RULES FOR CLASSIFICATION OF

Ships

PART 6 CHAPTER 7

NEWBUILDINGS
SPECIAL EQUIPMENT AND SYSTEMS – ADDITIONAL CLASS

Dynamic Positioning Systems

JULY 2011

DET NORSKE VERITAS AS

FOREWORD

DET NORSKE VERITAS (DNV) is an autonomous and independent foundation with the objectives of safeguarding life, property and the environment, at sea and onshore. DNV undertakes classification, certification, and other verification and consultancy services relating to quality of ships, offshore units and installations, and onshore industries worldwide, and carries out research in relation to these functions.

The Rules lay down technical and procedural requirements related to obtaining and retaining a Class Certificate. It is used as a contractual document and includes both requirements and acceptance criteria.

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CHANGES

General

The present edition of the rules includes amendments and additions approved by the Executive Committee as of June 2011 and supersedes the January 2011 edition of the same chapter.

The rule changes come into force as described below.

Text affected by the main rule changes is highlighted in red colour in the electronic pdf version. However, where the changes involve a whole chapter, section or sub-section, only the title may be in red colour.

This chapter is valid until superseded by a revised chapter.

Main changes coming into force 1 July 2011

- **Sec.1 General Requirements**

— In Table D1 References to documentation type “Z030 – System arrangement plan” and “Z020 – Local arrangement plan” have been amended to read “Z030 – Arrangement plan”.

- **Sec.4 Thruster Systems**

— A404 has been updated regarding emergency stop of main propellers for thrusters of **DPS**-series.
— Added new Guidance note to A404 to show requirement to Power Take Off (PTO) - step up gears location.

Corrections and Clarifications

In addition to the above stated rule requirements, a number of corrections and clarifications have been made in the existing rule text.

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SECTION 1
GENERAL REQUIREMENTS

A. Introduction

A 100 Background

101 The rules in this chapter apply to systems for dynamic positioning of ships and mobile offshore units, termed hereafter as, vessels.

102 The chapter details the above in two different notation series, being the **DPS-** series and the **DYNPOS-** series of class notations as outlined below in table A1. Both series are characterised and structured in line with the IMO MSC/Circ.645 "Guidelines for vessels with dynamic positioning systems".

Guidance note:

IMO MSC/Circ.645 "Guidelines for vessels with dynamic positioning systems", dated 6 June 1994, has defined equipment classes with the following correlation to these rules:

IMO equipment class	*DNV class notations*	*Additional information*
Not applicable	**DPS 0**	
	DYNPOS-AUTS	Additional requirements to achieve higher availability and robustness as compared to **DPS 0** will apply.
IMO equipment class 1	**DPS 1**	
	DYNPOS-AUT	Additional requirements to achieve higher availability and robustness as compared to **DPS 1** will apply.
IMO equipment class 2	**DPS 2**	
	DYNPOS-AUTR	Additional requirements to achieve higher availability and robustness as compared to **DPS 2** will apply.
IMO equipment class 3	**DPS 3**	
	DYNPOS-AUTRO	Additional requirements to achieve higher availability and robustness as compared to **DPS 3** will apply.
The **DYNPOS**- series comprise the **DYNPOS-AUTS**, **DYNPOS-AUT**, **DYNPOS-AUTR** and **DYNPOS-AUTRO** notations. The **DPS-** series comprise the **DPS 0**, **DPS 1**, **DPS 2** and **DPS 3** notations.		

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103 A dynamic positioning system with redundancy and higher degree of flexibility based on utilization of stand-by units and/or change-over mechanisms is described in Pt.6 Ch.26.

A 200 Scope

201 The rules in this chapter set technical requirements to design, documentation, certification and testing of systems for dynamic positioning of ships and mobile offshore units.

202 These rules do not include requirements or recommendations in regard to the vessels operation or other characteristics.

Guidance note:

Requirements, additional to these rules may be imposed by the national authority with whom the vessel is registered and/or by the administration within whose territorial jurisdiction it is intended to operate. Where national legislative requirements exist, compliance with such regulations shall also be necessary.

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203 The requirements in these rules are additional to the rules for main class.

Guidance note:

In particular see the relevant sections of:

Pt.4 Ch.1 Machinery Systems, General
Pt.4 Ch.2 Rotating Machinery, General
Pt.4 Ch.3 Rotating Machinery, Drivers
Pt.4 Ch.4 Rotating Machinery, Power Transmissions
Pt.4 Ch.5 Rotating Machinery, Driven Units
Pt.4 Ch.8 Electrical Installations
Pt.4 Ch.9 Instrumentation and Automation

Pt.4 Ch.14 Steering Gear.

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A 300 Objectives

301 The requirements are characterised and structured in line with the IMO MSC/Circ.645 "Guidelines for vessels with dynamic positioning systems".

302 The two notation series differ in their specific requirements and in general the **DYNPOS-** series notations are requiring a higher degree of availability and robustness as compared to the **DPS-** series notations. The detailed differences are outlined in the specific requirements given in this chapter.

A 400 Application and class notations

401 Vessels built and tested in compliance with the requirements in this chapter and the requirements of the rules for main class may be assigned one of the class notations given in Table A1.

Table A1 Class notations

Notation hierarchy		*Description*
Notations not requiring redundancy	**DPS 0**	Dynamic positioning system without redundancy.
	DYNPOS- AUTS	Dynamic positioning system without redundancy. Additional requirements to achieve higher availability and robustness as compared to **DPS 0** will apply.
	DPS 1	Dynamic positioning system with an independent joystick system back-up and a position reference back-up.
	DYNPOS- AUT	Dynamic positioning system with an independent joystick system back-up and a position reference back-up. Additional requirements to achieve higher availability and robustness as compared to **DPS 1** will apply.
Notations requiring redundancy	**DPS 2**	Dynamic positioning system with redundancy in technical design and with an independent joystick system back-up.
	DYNPOS- AUTR	Dynamic positioning system with redundancy in technical design and with an independent joystick system back-up. Additional requirements to achieve higher availability and robustness as compared to **DPS 2** will apply.
Notations requiring redundancy and separation of systems	**DPS 3**	Dynamic positioning system with redundancy in technical design and with an independent joystick system back-up. Plus a back-up dynamic positioning control system in an emergency dynamic positioning control centre, designed with physical separation for components that provide redundancy.
	DYNPOS- AUTRO	Dynamic positioning system with redundancy in technical design and with an independent joystick system back-up. Plus a back-up dynamic positioning control system in an emergency dynamic positioning control centre, designed with physical separation for components that provide redundancy. Additional requirements to achieve higher availability and robustness as compared to **DPS 3** will apply.

402 A qualifier **(A)** can when requested by the vessel owner be assigned to vessels with notation **DYNPOS-AUTR** or **DYNPOS-AUTRO** or **DPS 2** or **DPS 3**, which then shall undergo annual survey according to the applicable 5 yearly complete survey scope.

Guidance note:
Example of notations: **DYNPOS-AUTR(A)** or **DPS 2(A)**.

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A 500 Class entries from other classification societies to the DNV **DYNPOS- series**

501 Class entry to the **DYNPOS**- series will require verification towards the requirements for the relevant notation as given in 502 and 503.

502 The verification shall be based on documentation review, performance testing and FMEA failure testing as described in: E. Survey and Test upon Completion. The test shall be performed according to approved test programs.

503 The following documentation is required as basis for the documentation review:

— Dynamic Positioning control system including UPSs, position reference systems and sensors
— Back-up Dynamic Positioning control system including UPSs, position reference systems and sensors (for **DYNPOS-AUTRO**)
— Documentation on the independent joystick system with selectable heading control (for **DYNPOS-AUT**, **DYNPOS-AUTR** and **DYNPOS-AUTRO**)
— Thruster, propeller and rudder configuration
— Mode change systems (Dynamic Positioning- / Joystick- / Manual- control)

— Ship systems FMEA (Failure mode and effect analysis), and FMEA test program (for **DYNPOS-AUTR** and **DYNPOS-AUTRO**)
— Thruster emergency stop system at the Dynamic Positioning control centre
— Dynamic Positioning control centre lay-out, for **DYNPOS-AUTRO** also for the back-up Dynamic Positioning control centre
— For **DYNPOS-AUTRO**: Cable routing layout drawing, system arrangement plan and fire and flooding separation drawings.
— Environmental Regularity Number(**ern**), calculation.

504 Vessels to be assigned the qualifier **(A)** shall have an updated FMEA, with a corresponding FMEA test program.

505 Any deviations from requirements relevant for the class entry found as a result from the documentation review and testing required in 502 and 503 must be rectified before the vessel can be assigned the relevant DNV **DYNPOS** notation.

A 600 Class entries from other classification societies to the DNV DPS- series

601 In general, the **DPS-** series system design will be accepted based on a corresponding, valid and maintained Dynamic Positioning class notation, from the losing society.

Guidance note:
This implies that class entry vessels may have designs based on somewhat different requirements than those given in these rules.

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602 Documentation review, survey or testing will not be required prior to class assignment, unless the periodic Dynamic Positioning survey will be due or overdue (based on the date of the last survey or test from the losing society) when the vessel is taken into DNV class.

603 Vessels to be assigned the qualifier **(A)** shall have an updated FMEA, with a corresponding FMEA test program.

A 700 Environmental regularity number, ern

701 Vessels with one of the **DYNPOS-** series class notations listed in Table A1 will be given an environmental regularity number (**ern**). It will be entered as a notation in the "Register of vessels classed with DNV" as **ern(a, b, c, d)** where **a, b, c, d** are integer numbers reflecting probable regularity for keeping position in a defined area. See Sec.7 for details on the **ern** concept.

Guidance note:
Upon special request environmental regularity number **(ern)** may also be approved and entered as a notation in the "Register of vessels classed with DNV" also for vessels with the **DPS-** series notations.

