components are functionally related (**R**)
- iii) Details of the DP alarm system and any interconnection with the main alarm system (**R**)
- iv) General Arrangement drawing for DP Control Station including control console, control panel, layout of Navigation bridge deck, list of equipment, etc. (**R**)
- v) Failure modes and effects analysis (FMEA) (**DPS-2, DPS-3**) (**R, OB**)
- vi) DP station keeping capability analysis including environmental force calculation, thruster force calculation and capability polar plots for normal operational case and for post Worst Case Failure operational case (**R**)
- vii) DP system testing plan (**R, OB**)
- viii) Cable routing layout (**DPS-3**) (**R**)
- ix) Details of the emergency stop system for thrusters (**R**)
- x) Specification of safe operating envelope of environmental conditions for DP operation (**I**)
- xi) Basic design of DP system redundancy (**DPS-2, DPS-3**) (**R**)
- xii) Description of vessel emergency shutdown (ESD) system if applicable (**I**)
- xiii) Description of emergency disconnecting system (EDS) if applicable (**I**)
- xiv) Planned inspection and maintenance (**I, OB**)

7.3 Power System

Documents listed in this section are mainly related to the power system including all components and subsystems necessary to supply the DP system with power.

- i) Electrical power generation system (**R**)
- ii) Power distribution system (**R**)
- iii) Load analysis (**R**)
- iv) Auxiliary system distribution (**R**)
- v) Uninterruptable power supply system (**R**)
- vi) Description of bus-tie breaker protective functions where applicable (**R**)

7.5 Thruster System

- i) Thruster system arrangement (**R**)
- ii) Thruster control system (**R**)
- iii) Thrust output and power input curves (**I**)
- iv) Thruster auxiliary system (**R**)
- v) Thruster monitoring system (**R**)
- vi) Description of emergency stop system for thrusters (**R**)
- vii) Thrust response time for thrust and direction changes (**I**)
- viii) Thrust reductions due to interaction effects (**I**)
- ix) Manufacturer test procedure (**R**)

- x) DP trial test procedure (**R, OB**)
- xi) Manual for operation and maintenance (**I, OB**)

7.7 DP Control System

- i) DP Control system, scope and arrangement (**R**)
- ii) Details of the position reference system and environmental monitoring systems (**R**)
- iii) Details of the consequence analyzer (**DPS-2, DPS-3**) (**R**)
- iv) Certification of suitability of control equipment for the marine atmosphere (**I, OB**)
- v) Control system functional description (**I**)
- vi) Manufacturers' equipment operation documents (**R**)
- vii) Software quality plan (**I**)
- viii) FMEA of DP control system (**DPS-2, DPS-3**) (**R, OB**)
- ix) Manufacturer test procedure (**R, OB**)
- x) DP trial test procedure (**R, OB**)
- xi) Manual for operation and maintenance (**I, OB**)

9 Certification

9.1 Control and Monitoring System Equipment

Control and monitoring (alarms and instrumentation) system equipment used in a DP control system to be assigned a **DPS** notation is to be certified for suitability in the marine environment.

Hydraulic and pneumatic piping systems associated with the thruster system are to be subjected to pressure tests at 1.5 times the relief-device setting using the service fluid in the hydraulic system and dry air or dry inert gas for pneumatic systems as testing media. The tests are to be carried out in the presence of a Surveyor.

9.3 Components and Subsystems

The components and subsystems associated with the dynamic positioning system are to be certified or type approved according to the vessel's mandatory classification notation.

SECTION 2 Dynamic Positioning System Design

1 General

The dynamic positioning (DP) system includes subsystems of power supply system, thruster system and DP control system. Those subsystems and related components are to meet the requirements for the vessel's mandatory classification notations.

This Section provides general requirements for a DP system with a **DPS**-series notation. More detailed requirements for each subsystem are given in Sections 3, 4, 5 and 6 respectively.

Section 8 of this Guide provides the requirements for enhanced system notations (**EHS**) and Section 9 provides the requirements for station keeping performance notation (**SKP**).

3 DP System Technical Requirements

3.1 Basic Requirements

A DP system is to be designed to have a certain level of station keeping capability, reliability and redundancy. The class notation of DP System addresses the reliability based on the redundancy and fault tolerance of the DP system.