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B. Definitions

B 100 General

101 *Consequence analysis:* A monitoring function in the DP control system that issue an alarm if the vessel (in its current operating mode) in the current weather conditions would not be able to keep the heading and position in the case that any of the predefined worst case failures should occur.

Guidance note:
For detailed information and requirements to the consequence analysis function see Sec.3 H200.

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

— dynamic positioning control computer(s)
— sensor system
— display system
— operator panels
— positioning reference system
— associated cabling and cable routing.

Guidance note:
The DP-control system will normally consist of one or more computers. This is often referred to as the DP system,

but is only a part of the DP system by rule terminology.

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103 *Dynamic positioning system (DP system):* The complete installation necessary for dynamically positioning a vessel comprises of the following systems:

— power system
— thruster system
— DP-control system
— independent joystick system (when applicable).

104 *Dynamically positioned vessel (DP vessel):* A vessel which automatically maintains its position and heading (fixed location or predetermined track) exclusively by means of thruster force.

Guidance note:

For the **DYNPOS-** series an intact vessel shall be able to keep position and heading without contribution from transverse thrust generated by the combined use of propellers and rudders. For **DYNPOS-AUTR** and **DYNPOS-AUTRO** thruster force may include propulsion and steering (rudder) forces for back-up purposes only (e.g. after loss of one redundancy group), see Sec.4 A200.

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105 *Failure:* An occurrence in a component or system causing one or both of the following effects:

— loss of component or system function
— deterioration of functional capability to such an extent that the safety of the vessel, personnel, or environment is significantly reduced.

Guidance note:

For vessels that shall comply with **DYNPOS-AUTRO** or **DPS 3** requirements, the definition of single failure has no exceptions, and shall include incidents of fire and flooding, and all technical break-downs of systems and components, including all electrical and mechanical parts. Loss of stability (e.g. as a result of flooding) is not a relevant failure mode.

For vessels that shall comply with **DYNPOS-AUTR** or **DPS 2** requirements, certain exceptions will be allowed in the definition of single failure. Flooding and fire shall not be considered beyond main class requirements. Failure of static components, e.g. pipes, manual valves, cables etc. may not need to be considered if adequate reliability of a single component can be documented, and the part is protected from mechanical damage. Specific requirements will apply as given in the following sections of this rule chapter. Especially for **DYNPOS-AUTR** failure of a wide range of static components will considered as relevant single failures. See also Sec.2 B.

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106 *Joystick:* A device for readily setting of vectorial thrust output including turning moment.

107 *Operational mode:* The manner of control under which the DP-system may be operated, e.g.:

— automatic mode (automatic position and heading control)
— joystick mode (manual position control with selectable automatic or manual heading control)
— manual mode (individual control of thrust, azimuth, start/stop of each thruster)
— auto track mode (considered as a variant of automatic position control, with programmed movement of reference point).

108 *Position/heading keeping:* Maintaining a desired position/heading within the normal excursions of the control system and the environmental conditions.

109 *Positioning/heading reference system:* All hardware, software and sensors that supply information and or corrections necessary to give position/heading reference, including power supply.

110 *Power system:* All components and systems necessary to supply the DP-system with power. The power system includes:

— prime movers with necessary auxiliary systems including piping
— generators
— switchboards
— uninterruptible power supplies (UPS) and batteries
— distribution system including cabling and cable routing
— for **DYNPOS-AUTR** and **DYNPOS-AUTRO**: power management system (PMS).

111 *Redundancy:* The ability of a component or system to maintain its function when one failure has occurred. Redundancy can be achieved, for instance, by installation of multiple components, systems or alternative means of performing a function.

112 *Redundancy group*: All components and systems that is subject to a single failure as specified in Sec.2 B for the specific notations

Guidance note:

The redundancy groups will emerge as a consequence of the worst case single failure within each group. The Rules does not give requirements to the number of (beyond 2) or ratio between the defined groups. The groups are to be identified in the FMEA, verified by testing and incorporated in the consequence analysis.

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113 *Reliability:* The ability of a component or system to perform its required function without failure during a specified time interval.

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

— thruster with drive units and necessary auxiliary systems including piping
— thruster control
— associated cabling and cable routing
— main propellers and rudders if these are under the control of the DP system.

115 *Worst case failure:* Failure modes which, after a failure, results in the largest reduction of the position and/or heading keeping capacity. This means loss of the most significant redundancy group, given the prevailing operation. Failure modes related to the class notations as follows:

— for **DYNPOS-AUTS**, **DYNPOS-AUT, DPS 0** and **DPS 1**, loss of position may occur in the event of a single fault
— for **DYNPOS-AUTR**, loss of position is not to occur in the event of a single failure as specified in Sec.2 B300
— for **DPS 2**, loss of position is not to occur in the event of a single failure as specified in Sec.2 B400
— for **DYNPOS-AUTRO** and **DPS 3**, loss of position is not to occur in the event of a single failure as specified in Sec.2 B500.

C. Certification

C 100 General

101 The following equipment in the DP system shall be certified:

— dynamic positioning control system
— independent joystick control system with auto heading

If specifically required as part of the approval process:

— thruster control mode selection system.

Other equipment in the DP system shall be certified according to relevant parts of Pt.4 as for main class.

Guidance note:

Additionally, components and systems should be certified according to main class requirements.

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D. Documentation

D 100 General

101 The documentation submitted, shall include descriptions and particulars of the vessel and cover the requirements given in Table D1 and D200 to D400, as appropriate. These documentation requirements are in addition to the requirements for main class.

Table D1 Documentation requirements					
Object	*Documentation type*	*Additional description*	*Info*	*DYNPOS qualifiers*	*DPS qualifiers*
Dynamic positioning system	I260 – Cable routing layout drawing	All relevant cables.	AP	**AUTRO**	**3**
	Z030 – Arrangement plan	Fire and flooding separation.	AP	**AUTRO**	**3**
	Z071 – Failure mode and effect analysis (FMEA)	See D300.	AP	**AUTR**, **AUTRO**	**2**, **3**
	Z140 – Test procedure for quay or sea trial	Redundancy and failure modes based on FMEA	AP	**AUTR**, **AUTRO**	**2**, **3**
	Z200 – Environmental regularity number (ERN) calculation	See D200.	AP	All	Not applicable
Position keeping control centres	Z030 – Arrangement plan	Note 5	AP	All	All
Thrusters	Z110 – Data sheet	- thrust output and power input curves - response time for thrust changes - response time for direction changes -anticipated thrust reductions due to interaction effects.	FI, R	All	All
Main and back-up automatic dynamic positioning control systems	I010 – Control system philosophy		AP	All	All
	I020 – Control system functional description		AP	All	All
	I030 – Block diagram		AP	All	All
	I040 – User interface documentation		AP	All	All
	I050 – Power supply arrangement		AP	All	All
	I070 – Instrument and equipment list		FI	All	All
	I080 – Data sheet with environmental specifications		AP	All	All
	I140 – Software quality plan	Note 2	FI, L	All	All
	I150 – Circuit diagram	Note 3	AP	All	All
	Z071 – Failure mode and effect analysis		AP	**AUTR**, **AUTRO**	**2**, **3**
	Z120 – Test procedure at manufacturer		AP	All	All
	Z140 – Test procedure for quay and sea trial		AP	All	All
	Z160 – Operation manual	Notes 1 and 2	FI, L	All	All
	Z170 – Installation manual	Note 2	FI, L	All	All
	Z180 – Maintenance manual	Note 2	FI, L	All	All

Table D1 Documentation requirements (Continued)					
Object	*Documentation type*	*Additional description*	*Info*	*DYNPOS qualifiers*	*DPS qualifiers*
Independent joystick control system	I020 – Control system functional description		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I030 – Block diagram		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I040 – User interface documentation		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I050 – Power supply arrangement		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I070 – Instrument and equipment list		FI	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I080 – Data sheet with environmental specifications		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	I140 – Software quality plan	Note 2	FI, L	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	Z120 – Test procedure at manufacturer		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	Z140 – Test procedure for quay and sea trial		AP	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
	Z160 – Operation manual	Notes 1 and 2	FI, L	**AUT**, **AUTR**, **AUTRO**	**1**, **2**, **3**
Thruster control mode selection system	I020 – Control system functional description		AP	All	All
	I030 – Block diagram		AP	All	All
	I040 – User interface documentation		AP	All	All
	I050 – Power supply arrangement		AP	All	All
	I070 – Instrument and equipment list		FI	All	All
	I080 – Data sheet with environmental specifications		AP	All	All
	I140 – Software quality plan	Note 2	FI, L	All	All
	I150 – Circuit diagram	Note 3	AP	All	All
	Z120 – Test procedure at manufacturer		AP	All	All
	Z140 – Test procedure for quay and sea trial		AP	All	All
	Z160 – Operation manual	Notes 1 and 2	FI, L	All	All
Position reference systems	I040 – User interface documentation		AP	All	All
	I050 – Power supply arrangement		AP	All	All
	I070 – Instrument and equipment list		FI	All	All
	I080 – Data sheet with environmental specifications		AP	All	All
	Z140 – Test procedure for quay and sea trial		AP	All	All
	Z160 – Operation manual	Notes 1 and 2	FI, L	All	All

Table D1 Documentation requirements (Continued)					
Object	*Documentation type*	*Additional description*	*Info*	*DYNPOS qualifiers*	*DPS qualifiers*
Vertical reference, heading reference, wind and other sensor systems	I040 – User interface documentation		AP	All	All
	I050 – Power supply arrangement		AP	All	All
	I070 – Instrument and equipment list		FI	All	All
	I080 – Data sheet with environmental specifications		AP	All	All
	Z140 – Test procedure for quay and sea trial		AP	All	All
Main electric power system	E040 – Alternating current (AC) power consumption balance	Note 4	AP	All	All
Power management system	Z071 – Failure mode and effect analysis		AP	**AUTR**, **AUTRO**	**2**, **3**
Info: AP – For approval, FI: For information, L: Local handling, R: On request					
Note 1: One copy shall be submitted to the approval centre. Note 2: Shall be available during certification and trials. See also Pt.4 Ch.9. Note 3: For essential hardwired circuits (for emergency stop, shutdown, interlocking, mode selection, back-up selection etc.). Details of input and output devices and power sources for each circuit. Note 4: For dynamic positioning operation. For vessels with the qualifiers **AUTR**, **AUTRO**, **2** and **3** the load calculations shall also reflect the situation after the maximum single failures. May be a part of the power consumption balance as required in Pt.4 Ch.8 Electrical Installations. Note 5: For qualifiers **AUTRO** and **3** also the emergency DP-control centre shall be covered.					