- i) For a vessel with the notation **DPS-0**, or **DPS-1**, a loss of position may occur in the event of a single fault.
- ii) For a vessel with the notation **DPS-2**, a loss of position may not occur in the event of a single fault in any active component or system, excluding a loss of compartment or compartments.
- iii) For a vessel with the notation **DPS-3**, a loss of position may not occur in the event of a single fault in any active or static component or system, including complete loss of a compartment due to fire or flood.
- iv) The redundant components and systems are to be immediately available and with such capacity that the DP operation can continue for such a period that the work in progress can be terminated safely.
- v) The period for safely terminating a work in progress is to be specified by the Owner.

The selection of the level of DP class notation of the vessel for a particular operation is outside the scope of this Guide. Some Coastal States impose minimum DP Equipment Class requirements for activities carried out within their jurisdiction.

The station keeping capability is normally presented by the limiting environmental conditions under which the vessel can maintain the position and heading. The limiting environmental conditions and operational modes for a DP vessel are to be defined by the Owner.

3.3 Redundancy Design

3.3.1 DPS-Series Notations

For the notation **DPS-0** and **DPS-1**, there is no requirement for redundant systems.

For the **DPS-0** notation, the dynamic positioning system is to have a manual position control system.

For the **DPS-1** notation, the dynamic positioning system is to include an automatic dynamic positioning system and a manual position control system.

A vessel with **DPS-2** or **DPS-3** notation is required to have an automatic dynamic positioning system, manual position control system and to be single fault tolerant.

The single fault tolerance is to be achieved by the design of redundant systems. The station keeping capability after a single fault is to be achieved by providing control, electric power and thrust.

For the **DPS-2** notation, static components will normally not be considered to fail.

For the **DPS-2** notation, a single fault includes:

- i) Any active component or system (generators, thrusters, switchboards, DP control computers, sensors, remote controlled valves, etc.)

For the **DPS-3** notation, a single fault includes:

- i) Items listed above for **DPS-2**, and any normally static component is assumed to fail
- ii) Any components in any one watertight compartment from flooding
- iii) Any components in any one fire subdivision from fire

3.3.2 Consideration of Redundancy

- i) The redundancy is to have two or more items of equipment or system required to perform a function so that the redundant unit can take over from the failed unit without unacceptable interruption of the function.
- ii) Redundancy is to be based on systems which are immediately available for use, namely on running machinery. In general, full stop and restart of the system do not comply.
- iii) Automatic start of equipment may be accepted as contributing to redundancy only if they can be tested to prove that they can be brought into operation before position and heading keeping performance is degraded.
- iv) The redundancy depends on systems being available in both number and capacity to produce the required DP capability after worst case failure. Independence of redundancy groups is to take into account all technical functions.
- v) The redundancy design can consist of two fully redundant power and thruster systems each capable of maintaining position and heading if the other fails. The design can also make use of multiple systems each providing partial redundancy such that the vessel can maintain position with all combinations of independent systems that survive any defined fault. The redundancy design is to provide suitable combinations of available systems following any defined fault.
- vi) The transfer of failures between redundant subsystems is to be prevented by separation of the redundant systems.
- vii) The failure of redundant components or systems is to be revealed by alarms. The possibility of hidden failures is to be minimized through periodic testing.

3.3.3 Basic Design of Redundancy and Redundancy Concept

Basic design of redundancy and the redundancy concept of the DP system are to be developed at the early design stage and are to be submitted to ABS for review.

The documentation is to include at least the following:

- i) General arrangement of DP system
- ii) Worst case failure design intent (WCFDI)
- iii) Limiting environmental conditions for DP operation
- iv) Power plant configurations for DP operation
- v) Allowable loss of power sources after one failure
- vi) Allowable number of failed thrusters
- vii) Time period for safely terminating a DP operation after each considered single fault

The documentation is to be reviewed during the design process is to confirm if the worst case failure design intent is met.

The worst case failure design intent is to describe the minimum amount of propulsion and control equipment remaining operational following the worst case failure. The worst case failure design intent is to be used as the basis of the design development.

3.5 Physical Separation

For a vessel with a **DPS-3** notation, the redundancy groups are to be separated by bulkheads and decks that are fire-insulated by A-60 class divisions. The separation is to be watertight if below the damage waterline.