102 For general requirements to documentation, see Pt.0 Ch.3 Sec.1.

103 For a full definition of the documentation types, see Pt.0 Ch.3 Sec.2.

D 200 (ern) calculation for the DYNPOS- series

201 Calculation of the environmental regularity number evaluation, **ern**, shall be submitted for approval for all notations in the **DYNPOS-** series. The position holding performance shall be quantified according to the concept for **ern**, see Sec.7. The calculations shall be presented in form of a report, which shall include the following information as a minimum:

- Thruster data: Maximum thrust, location, power
- Vessel data used in the calculations to be presented as numerical values together with (simplified) layout drawings showing both projected frontal and lateral areas affected by wind and current. Information about length (overall and Lpp), breath, draught shall also be given.
- Calculation: Description of mathematical method used in the calculations. Tables giving information for each calculated point: Environmental forces for wind, wave and current. Thrust output for each thruster, total thruster force and total turning moment
- Conclusion: Environmental regularity numbers, **ern**.

D 300 Failure mode and effect analysis (FMEA)

301 For vessels with the notations **DYNPOS-AUTR**, **DYNPOS-AUTRO**, **DPS 2** or **DPS 3**, documentation of consequences of single failures in accordance with rule requirements is required in the form of a failure mode and effect analysis (FMEA).

302 The purpose of the FMEA is to give a description of the different failure modes of the equipment when referred to its functional task. Special attention shall be paid to the analysis of systems that may enter a number of failure modes and thus induce a number of different effects on the DP system performance. The FMEA shall include at least the information specified in 303 to 306.

303 The FMEA shall clearly describe the design intent and the intended overall redundancy. The system operational mode(s) for DP operation(s) shall be described and prerequisites for achieving the required failure tolerance and redundancy shall be included.

304 A breakdown of the DP system, into functional blocks shall be made. The functions of each block shall be described. The breakdown shall be performed to such a level of detail that the functional interfaces between the functional blocks are shown.

305 A description of each physically and functionally independent item and the associated failure modes with their failure causes related to normal operational modes of the item shall be furnished.

306 A description of the effects of each failure mode alone on other items within the system and on the overall DP system shall be made.

Guidance note:

Description of FMEA systematic may be found in IEC Publication 60812 and IMO HSC Code, Annex 4.

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307 FMEA(s) and redundancy test program(s) shall be kept on board. The FMEA(s) and redundancy test program(s) shall at all times be updated to cover alterations to the DP system hardware or software.

Guidance note:

This is not to be understood as a requirement for an FMEA for the software. However the FMEA (or other relevant documentation) should include identification of the software version(s) installed, and documentation giving this information should be updated when new versions are installed.

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D 400 Operation manuals

401 Operation manuals according to Table D1 shall be kept on board. The manuals shall include information on the DP system, its installation and structure as well as operation and maintenance.

Guidance note:

These manuals cover the technical systems. Manuals for DP operations are not normally included and may be produced separately, according to operational requirements.

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402 Operation manuals shall at least cover the following:

— definitions of symbols and nomenclature
— functional description
— operating instructions, normal conditions
— operating instructions, failure conditions
— man and machine communication systems
— back-up systems
— monitoring
— maintenance and periodical performance test
— fault-finding procedures.

Functional description

— different functions including back-up functions shall be explained in detail.

Operating instructions

— description of the normal operation of the equipment, including adjustments and change of limit values, possible modes of presentation, starting and stopping systems
— description of operation of the DP system in different operational modes
— description of transition from one operational mode to another.

Fault-finding procedures

— description of fault symptoms with explanation and recommended corrective actions
— instructions for tracing faults back to functional blocks or systems.

E. Survey and Test upon Completion

E 100 General

101 Upon completion, the DP system shall be subjected to final tests. The program shall contain test procedures and acceptance criteria.

Guidance note:

It is assumed that prior to the DP-control system test, all systems and equipment included in the DP system have been tested according to main class. This should at least include:

- load test according to main class
- transfer of thruster control
- manual override of thruster control
- emergency stop
- communication systems

- main alarm system as for main class and **E0** (if applicable)
- integrated automation systems (if applicable).

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102 When deemed necessary by the attending surveyor, tests additional to those specified by the test program may be required.

E 200 Measuring system

201 All sensors, peripheral equipment, and reference systems shall be tested as part of the complete DP system.

202 Failures of sensors shall be simulated to check the alarm system and the switching logic.

E 300 Thrusters

301 Functional tests of control and alarm systems of each thruster shall be carried out.

302 All signals exchanged between each thruster and the DP system computers shall be checked.

303 The different modes of thruster control shall be tested. Proper operation of mode selection shall be verified.

E 400 UPS power supply

401 The capacity of the UPS batteries shall be tested, in addition to verification of the alarms required in Sec.5 E103.

E 500 Independent joystick thruster control system

501 All functions of the independent joystick system shall be tested.

E 600 Complete DP system test

601 The complete DP system shall be tested in all operational modes, with simulation of different failure conditions to try out switching modes, back-up systems and alarm systems.

Guidance note:
Different operational modes apply to the DP-control system, the power system, thruster systems etc.

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602 Change of command between the automatic DP-control system, independent joystick system and the individual thruster lever systems shall be demonstrated.

603 Position and heading keeping function shall be demonstrated on all possible combinations of position reference systems (PRS), and on each PRS as a single system. Position change function shall, if implemented, be demonstrated on each PRS as a single system. Selecting and de-selecting of PRS shall also be tested.

604 During sea trials the offset inputs for each position reference system and relevant sensors in the DP control system should be verified and demonstrated to the attending surveyor by setting out the offsets on drawings. It should be verified that these fit with the actual placing of the equipment.

605 Manual override, as required by Sec.3 D. and Sec.4 A402 shall be demonstrated during normal operation and failure conditions.

606 A duration test shall be carried out for at least 8 hours with the complete automatic system in operation. All failures shall be recorded and analysed.

Guidance note:
The time spent on DP functional tests may normally be deducted from the time required for the duration test.

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607 A high seas trial shall be carried out with full system operation for at least 2 hours. The weather conditions must be such that an average load level on the thrusters of 50% or more is achieved.

Guidance note:
The test described in 607 is dependent on weather conditions and may be omitted if satisfactory results were obtained from the test described in 606. Typically this will be required for DP-control systems of novel design.

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608 Emergency stop function shall be demonstrated.

609 For notations **DYNPOS-AUTR** and **DYNPOS-AUTRO**, alarm upon loop failure as required by Sec.4 A405 shall be demonstrated.

610 For the DYNPOS- series: For steering gears included under DP control a test shall be carried out verifying that maximum design temperature of actuator and all other steering gear components is not exceeded when the rudder is continuously put over from border to border within the limits set by the DP-control system, until temperature is stabilized.

Guidance note:

The test should be carried out with the propeller(s) running with an average propulsion thrust of not less than 50%, unless the control system ensures that rudder operation is performed at zero propulsion thrust only, upon which the test may be carried out without the propeller(s) running. The test may be carried out in any steering gear control mode. Number of steering gear pumps connected and rotation speed are to be the maximum allowed during DP operation.

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E 700 Redundancy tests for DYNPOS-AUTR, DYNPOS-AUTRO, DPS 2 and DPS 3

701 A selection of tests within each system analysed in the FMEA shall be carried out. Specific conclusions of the FMEA for the different systems shall be verified by tests when redundancy or independence is required.

Guidance note:

For **DYNPOS-AUTRO** and **DPS 3** this implies that loss of all systems in relevant fire zones should be tested.

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702 The test procedure for redundancy shall be based on the simulation of failures and shall be performed under as realistic conditions as practicable.

Guidance note:

It is understood that not all failure modes in all systems are possible to simulate. For such failure modes the acceptance of the system will be based on the theoretical FMEA, and hence the documentation analysis of these failure modes should be emphasized in the FMEA.

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703 For notation **DPS 2**: In case redundancy is based upon change-over of a single stern thruster as described in Sec.2 B202, then the functionality of the change over mechanism and availability of the thruster after single failure shall be demonstrated at sea-trials.

SECTION 2
GENERAL ARRANGEMENT

A. General

A 100 General

101 The general requirements for DP system design are presented in Table C1. Comparison of the main differences between the **DPS**-series and the **DYNPOS**-series of notations are presented in Table C2.

102 For **DYNPOS-AUTR**, **DYNPOS-AUTRO**, **DPS 2** and **DPS 3**, the design and level of redundancy employed in system arrangements shall be to the extent that the vessel maintains the ability to keep position after worst case failure(s).

Guidance note:

In general the **DYNPOS-** series of notations are requiring a higher degree of availability and robustness as compared to the **DPS-** series of notations. The detailed differences are outlined in the specific requirements given in these rules.