Cables for redundant equipment or systems are not to be routed together through the same compartments.

If not avoidable, cables for redundant systems are to be separated by at least one A-60 barrier. Thus cables associated with one system could be run in an A-60 class duct with the other system running through the compartment or both sets of cables routed through separate ducts.

Redundant piping system (i.e., piping for fuel, cooling water, lubrication oil, hydraulic oil, etc.) is not to be routed together through the same compartments.

If not avoidable, such pipes are to be separated by at least one A-60 barrier. Thus pipe-work associated with one system could be run in an A-60 class duct with the other system running through the compartment or both sets of pipe-work routed through separate ducts.

3.7 DP System Equipment Requirements

To meet the requirements for a DPS-series notation, the minimum number of subsystems and components and the redundancy for: power system, thruster system and DP control system are provided in Section 2, Table 1. The detailed requirements for each subsystem and the arrangement of the equipment are given in Sections 3, 4, 5 and 6, respectively.

3.9 Station Keeping Performance

A DP system is to be designed to be able to maintain the position and heading under the specified limiting environmental conditions. The design environment is to be specified by the owner.

- i) A vessel with a **DPS-0** or **DPS-1** notation is to be able to maintain position and heading under specified environmental conditions with all thrusters intact.
- ii) A vessel with a **DPS-2** or **DPS-3** notation is to be able to maintain position and heading under specified environmental conditions during and after any single fault of the DP system.
- iii) The station keeping performance assessment is to be carried out for:
 - a) Design environmental conditions
 - b) Normal operational condition
 - c) Standby condition (where applicable)
 - d) All thruster intact condition
 - e) Worst case failure condition (according to basic design of the redundancy system)
 - f) Other conditions, such as the failure of the most effective thruster or least effective thruster, may be included in the assessment as well.
- iv) The environmental load calculations, including those for wind, current and wave drift forces, are to follow suitable procedures. API RP 2SK, *ABS Rules for Mobile Offshore Drilling Units* can be used for environmental load calculation.
- v) Thruster degradation due to interactions is to be considered in the station keeping capability assessment.
- vi) Other effects due to industrial activities, such as pipe tension, heavy lift, hawser tension, riser load, etc., are to be taken into account in the station keeping capability analysis.

- vii) The effect of the vessel's industrial activities on available power for the DP system is also to be considered in the assessment.
- viii) Station keeping capability can be presented using traditional DP capability plots or using thrust utilization plots.
- ix) The station keeping capability analysis report is to be submitted for review. The following information is to be included in the report:

 - a) Vessel general arrangement and main particulars
 - b) Projected areas for wind and current
 - c) Available power for DP system
 - d) Thruster arrangement, maximum thrust
 - e) Thruster degradation
 - f) Wind, current and wave force coefficients
 - g) Wind and wave relationship used where applicable
 - h) Description of analysis method
 - i) DP capability plots
 - j) Thrust utilization under the specified limiting environmental conditions where applicable

TABLE 1
Summary of DP System Requirements for ABS DPS Notations⁽⁴⁾ (1 November 2013)

Subsystem or Component	Equipment		Minimum Requirements for each Classification Notation				Remarks
			DPS-0 ⁽¹⁾	DPS-1	DPS-2	DPS-3 ⁽⁵⁾	
Power System	Generators and Prime Movers		Non-redundant	Non-redundant	Redundant	Redundant, in separate compartments ⁽⁵⁾	See Subsection 3/3
	Main Switchboard		1	1	1 with bus-tie	2 with bus-ties, in separate compartments	See Subsection 3/5
	Bus-tie Breaker		0	0	1	2	
	Distribution System		Non-redundant	Non-redundant	Redundant	Redundant, in separate compartments	
	Power Management ⁽²⁾		No	No	Yes	Yes	
Thrusters	Arrangement of Thrusters		Non-redundant	Non-redundant	Redundant	Redundant, in separate compartments	See Subsection 4/3
Control System	DP Control: Number of Control Computers		0	1	2	2 + 1 in backup control station	See 5/3.5
	Manual Position Control: Joystick with Auto Heading		Yes	Yes	Yes	Yes	
	Manual Thruster Control		Yes	Yes	Yes	Yes	See 4/9.5
	Position Reference Systems		1	2	3	2 + 1 in backup control station	See Subsection 5/11, 10/3.3, 10/5.5, 10/7.3
	Sensors:	Wind	1	2	3	2 + 1 in backup control station	
		MRU ⁽³⁾	0	1	3	2 + 1 in backup control station	
		Gyro	1	2	3	2 + 1 in backup control station	
	UPS		0	1	2	2 + 1 in separate compartment	See Subsection 3/9
Backup Control Station for Backup Unit			N/A	N/A	N/A	Yes	See 5/9.3
Consequence Analyzer			No	No	Yes	Yes	See Subsection 5/13
FMEA			No	No	Yes	Yes	See Subsection 2/11