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B. Redundancy and Failure Modes

B 100 General

101 These requirements apply primarily to DP systems with **DYNPOS-AUTR**, **DYNPOS-AUTRO**, **DPS 2** and **DPS 3** notations. For **DYNPOS-AUTS**, **DYNPOS-AUT**, **DPS 0** and **DPS 1** notations, the redundancy requirements are according to main class, unless specific requirements are stated.

102 Based on the relevant single failure definition in B300, B400 and B500, worst case failures shall be determined in the FMEA. The consequence of the identified worst case failure(s) in terms of reduction in position and heading keeping ability shall be used as the criterion for the consequence analysis described in Sec.3 H200.

103 In order to meet the single failure criteria in B300, B400 and B500, redundancy of components will be necessary as follows:

— for notation **DYNPOS-AUTR**, redundancy of all active components and specified static components
— for notation **DPS 2**, redundancy of all active components and specified static components, except for possible exemptions based on the requirements in B202 and B400 with guidance notes.
— for notation **DYNPOS-AUTRO** and **DPS 3**, redundancy of all components and physical separation of the components.

B 200 Redundancy

201 For **DYNPOS-AUTR**, **DYNPOS-AUTRO** and **DPS 3**: The DP system shall be designed with redundancy. A position keeping ability shall be maintained without disruption upon any single failure. Full stop of thrusters and subsequent start-up of available thrusters is not considered an acceptable disruption.

Guidance note:

Component and system redundancy, in technical design and physical arrangement, should in principle be immediately available with the capacity required for the DP system to safely terminate the work in progress. The consequence analysis required in Sec.3 H200 will give an indication whether the position and heading can be maintained after a single failure.

The transfer to components or systems designed and arranged to provide redundancy, should be automatic and operator intervention should be avoided.

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202 For **DPS 2**: The requirement in 201 also applies to this notation, however it can be accepted that the system is dependent on change-over of a single stern thruster in order to maintain position keeping ability after loss of one redundancy group. The change over may be based on full stop and restart.

Guidance note:

A typical thruster configuration with two bow tunnel thrusters, one single stern tunnel thrusters and two pitch propellers with high-lift rudders, distributed between two redundancy groups will be accepted for **DPS 2** notation as long as the single stern tunnel thruster is arranged for being changed over between the two redundancy groups.

When such design are chosen as bases for the redundancy the possibility for hidden failures causing loss of the change-over function and the possibility for single failures rendering both redundancy groups must be carefully considered in order to minimize the possibility of such failures. Adequate evaluations are to be included in the FMEA

required in Sec1 D300.

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203 For **DYNPOS-AUTR**, **DYNPOS-AUTRO** and **DPS 3**: Redundancy shall be based upon running machinery. Automatic or manual intervention arranged to improve the position keeping ability after a failure will be accepted, but can not be considered by the consequence analysis. Automatic start of equipment may be accepted as contributing to redundancy only if their reliability and simplicity of operation is satisfactory so that they can be brought into operation before position and heading keeping performance is degraded.

Guidance note:

The redundancy requirements will not be considered as complied with if based upon start or restart of generators and/ or thrusters.

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204 For **DPS 2**: The requirement in 203 also applies to this notation; however change-over of a single stern thruster as described in 202 can be accepted.

B 300 Failure modes for notation DYNPOS-AUTR

301 The loss of position shall not be allowed to occur in the event of a single failure in any active component or system, nor in any static components as specified in these rules. Single failure criteria for **DYNPOS-AUTR** include:

— any active component or system
— static components as specified in the rules
— other static components which are not properly documented with respect to protection
— a single inadvertent act of operation. If such an act is reasonably probable
— systematic failures or faults that can be hidden until a new fault appears
— automatic interventions caused by external events, when found relevant (e.g. automatic action upon detection of gas).

Guidance note:

In order to reduce the probability of inadvertent acts, the following may be used:

- double action
- operation of two separate devices
- using screen based question pop-ups.

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302 The following components/systems are also considered to fail as consequence of a single failure:

— coolers
— filters
— motorised valves
— fuel oil service tanks and appurtenant piping supplying the engine(s)
— electrical and electronic equipment (this includes all onboard equipment and systems, e.g. any safety shut-down systems (spurious shut down), vessel control systems, etc…)
— When considering single failures of switchboards, the possibility of short-circuit of the bus-bars has to be considered

B 400 Failure modes for notation DPS 2

401 The single failure criteria shall be based on the same criteria as given for **DYNPOS-AUTR** as given in B300. However, based on proper FMEA, static components like coolers, filters and piping/tanks may be considered as not failing.

Guidance note:

Reference is made to IMO MSC/Circ.645 “Guidelines for vessels with dynamic positioning systems”, dated 6 June 1994 part 2.2.2:

For equipment class 2, a loss of position is not to occur in the event of a single fault in any active component or system. Normally static components will not be considered to fail where adequate protection from damage is demonstrated, and reliability is to the satisfaction of the Administration. Single failure criteria include:

.1 Any active component or system (generators, thrusters, switchboards, remote controlled valves, etc.).

.2 Any normally static component (cables, pipes, manual valves, etc.) which is not properly documented with respect to protection and reliability.

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B 500 Failure modes for notation DYNPOS-AUTRO and DPS 3

501 For class notation **DYNPOS-AUTRO** and **DPS 3** loss of position shall not be allowed to occur in the event of a single failure. In addition to the single failures listed under B300, the single failure criteria for **DYNPOS-AUTRO** and **DPS 3** include:

— all static components in the DP system
— all components in any watertight compartment, from fire and flooding
— all components in any one fire-subdivision, from fire or flooding (for cables, see also B701).

B 600 Independence

601 Independence shall take into account all technical functions. Use of shared components may be accepted if the reliability is sufficiently high and/or the effect of failure is sufficiently low.

Guidance note:

Particular attention should be paid to the redundancy and independence of ventilation and cooling facilities for equipment where temperature problems are anticipated. Such facilities may be considered with respect to the intended area of operation.

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B 700 Separation requirements for DYNPOS-AUTRO and DPS 3

701 Systems that form the designed redundancy requirement shall be separated by bulkheads and decks, fire-insulated by A-60 class division, and in addition, watertight if below the damage water line.

Guidance note 1:

The term “systems” shall be understood to also include single components, cabling, and piping.

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Guidance note 2:

If two A-0 bulkheads are arranged in areas with low fire risk, this may be accepted based on case-by-case approval.

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Guidance note 3:

Cabling to equipment that forms part of the designed redundancy requirement shall be separated by a-60 class division. When this is practically unavoidable, cables running together within an A-60 cable duct or equivalent fire-protection can be accepted. This alternative is not accepted in high fire risk areas, e.g. engine rooms and fuel treatment rooms. Cable connection boxes are not allowed in such ducts. This, as far as practicable, also applies to piping.

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Guidance note 4:

On open deck, cables in separate pipes that are separately routed may be accepted.

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Guidance note 5:

Suitable means should be provided to keep the ambient temperature inside of an A-60 cable duct within maximum temperature for the cables, when necessary, taking into account the temperature rise of cables under full power.

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Guidance note 6:

Watertight separation should also be considered in areas above the damage water line where large quantity of liquids may occur as a consequence of leakage. Special attention should be paid to areas where leakage of flammable liquids may occur. Identification and analysis of such failure modes shall be part of the FMEA.

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702 Watertight doors in A60 insulated bulkheads need not to be insulated. Reference is made to SOLAS Chapter. II-2 Reg. 9.4.2.4. In such cases the materials of the doors shall have melting points of not less than 950 °C and combustible materials shall be installed with a minimum distance of 450 mm from the door.

C. System Arrangement

C 100 General

101 The requirements for system arrangement for the different notations **DYNPOS-** series and the **DPS-** series are summarised in Table C1. Specific requirements for each subsystem are presented under the respective section headings.

Table C1 System arrangement

Subsystem or component			*Minimum requirements for class notations*			
			DYNPOS-AUTS	**DYNPOS-AUT**	**DYNPOS-AUTR**	**DYNPOS-AUTRO**
			DPS 0	**DPS 1**	**DPS 2**	**DPS 3**
Electrical power system	Electrical system		No-redundancy 3)	No-redundancy 3)	Redundancy in technical design	Redundancy in technical design and physical separation (separate compartments)
	Main switchboard		1 3)	1 3)	1	2 in separate compartments
	Bus-tie breaker		0 3)	0 3)	1	2, 1 breaker in each MSB
	Distribution system		Non-redundant 3)	Non-redundant 3)	Redundant	Redundant, through separate compartments
	Power management		No	No	**AUTR**: Yes **DPS 2**: No	**AUTRO**: Yes **DPS 3**: No
Thrusters	Arrangement of thrusters		No-redundancy	No-redundancy	Redundancy in technical design 4)	Redundancy in technical design and physical separation (separate compartments)
	Single levers for each thruster at main DP-control centre		Yes	Yes	Yes	Yes
Positioning control system	Automatic control; number of computer systems		1	1	2	2 + 1 in alternate control centre
	Manual control; independent joystick system with automatic heading control 2)		No	Yes	Yes	Yes
Sensors	Position reference systems		1	2	3	3 whereof 1 in alternate control centre
	External sensors	Wind	1	1	2	2 whereof 1 in alternate control centre
		Gyro compass	1	1	3 1)	3 1) whereof 1 in alternate control centre
		Vertical reference sensor (VRS)	1	1	**AUTR**: 3 **DPS 2**: 2 5)	3 whereof 1 in emergency control centre
UPS			0	1	2	2 + 1 in separate compartment
Printer			Yes	Yes	Yes	Yes
Alternate control centre for dynamic positioning control back-up unit			No	No	No	Yes

1) One of the three required gyros may be replaced by a heading device based upon another principle, as long as this heading device is type approved as a TDH (Transmitting Heading Device) as specified in IMO Res. MSC.116 (73). For notation **DYNPOS-AUTRO** and **DPS 3** this is not to be the gyro placed in the alternate control centre.

2) The heading input may be taken from any of the required gyro compasses.

3) When this is part of the ship normal electrical power system (i.e. used for normal ship systems, not only the DP system), then Pt.4 Ch.8 applies.

4) For **DPS 2** see also B202.

5) Where necessary for the correct functioning of position reference systems, at least three vertical reference sensors are to be provided for notation **DPS 2**. If the DP-control system can position the ship within the operating limits without VRS corrections, only 2 VRSs are required.

102 In general additional requirements to achieve higher availability and robustness will apply to the **DYNPOS-** series as compared to the **DPS**-series of notations. An overview of the main differences between the two series are summarised in Table C2 for quick reference. Specific requirements for each subsystem are presented under the respective section headings.

Table C2 Comparison table for the main differences between the DPS-series and the DYNPOS-series of notations.
(For complete overview of the differences the whole rule chapter must be considered.)

Technical item:	*Rule reference*	*Class notations*							
		DPS 0	**DYNPOS-**	**DPS 1**	**DYNPOS-**	**DPS 2**	**DYNPOS-AUTR**	**DPS 3**	**DYNPOS-**
Thruster configuration without stern thrusters, i.e. side thrust based on combination of rudders and propellers.	Sec.4 A201 & A301	Yes	No	Yes	No	No	No	No	No
Redundancy can be based upon change over of a single stern thruster.	Sec.2 B202 & 204	NA	NA	NA	NA	Yes	No	No	No
Additional monitoring requirements for steering gear.	Pt.4 Ch.14 Sec.1 E802	No	Yes	No	Yes	No	Yes	No	Yes
Power Management System required.	Sec.5 C101	No	No	No	No	No	Yes	No	Yes
Common static components may be accepted in redundant fuel oil, fresh water cooling and pneumatic systems.	Sec.6 B101 & Sec. 2 B401	NA	NA	NA	NA	Yes	No	No	No
Number of VRSs required.	Sec.2 C101 & Table C1	1	1	1	1	2*	3	3	3
Loop monitoring of emergency stop loops.	Sec.4 A405	No	No	No	No	No	Yes	No	Yes
HMI for position reference systems required outside DP-control system operator station(s).	Sec.3 E200	No	Yes	No	Yes	No	Yes	No	Yes
Main DP-control system shall include a joystick mode.	Sec.3 C107	No	No	No	Yes	No	Yes	No	Yes
ERN required.	Sec.1 A701 & Sec.7	No	Yes	No	Yes	No	Yes	No	Yes
Class entry from other class societies will be based on corresponding valid notation from loosing class society.	Sec.1 A600	Yes	No	Yes	No	Yes	No	Yes	No
Class entry from other class societies requires documentation approval and testing (functional and FMEA) at entry.	Sec.1 A500	No	Yes	No	Yes	No	Yes	No	Yes

NA = Not Applicable

* Where necessary for the correct functioning of position reference systems, at least three vertical reference sensors are to be provided for notation **DPS 2**. If the DP-control system can position the ship within the operating limits without VRS corrections, only 2 VRSs are required.

C 200 DP-control centre

201 The DP vessel shall have its DP-control centre designated for DP operations, where necessary information sources, such as indicators, displays, alarm panels, control panels and internal communication systems are installed. This equipment shall be arranged with easy access to the operator so that he/she does not need to change position when operating the control systems at the DP-control centre.

Guidance note 1:

Changing orientation will be accepted provided that the operator's view of the operating area will not change significantly. This implies that the operator should not be forced to turn his back to the operating area when changing between different control systems (DP-control system, manual thruster levers, and joystick control system).

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Guidance note 2:

This may be a dedicated part of the navigation bridge. System components that do not require frequent or immediate operator attention may be installed in alternate locations.

Systems that are required to be located at the DP-control centre includes: DP-control and independent joystick control operator stations, required position reference systems HMI, manual thruster levers, mode change systems, thruster emergency stops, internal communications.

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202 In case some of the installed equipment is portable it shall have its dedicated fixed location at each work station were it is intended to be used. The orientation of levers and indicators shall be in accordance with the vessel axis at all intended locations.

Guidance note:

One typical example of such equipment is portable joystick operator stations. It is assumed that the required equipment is placed at the DP-control centre during DP operations.

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203 The location of the DP-control centre shall be chosen to suit the main activity of the vessel.

204 The DP-control centre shall be arranged such that the DP operator has a good view of the vessel's exterior limits and the surrounding area.

205 For vessels with **DYNPOS-AUTRO** and **DPS 3** notation, an emergency DP-control centre shall be arranged for the location of the back-up DP-control system. This centre shall be separated by A-60 insulation from the main centre, and located with optimum ease of access from the main DP-control centre.

Guidance note:

The back-up control centre may be used as an alternative if the main DP-control centre is on fire. This should be considered when the location of the back-up control centre is chosen.

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206 The emergency DP-control centre shall be arranged with similar view to the vessel's exterior limits and the surrounding area as the main DP-control centre.

Guidance note:

For vessels that carry out DP operations were the DP operators view of the working area is not considered necessary, the view from the DP back-up control room may not be similar as from the main DP-control centre. This will apply e.g. for drilling units.

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C 300 Arrangement of positioning control systems

301 Notation **DYNPOS-AUTS** and **DPS 0** shall include an automatic control mode and an independent manual position control mode based on the control levers of each thruster.

302 Notation **DYNPOS-AUT** and **DPS 1** shall include:

— an automatic position control mode
— an independent joystick system with automatic heading control
— manual levers for each thruster.

Guidance note:

A joystick and a joystick mode included in the automatic positioning control system will not replace the requirement for an independent joystick system on notations where an independent joystick is required (**DYNPOS-AUT**, **DYNPOS-AUTR**, **DYNPOS-AUTRO**, **DPS 1**, **DPS 2** and **DPS 3**). Reference is made to Sec.3.

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303 Notation **DYNPOS-AUTR** and **DPS 2** shall include:

— an automatic position control mode consisting of at least two mutually independent control systems
— an independent joystick system with automatic heading control
— manual levers for each thruster.

304 Notation **DYNPOS-AUTRO** and **DPS 3** shall include:

— an automatic position control mode consisting of at least two mutually independent control systems
— an independent joystick system with automatic heading control
— manual levers for each thruster
— an automatic back-up positioning control system.

Guidance note:

This guidance note applies for 301 to 304. Use of combined mechanical levers for two or more thrusters may be accepted in accordance with the following principles:. For notations not requiring redundancy (**DYNPOS-AUTS, DYNPOS-AUT**, **DPS 0** and **DPS 1**) where the minimum requirement is one aft thruster and one forward thruster and one longitudinal thruster:

- at least one lever for thruster(s) providing transverse thrust forward
- at least one lever for thruster(s) providing transverse thrust aft
- at least one lever for thruster(s) providing longitudinal thrust.

For notations requiring redundancy (**DYNPOS-AUTR, DYNPOS-AUTRO**, **DPS 2** and **DPS 3**) where the minimum requirement is two aft thrusters, two forward thrusters and two longitudinal thrusters:

- at least two levers for thrusters providing transverse thrust forward
- at least two levers for thrusters providing transverse thrust aft

- at least two levers for thrusters providing longitudinal thrust.

As an example this means that two bow tunnel thrusters for notation **DYNPOS-AUT** can use a common HW lever. Another example is two bow tunnel thrusters and one bow azimuth thruster for **DYNPOS-AUTR** where the two bow tunnel thrusters can use a combined lever, while the bow azimuth lever is providing the required redundancy. However, on a **DYNPOS-AUTR** vessel where the redundancy is provided by two bow tunnel thrusters only, these can not use a common lever.

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305 For notations **DYNPOS-AUTRO** and **DPS 3:** The back-up system shall include an automatic position control mode, and shall be interfaced with a position reference, VRS and Gyro compass which shall be able to operate independently of the main system of 304.

C 400 Arrangement and layout of control panels

401 The information sources like displays, indicators, etc. shall provide information in a readily usable form.

Guidance note:
Reference is made to Pt.4 Ch.9 Sec.6.

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402 The operator shall be provided with immediate information of the effect of any actions, preferably with graphics.

403 Where applicable, feedback signals shall be displayed, not only the initial command.

404 Easy switch-over between operational modes shall be provided. Active mode shall be positively indicated.

405 Positive indications of the operational status of the different systems shall be given.

406 Indicators and controls shall be arranged in logical groups, and shall be co-ordinated with the geometry of the vessel, when this is relevant.

407 If control of a sub-system can be carried out from alternate control stations, positive indication of the station in charge shall be provided. When responsibility is transferred from one station to another, this shall be indicated.

Guidance note:
For control transfer arrangements, see Pt.4 Ch.9 Sec.3.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

408 Precautions shall be taken to avoid inadvertent operation of controls if this may result in a critical situation. Such precautions may be proper location of handles etc, recessed or covered switches, or logical requirements for operations.

409 Interlocks shall be arranged, if erroneous sequence of operation may lead to a critical situation or damage of equipment.

410 Controls and indicators placed on the navigation bridge shall be sufficiently illuminated to permit use at night without difficulty. Lights for such purposes shall be provided with dimming facilities.

C 500 Arrangement and layout of data communication links

501 When two or more thrusters and their manual controls are using the same data communication link, this link shall be arranged with redundancy in technical design.

502 The independent joystick may share the redundant communication link described in 501 with the manual control, but not with the DP-control system.

503 When the DP-control system uses a data communication link, this link shall be separate from the communication link(s) for manual control.

504 The communication link for the DP-control system shall be arranged with redundancy in technical design for **DYNPOS-AUTR** and **DPS 2**, and with redundancy in technical design and physical separation for **DYNPOS-AUTRO** and **DPS 3**.