Notes:

- DPS-0** is an ABS system class. It is a manual position control system fitted with automatic heading control and with a free-standing position reference system. **DPS-1**, **DPS-2** and **DPS-3** are in line with IMO equipment class 1, class 2 and class 3, respectively.
- If all thrusters are direct diesel drive, a power management system is not required.
- (1 November 2013) If position reference systems are dependent on correction of the measurements for roll and pitch noise, their associated MRUs are required.
- (1 November 2013) For enhanced system (**EHS-P**, **EHS-F** and **EHS-C**), additional information is provided in Section 8, Table 1.
- (1 November 2013) Where “separate compartments” is indicated, the equipment is to be located in separate compartments arranged to support the worst case failure design intent in respect of **DPS-3** failure criteria.

5 Essential Non-DP Systems

5.1 General

The essential non-DP systems, such as common fire suppression systems, engine ventilation systems, emergency shutdown systems, etc., may interfere with the DP system.

The redundancy concept for the DP system is to be followed through to these systems so that actions or failures initiated by these systems do not cause consequences that exceed the worst case failure design intent. The actions initiated by these systems are to be scaled to the detected threat level and are to be addressed in the FMEA of the DP system.

5.3 Emergency Shutdown System and DP Redundancy

The DP system is not to be affected by failures of the emergency shutdown systems. For DPS-2 that will include any failure in the shutdown systems and for DPS-3 it will include the effect of fire on associated cabling and piping in any compartment.

The effect on the DP system due to any reasonable act of mal-operation is to be considered. This means that the shutdown systems are treated in the same way as any other part of the vessel's DP system that meet the same redundancy requirements and have their failure modes analyzed in the FMEA of the DP system.

In spaces such as thruster rooms and auxiliary machinery spaces, an immediate effect on DP systems due to a spurious shutdown of ventilation is to be prevented and to be confirmed during FMEA proving trials.

5.5 Fire Protection

Fixed firefighting systems may include CO₂ or other fire suppressant agents such as water mist. These systems are to be arranged in a manner that supports the overall divisions in the DP redundancy concept.

Where possible, the release of the fire suppressant is to only affect one redundant machinery group.

5.7 Fuel Quick Closing Valves

These valves are provided to allow rapid isolation of fuel supplies in emergency situations. The valves are to be provided in line with the requirement of the vessel's mandatory classification notations. They are to be arranged in a manner that allows fuel to be isolated to only one redundant machinery group without affecting the operation of any others.

7 Alarms, Monitoring and Instrumentation

The main purpose of the alarm and monitoring system is to give the DP operators the abnormal condition and status information they require to maintain safe and efficient operation of the system. Information relating to power management, propulsion, ballast control, HVAC, etc., are to be available.

The displays and alarms as specified in Section 2, Table 2 are to be provided at DP control stations, as applicable.

Section 2, Table 2 provides the summary of minimum basic instrumentation at the main DP control station. Additional instrumentation may be necessary. The detailed information for displays and alarms for the DP system's components and subsystems are given in Sections 3, 4, 5, and 6 respectively.