505 For **DYNPOS-AUTR** no failure mode as specified in B300, for **DPS 2** as specified in B400, for **DYNPOS-AUTRO** and **DPS 3** as specified in B500, shall have an effect on the functionality of both networks.

Guidance note:
For **DYNPOS-AUTR** and **DPS 2** control cables and communication links belonging to different redundancy groups

should be separated as far as practically possible.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

D. Internal Communication

D 100 General

101 A two-way voice communication facility shall be provided between the DP-system control centre and the navigation bridge, ECR and relevant operation control centres.

102 The two-way voice communication system shall be supplied by a battery or an uninterruptible power supply as a stand-by power supply sufficient to operate the system for at least 30 minutes.

Guidance note:

Operational Control Centre (applicable to ships and offshore) is any on-board location where key members of the crew can communicate decisions in normal and emergency situations. Operation Control Centres may be: the bridge; the engine control room; a cargo control station; the dynamic positioning control centre, the centralised control room [CCR], the emergency dynamic positioning room, the driller's cabin, or any other location from where normal and emergency situations may be controlled.

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SECTION 3
CONTROL SYSTEMS

A. General Requirements

A 100 General

101 Thrusters and sensors used in DP operations shall have indications for:

— "running"
— "available for DP"
— "in DP operation".

B. Independent joystick control system

B 100 For Notations DYNPOS-AUT, DYNPOS-AUTR, DYNPOS-AUTRO, DPS 1, DPS 2 and DPS 3

101 It shall be possible to control the thrusters manually by a common joystick independent of the DP-control system. The independent joystick system shall include selectable automatic heading control.

102 Upon selection of control from the independent joystick control system enabling of the thrusters for joystick control shall be straightforward.

103 Any failure in the independent joystick control system shall initiate an alarm.

104 Any failure causing operator loss of control of the thrusters in the independent joystick control system shall freeze the thrust commands or set the thrust commands to zero. If the failure affects only a limited number of thrusters, the command to these affected thrusters may be set to zero, while keeping the other unaffected thrusters in joystick control.

C. DP-control system

C 100 General

101 The positioning control system shall perform self-check routines which shall bring the system to a stop, or automatically change-over to a standby (slave) system when critical failure conditions are detected. An alarm shall be initiated in case of failure.

102 Automatic control mode shall include control of position and heading. Set points for position and heading shall be independently selectable. It shall be possible to individually enter new position and heading set points in automatic control mode.

Guidance note:
The Rules does not give any specific acceptance criteria for vessel positioning performance. However, in moderate weather conditions and with a fully operational DP system the vessel should generally be able to demonstrate position keeping accuracy typically within a 3 meter radius and ± 1° of heading, given sufficient accurate position and heading reference input.

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103 When stopped, either by automatic or manual means the positioning control system shall set the thrust commands to zero.

104 Loss of one or multiple position reference system input and/or one or multiple sensor inputs shall not lead to significant change in thrust output.

Guidance note:
This includes the situation when DP-control system loses the last available position reference system input or sensor input. Position or heading drive off is not accepted after such failures.

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105 Upon recovery of position and heading reference input the DP-control system shall not automatically apply the last position or heading set point (set points before loss of input) when this is significantly different from the actual vessel position and/or heading. If any other set point than the actual vessel position and/or heading is applied then it is to be operator chosen.

106 When combining position reference systems and/or sensors in one unit were more than one function or

system can be lost upon one common failure, the consequence to the total system upon such a failure shall not exceed loss of any one non-combined unit in a minimum configuration as specified in Sec.2 Table C1. See also C306.

Guidance note:

Unit is to be understood as one piece of equipment (or one system) for each sensor and position reference system as required in Sec.2 Table C1. The rule is applicable when equipment/systems serving more than one such function are part of the DP system.

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107 For **DYNPOS-AUT**, **DYNPOS-AUTR** and **DYNPOS-AUTRO**: It shall be possible to control the thrusters manually by a common joystick in the main DP-control system from all operator stations. For **DYNPOS-AUTRO** the requirement also applies to the back-up DP-control system. The joystick mode shall include selectable automatic and manual heading control.

108 The DP-control centre is the main control station for equipment in the DP-control system which requires manual operation.

109 Sensors and/or reference systems may be shared with other systems provided failure in any of the other systems cannot spread to the DP system.

C 200 Additional for DYNPOS-AUTR, DYNPOS-AUTRO, DPS 2 and DPS 3

201 There shall be at least two automatic positioning control systems. These systems shall be arranged such that, after the occurrence of any single failure within the DP-control system, command output to a group of thrusters able to position the ship, can still be produced. For **DYNPOS-AUTRO** and **DPS 3** a single automatic back-up positioning control system shall also be arranged, as required in Sec.2 C205.

202 One of the main positioning control systems shall be selected as the online system. This selection shall be possible by manual means and by automatic action on failure of the online system. The other system(s) shall be in standby condition for auto or manual change over. It shall not be possible to automatically or manually select a controller which is not ready to assume command as the active controller.

203 Any failure of an online or standby positioning control system, sensor or positioning reference system selected, shall initiate an alarm.

Guidance note:

When more than two position reference systems and/or sensors inputs for the same parameters are used by the DP-control system then voting mechanisms should be utilised in order to: identify incorrect input, take correct action upon the failure in order to minimize the consequence of failure and alarm the operator.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

204 If two or more positioning control systems are in use, then self monitoring and comparison between systems shall be arranged, so that operation warnings can be produced upon detection of an unexpected difference in thrust command or position or heading. Such techniques shall not jeopardise the independence of each system or risk common mode failures.

205 The automatic transfer of online responsibility shall not cause thrust changes of such magnitude that it will be detrimental to the positioning of the vessel.

206 There shall be an identification of the status of the positioning control systems at the operator panel.

C 300 Additional for DYNPOS-AUTRO and DPS 3

301 If three positioning control computers are chosen for the main system, one of these may serve as the back-up-, provided that the necessary independence, as required for the back-up, is achieved.

302 There shall be at least one positioning reference system and one set of sensors connected to the back-up positioning control system, in such a way that their operation is ensured, independent of the condition of the main system.

Guidance note:

For wind sensors, GPS antennas, etc. and belonging cabling which cannot possibly be located in the same fire zone as the back-up control room, the independence and separation between main and back-up DP-control systems, position reference systems and sensors should be ensured by use of physical distance and separation as far as practically possible.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

303 The back-up positioning control system shall operate as a “hot back-up”, and shall, at all times, be ready to assume command, and maintain the position from the moment of assuming command.

304 The back-up positioning control system shall perform self check routines and communicate its status to the main system. An alarm shall be initiated if it fails or is not ready to take control.

305 The back-up positioning control system shall be capable of being activated by the operator, at the main DP-control centre and at the back-up centre. The nature of the switching shall be such that no single failure will render the back-up inoperable together with the main system.

306 The requirement given in C106 applies to both the required installation on the main DP-control centre and to the required installation on the back-up DP-control centre separately.

D. Thruster control mode selection

D 100 General

101 The thruster control modes, i.e. manual, independent joystick and automatic, shall be selectable by a simple device located in the DP-control centre. The control mode selector system may consist of a single selector switch or individual selectors for each thruster.

Guidance note:

For vessels with nautical notations reference is also made to Pt.6 Ch.8 Sec.6 for vessels with **NAUT-OC** or **NAUT-AW** notations and to Pt.6.Ch.20 Sec.4 for vessels with **NAUT-OSV** notations

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

102 The control mode selection system shall be arranged so that it is always possible to select manual controls after any single failure in the DP-control mode or in the independent joystick control mode, included failures in the thruster control mode system itself. This applies also to the control mode selection system intended to be used by the operator during normal operation.

103 For **DYNPOS-AUTR**, **DYNPOS-AUTRO**, **DPS 2** and **DPS 3** notations, mode selection systems shall not violate redundancy requirements.

Guidance note:

A common switch may be accepted as long as each thruster system is electrically independent.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

104 For **DYNPOS-AUTRO** and **DPS 3** the back-up DP-control system shall still be selectable even if the control mode selection system is damaged by fire.

Guidance note:

The mode selector may consist of a single switch also for **DYNPOS-AUTRO** and **DPS 3** even if this may be damaged by a fire, or other hazards, provided that the back-up DP-control system is still selectable.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

E. Positioning Reference Systems

E 100 General

101 Where more than one positioning reference system is required, at least two shall be based on different principles.

Guidance note:

For **DYNPOS-AUT** and **DPS 1** special considerations may be given where the use of two different measuring principles would not be practicable during DP operation. This means that e.g. two DGPS systems may be accepted for these notations.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

102 Positioning reference systems shall comply with the relevant main class rules for electrical, mechanical, and hydraulic components and subsystems.

103 Monitoring of positioning reference systems shall include alarms for electrical and mechanical functions, i.e. power, pressure, temperature as relevant.

104 Positioning reference systems shall provide new position data with a refresh rate and accuracy suitable for the intended DP operations.

Guidance note 1:

Systems that only produce new position data with long intervals relative to the response time of the DP vessel, will not be considered as positioning reference systems, as required in Sec.2 Table C1, unless it can be demonstrated that the performance is adequate in all operational modes and operational weather conditions.

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Guidance note 2:

The accuracy of the position reference data is generally to be within:

- a radius of 2% of water depth for bottom-based systems
- within a radius of 3 m for surface-based systems.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 3:

For satellite based systems, interface and necessary equipment for receiving differential correction signals is required installed.

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105 It shall be simple for the operator to establish the operational status of all position reference systems at any time. Which systems that is in operation, with data accepted or discarded, shall be clearly identified.

106 When data from several position references are combined into a mean positioning, by filtering techniques, the reference position of each shall, at least, be available at the operator's request.

107 When several systems are combined to provide a mean reference, the mean value used shall not change abruptly by one system being selected or deselected.

108 Failures in a positioning reference system that might give degraded quality, loss of position signal or loss of redundancy shall initiate an alarm.

109 Limit alarms shall be provided for systems, which have defined range limits.

110 If a positioning reference system can freeze or otherwise produce corrupt data output, a method shall be provided to enable rejection of the data.

111 When more than one positioning reference system is required, then each shall be independent with respect to signal transmission and interfaces.

Guidance note 1:

In order for two satellite based systems to be considered as independent it must be possible to set them up with different differential correction signals.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

For **DYNPOS-AUTR**, **DYNPOS-AUTRO**, **DPS 2** and **DPS 3**:
Interfaces to the dynamic positioning computer system shall be in accordance with the overall redundancy requirement. Systems should be equally distributed between the redundant groups, and so arranged that systems based on the same principle are equally distributed between the redundant groups.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

112 Power supply to the position reference systems shall be from UPS (except for notation **DYNPOS-AUTS** and **DPS 0**). For **DYNPOS-AUTR**, **DYNPOS-AUTRO**, **DPS 2** and **DPS 3** arrangement of power supplies shall be in accordance with the overall redundancy requirement.

Guidance note 1:

For **DYNPOS-AUTR**, **DYNPOS-AUTRO**, **DPS 2** and **DPS 3**:
Systems power supply should be equally distributed between the UPSs, and so arranged that power supply to systems based on the same principle are equally distributed between the UPSs.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

Power supply to units providing correction signal to DGPSs must follow the same redundant distribution principle.

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Guidance note 3:

The requirement for UPS supply for position reference systems is not applicable for parts of the systems which are not actively in use during positioning. E.g. Hydro acoustic positioning reference system transducer hoist systems or taught wire derrick control systems.

For taut wire systems, the heave compensation system need not be powered by UPS supply as long as at least one other position reference system is available and powered from UPS.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

113 For **DYNPOS-AUTRO** and **DPS 3** at least one of the positioning reference systems shall be connected directly to the back-up positioning control system and separated by A-60 class division, from the other positioning reference systems.

E 200 Position reference system user interface for the DYNPOS- series

201 For **DYNPOS-AUTS**: The required position reference system' HMI is to be independent of the DP-control system. This HMI is to be placed at the DP-control centre in view of the DP operator.

202 For **DYNPOS-AUT**: At least one of the required position reference systems' HMI is to be independent of the DP-control system. This HMI is to be placed at the DP-control centre in view of the DP operator.

203 For **DYNPOS-AUTR** and **DYNPOS-AUTRO**: At least two of the positioning reference systems' HMIs are to be independent of the DP-control system. These HMIs are to be placed at the main DP-control centre in view of the DP operator. The two reference systems fulfilling this requirement shall have their power supply from different UPSs. For **DYNPOS-AUTRO** one of these systems shall be the system required to be placed at the back-up DP-control centre.

Guidance note:

For **DYNPOS-AUTRO** this implies that if only one reference system placed on the main DP-control centre is equipped with separate HMI, the system placed in the backup control centre must have a slave HMI on the main DP-control centre and be capable of being taken in to use by the main DP-control system.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

F. Sensors

F 100 General

101 Sensors shall provide new data with a refresh rate and accuracy suitable for the intended DP operations.

Guidance note:

Gyros should be type approved as a TDH (Transmitting Heading Device) as specified in IMO Res. MSC.116 (73).

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

102 When more than one sensor for a specific function is required, then each shall be independent with respect to power, signal transmission, and interfaces. For **DYNPOS-AUTR**, **DYNPOS-AUTRO**, **DPS 2** and **DPS 3** arrangement of power supply shall be in accordance with the overall redundancy requirement. For notations where no or only UPS is required power may be taken from the same distribution/UPS.

103 Monitoring of sensors shall include alarms for electrical and mechanical functions, i.e. power, pressure, temperature as relevant.

104 It shall be simple for the operator to establish the operational status of all sensors at any time. Which systems that is in operation, with data accepted or discarded, shall be clearly identified. Sensor data shall be available at the operator's request.

105 When failure of a sensor is detected, an alarm shall be initiated even if the sensor is in a standby or offline use at the time of failure.

Guidance note:

During DP operations, it is important that permanent failures of any sensor, whether it is being used or not at the time, is brought to the attention of the operator. Temporary trouble of an operational nature, e.g. disturbance of acoustic systems, out of range warnings, in offline or standby sensors do not need to initiate an alarm.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

106 For the notation **DYNPOS-AUTRO** and **DPS 3** the sensors connected directly to the back-up positioning control system shall in general be installed in the same A-60 fire zone as the back-up DP-control system.

G. Display Units

G 100 General

101 The display unit shall present a position plot including the location of the vessel relative to the reference sources. The plot may be vessel relative, or a true motion presentation.

102 For positioning control systems, designed with redundancy, there shall be at least two DP-control system operator stations.

103 If the display is used for presentation of warnings or alarms, these shall have priority over other information and not be inhibited by other data currently being displayed.

104 The display units shall support the operator with necessary information in order to ensure safe operation in all modes.

H. Monitoring

H 100 General

101 The DP-control centre shall receive alarms and warnings reflecting the status of the DP system.

Guidance note:

The alarms from power and thruster systems may be group alarms for each prime mover, generator, or thruster, as generated by the general alarm system of the vessel.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

102 If the alarms in the DP-control centre are slave signals of other alarm systems, there shall be a local acknowledgement and silencing device.

103 The silencing device in 102 shall not cause inhibiting of new alarms.

104 An alarm shall be initiated when the vessel exceeds pre-set position and heading limits.

105 Any failure of an online or standby positioning control system, sensor or positioning reference system selected, shall initiate an alarm.

106 The alarms to be presented in the DP-control centre shall normally be limited to functions relevant to DP operation.

H 200 Consequence analysis for DYNPOS-AUTR, DYNPOS-AUTRO, DPS 2 and DPS 3 notations

201 The DP-control systems shall perform an analysis of the ability to maintain position after worst case failures. An alarm shall be initiated, with a maximum delay of 5 minutes, when a failure will cause loss of position in the prevailing weather conditions.

Guidance note:

This analysis should verify that the thrusters remaining in operation after the worst case failure can generate the same resultant thruster force and moment as required before the failure.

The analysis should consider the average power and thrust consumption. Brief, dynamic effects should be removed by filtering techniques.

For operations which will take a long time to safely terminate, the consequence analysis should include a function which simulates the thrust and power remaining after the worse case failure, based on manual input of weather trend.

Typically, the worst case failure will be loss of one complete switchboard, one engine room, or a group of thrusters that are subject to a common failure mode.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

202 The consequence analysis shall be repeated automatically at pre-set intervals. The operator shall be able to monitor that the analysis is in progress.

203 The analysis shall have a lower priority than the control and alarm tasks. If the analysis is not completed within 2 minutes then an alarm shall be initiated.

SECTION 4
THRUSTER SYSTEMS

A. General

A 100 Rule application

101 Thrusters shall comply with main class requirements.

102 The thrusters shall be designed as "dynamic positioning thrusters" or "propulsion thrusters" according to Pt.4 Ch.5. The thruster systems shall be designed for continuous operation.

Guidance note:
Generally no restrictions should be put on the starting intervals of electrical machines. If required, the arrangement is subject to approval in each case.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

103 When the main propulsion propellers are included under DP-control, they shall be considered as thrusters and all relevant functional requirements of these rules will apply.

104 When the main steering system is included under DP-control, the steering gear shall be designed for continuous operation.

Guidance note:
For the **DYNPOS-** series: Additional requirements for steering gear under DP control, see also Pt.4 Ch.14.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

A 200 Thruster configuration for the DYNPOS- series:

201 The thruster configuration shall include thrust units which together will produce, at any time, transverse and longitudinal thrust, and a yawing moment. When intact, the DP system shall be able to produce such combined forces without contribution from transverse thrust generated by the combined use of propellers and rudders.

Guidance note 1:
Transverse thrust generated by the combined use of propellers and rudders will not be considered as "thrust units" in this context. Reference is also made to the definition in Sec.1 B104 with corresponding guidance note.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:
The rules do not specify the number or size of thrusters to make up the configuration. The position holding capability resulting from a chosen configuration will be documented by the "environmental regularity numbers" (**ern**).

Thrusters should be located with consideration of effects, which will reduce their efficiency, e.g. thruster-hull, and thruster-thruster interaction, and shallow-immersion effects.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

202 When a redundant thrusters configuration is required, there shall be transverse and longitudinal thrust, and yawing moment after any single failure.

Guidance note:
Transverse thrust generated by the combined use of propellers and rudders may upon special consideration, be accepted as equivalent to a side thruster for back-up purposes, and must in such cases be proven on trials. Transverse thrust generated by the combined use of propellers and rudders will not be taken into consideration when calculating the first **ern** number

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

A 300 Thruster configuration for the DPS- series:

301 The thruster configuration shall include thrust units which together will produce, at any time, transverse and longitudinal thrust, and a yawing moment.

Guidance note 1:
In this context transverse thrust generated by the combined use of propellers and rudders may be accepted as bases for normal DP operations. Reference is made to Sec.2 B202, B203 and B204.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:
The rules do not specify the number or size of thrusters to make up the configuration.

Thrusters should be located with consideration of effects, which will reduce their efficiency, e.g. thruster-hull, and thruster-thruster interaction, and shallow-immersion effects.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

302 When a redundant thrusters configuration is required, there shall be transverse and longitudinal thrust, and yawing moment after any single failure.

Guidance note:
Reference is made to Sec.2 B202 with corresponding guidance note.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

A 400 Thruster control

401 Individual and separate manual follow up control of each thruster shall be arranged in the DP-control centre. The manual control shall be independent of the DP-control system and include azimuth and thrust (e.g. pitch and/or r.p.m.) control, as relevant. See also Sec.2 C300 with corresponding guidance notes.