TABLE 2
Summary of Minimum Instrumentation at DP Control Station (1 November 2013)

System	Monitored Parameters	Alarm	Display
Thruster Power System (See Subsections 4/9 & 4/11)	Engine lubricating oil pressure – low	x	
	Engine coolant temperature – high	x	
	CPP hydraulic oil pressure – low and high	x	
	CPP hydraulic oil temperature – high	x	
	CPP pitch		x
	Thruster RPM		x
	Thrust direction		x
	Thruster motor/semiconductor converter coolant leakage	x	
	Thruster motor semiconductor converter temperature		x
	Thruster motor short circuit	x	
	Thruster motor exciter power available		x
	Thruster motor supply power available		x
	Thruster motor overload	x	
	Thruster motor high temperature	x	
	Thruster operation (on-line/off-line)		x
Power Distribution System (See Subsection 3/5)	Status of automatically controlled circuit breakers		x
	Bus bar current and power levels		x
	High power consumers – current levels		x
	Status of power management system	x	x
	Spinning reserve		x
System Performance (See Section 5)	Excursion outside operating envelope	x	
	Control system fault	x	
	Position sensor fault	x	
	Vessels target and present position and heading		x
	Wind speed and direction		x
	Selected reference system		x
Specific Requirements for DPS-2 & DPS-3 (See Section 5)	Thruster location (pictorial)		x
	Available thrust used and thrust vector		x
	Available thrusters on stand-by		x
	Consequence analyzer alert	x	
	Position information of individual position reference systems connected		x

9 Communications and DP Alert System

9.1 Communications

Communication is a key management tool during execution. This is to be incorporated in the design phase.

- i) At least, one means of voice communication is to be provided between each DP control station and the navigation bridge, the engine control position, any other relevant industrial function control centers associated with DP and any location required by the vessel's mandatory classification notation.
- ii) The voice communication system is to be powered by a battery or an uninterruptible power supply system sufficient to operate the system for at least 30 minutes.
- iii) The Communication systems are to be located within easy reach of the DP operator at the DP control stations.

9.3 DP Alert System (1 November 2013)

DP alert statuses in operation are to be clearly defined and are, at least, to have the following three levels

- i) Normal operational status
- ii) Degraded DP status
- iii) DP emergency status

A system of visual and audible alarms are to be provided in key locations and to be manually activated to indicate DP operational status. Where such an alert system is not easily included the means of clear communication of the statuses are to be agreed before commencement of operations. Section 10 of this Guide provides more detailed information for specific vessel types.

The guidance provided by IMCA M 103 “Guidelines for Design and Operation of Dynamically Positioned Vessel” and by MTS “DP Vessel Design Philosophy Guideline” can be used for the design of DP alert system.

11 Failure Mode and Effects Analysis

11.1 General

FMEA is only applicable to **DPS-2** and **DPS-3** notations. In general, two FMEAs are to be considered, one covering the main DP control systems and the other for all other systems onboard related to DP operations.

The purpose of the FMEA is to indicate whether or not the DP system meets the requirements of the relevant DP notation and complies with the vessel’s WCFDI.

The DP FMEA is to be performed based on this Guide, IMCA M 166, IMCA M 178, IEC 60812, “DP Vessel Design Philosophy Guideline” by MTS, Annex 4 of IMO *High Speed Craft Code* or equivalents.

The objective of the DP FMEA is to, at least, include the following:

- i) Identify and provide recommendations to eliminate or mitigate the effects of all single faults and common mode failures in the vessel DP equipment which, if any occurs, would cause total or partial loss of station keeping capability.
- ii) Demonstrate effective redundancy.
- iii) Identify potential “hidden” failures and determine the effects of a second failure.

Results of the DP FMEA are to be verified during FMEA proving trials. The DP FMEA test program is to be developed based on the analysis results, analysis method and assumptions. The relevant test program is to be provided to ABS for review and approval.

DP FMEA and DP FMEA test programs are to be kept onboard and they are to be updated to cover subsequent alterations to the DP system hardware or software.

11.3 Failure Mode Analysis

For a **DPS-2** or a **DPS-3** notation, loss of position is not allowed to occur in the event of a single fault. Single fault includes, but is not limited to following:

- i) All redundant components, systems or subsystems
- ii) A single inadvertent act of operation (ventilation, fire suppression, ESD) where applicable and if such an act is reasonably probable
- iii) Hidden failures (such as protective functions on which redundancy depends) where applicable
- iv) Common failure modes
- v) Governor and AVR failure modes where applicable
- vi) Main switchboard control power failure modes
- vii) Bus-tie protection where applicable
- viii) Power management system