Guidance note:
For vessels with notation **DYNPOS-AUTRO** or **DPS 3**, manual control will not be required for the emergency DP-control centre.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

402 Manual thruster control mode shall be available at all times, also during all failure conditions in dynamic positioning or independent joystick control systems. Manual thruster control mode is not required to be available upon failures modes where the bridge needs to be evacuated.

Guidance note:
Manual thruster control mode shall be understood as manual control of main propulsion, dynamic positioning thrusters and rudders.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

403 A single failure in the thruster control system shall neither cause significant increase in thrust output nor make the thruster rotate.

Guidance note 1:
This also applies to rudders when the rudders are under DP-control. See Pt.3 Ch.3 Sec.2.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:
It may be accepted that a thruster rotates, if at the same time the thrust output is set to zero.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

404 It shall be possible to stop each thrusters individually from the main DP-control centre by means independent of the positioning and thruster control systems. This emergency stop shall be arranged with separate cables for each thruster.

For the **DPS**-series of notations: It is accepted that emergency stop of main propeller can cause stop of other thrusters. For **DPS 2** and **DPS 3** notations thrusters stopping as a consequence of emergency stop of a main propeller must belong to the same redundancy group as the main propeller.

Guidance note 1:
For vessels with notation **DYNPOS-AUTRO** or **DPS 3**, emergency stop will not be required at the back-up DP-control centre.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:
For the **DYNPOS**-series of class notations, this imply that Power Take Off (PTO)-step up gears for alternators powering other thrusters in the DP system, must be arranged on the primary side of the propulsion clutch, see Figure 1.

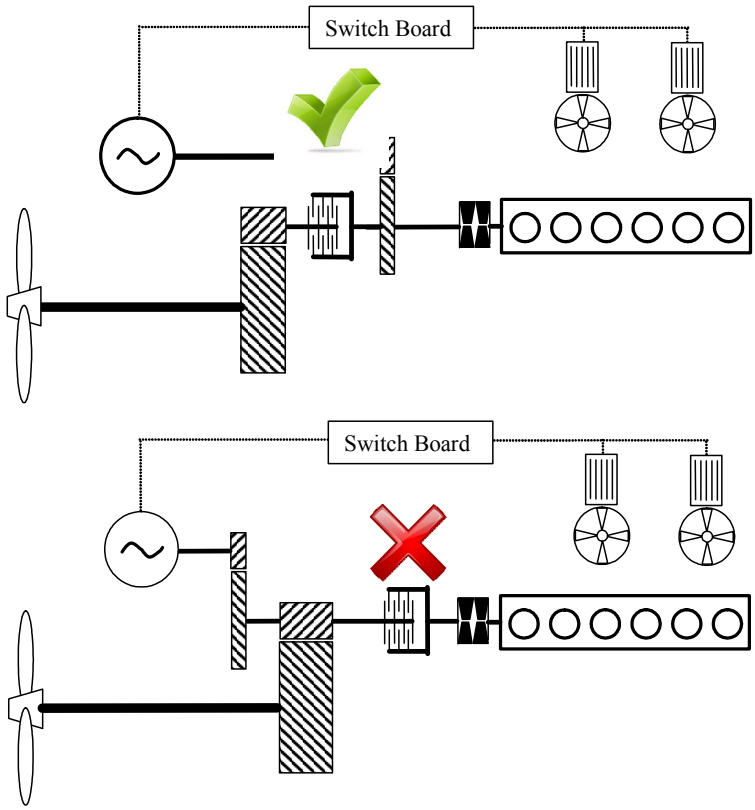

Fig. 1
Acceptable and unacceptable clutch arrangement for DYNPOS.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

405 For notations **DYNPOS-AUTR** and **DYNPOS-AUTRO**, an alarm shall be initiated upon loop failure, i.e. broken connections or short-circuit, in the emergency stop system.

Guidance note:
For emergency stop arrangement for other notations, see Pt.4 Ch.8 Sec.2.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

A 500 Indication

501 Running and stop, pitch and r.p.m. and azimuth for each thruster shall be displayed at the DP-control centre.

502 The displays of 501 shall be continuously available. At least pitch and r.p.m. and azimuth displays shall be readable from the normal position of the DP operator. Slave panel meters shall be installed if the displays are not readable from the normal position of DP operator.

503 The indication shall not be common with the feedback used by the closed-loop control system.

504 Azimuth thruster used for steering, additional monitoring shall be arranged as required in Pt.4 Ch.14 Sec.1 Table E1.

SECTION 5
POWER SYSTEMS

A. General

A 100 General

101 The power systems shall comply with the relevant rules for main class, for all class notations in this chapter. For **DYNPOS-AUTR**, **DYNPOS-AUTRO**, **DPS 2** and **DPS 3** additional requirements will apply in regard to redundancy and with respect to maximum single failure, as specified for each notation. See Sec.2 for the definition of a single failure.

Guidance note:

IMO MSC/Circ.645 "Guidelines for vessels with dynamic positioning systems"

Item 3.2.3:

"For equipment class 2, the power system should be divisible into two or more systems such that in the event of failure of one system at least one other system will remain in operation. The power system may be run as one system during operation, but should be arranged by bus-tie breakers to separate automatically upon failures which could be transferred from one system to another, including overloading and short-circuits."

Item 3.2.4:

"For equipment class 3, the power system should be divisible into two or more systems such that in the event of failure of one system, at least one other system will remain in operation. The divided power system should be located in different spaces separated by A-60 class division. Where the power systems are located below the operational waterline, the separation should also be watertight. Bus-tie breakers should be open during class 3 operations unless equivalent integrity of power operation can be accepted according to 3.1.3".

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102 Means shall be implemented in order to prevent overloading of the power plant, e.g. by use of interlocks, thrust limitations or other means. Means shall also be implemented to prevent reactive overload.

B. Number and capacity of generators

B 100 General

101 For notation **DYNPOS-AUTS**, **DYNPOS-AUT**, **DPS 0** and **DPS 1** the generator capacity shall be in accordance with the main class.

Guidance note:

It is accepted that all generators are in operation to run all thrusters 100%.

Particular attention should be paid to starting conditions of thruster motors, especially with one generator out of service. The effect of voltage drop during starting periods may cause under-voltage trips of control circuits, and main class requirements must be observed. When starting thrusters on dedicated generators with no other loads connected which would be affected by voltage deviations, voltage drop in excess of rules' limits may be accepted.

The high reactive load demands, which may occur in DP thruster operation should be considered when selecting number and type of generators, further, the dynamic load variations for diesel engines should be taken into consideration.

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102 For **DYNPOS-AUTR**, **DYNPOS-AUTRO**, **DPS 2** and **DPS 3** the number of generators shall comply with the redundancy requirements as defined in the single failure criteria in Sec.2.

C. Power management

C 100 General

101 For **DYNPOS-AUTR** and **DYNPOS-AUTRO**: An automatic power management system shall be arranged, operating with both open and closed bus-bar breakers. This system shall be capable of performing the following functions:

— load dependent starting of additional generators
— block starting of large consumers when there is not adequate running generator capacity, and to start up generators as required, and hence to permit requested consumer start to proceed
— if load dependent stop of running generators is provided, facilities for disconnection of this function shall be arranged.

Guidance note:

Exemption from the requirement for an automatic power management system (PMS) may be granted, provided that functions for blackout prevention, tripping of non-essential consumers and block starting of large consumers are taken care of by other systems. Exemptions will be given to systems where PMS will add few or no benefits.

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102 A failure in a power management system shall not cause alteration to the power generation, and shall initiate an alarm in the main DP-control centre.

Guidance note:

Special attention should be paid to ensure redundant distribution (for **DYNPOS-AUTRO** and **DPS 3** also separation) of I/O signals so that effects of single failures in the PMS system will be in accordance with the overall redundancy requirements.

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103 It shall be possible to operate the switchboards in manual as required for the main class, with the power management system disconnected.

104 Overload, caused by the stopping of one or more generators, shall not create a black-out.

Guidance note:

Reduction in thruster load, i.e. pitch or speed reductions, should be introduced to prevent blackout and enable standby generators to come online. If this function is taken care of by the positioning control system, the function shall be co-ordinated with the power management system.

Load reductions should preferably be achieved through the tripping of unimportant consumers, and the requirement does not exempt such means. But, it is common that the relative load proportions will require thruster load reduction, in order to effectively reduce overload situations.

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105 When generators in different redundancy groups are running in parallel, as accepted for **DYNPOS-AUTR** and **DPS 2**, this will introduce the possibility that a single failure may propagate between systems. In such cases it is required that protective measures are implemented in the system in order to ensure the required integrity between the redundancy groups. Analysis of relevant failure modes shall be addressed in the FMEA.

Guidance note 1:

Ref. A101 and IMO MSC/Circ.645 "Guidelines for vessels with dynamic positioning systems" item 3.2.4: For **DYNPOS-AUTRO** and **DPS 3**: Bus-tie breakers providing redundancy should be open during class 3 operations.

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Guidance note 2:

Examples of failure modes that typically will be relevant are:

- governor failure
- AVR failure
- under voltage, e.g. as a consequence of short circuit (, and system "ride through" capability)
- overvoltage
- short circuits and over-current
- earth failures
- failures related to load sharing (active and reactive load, reverse power, communication, I/O…)
- failures in the power management system.

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D. Main and distribution switchboards arrangement

D 100 General

101 For **DYNPOS-AUTS**, **DYNPOS-AUT**, **DPS 0** and **DPS 1** notations the main class requirements are applicable and adequate.

D 200 Additional for notation DYNPOS-AUTR, DYNPOS-AUTRO, DPS 2 and DPS 3

201 The switchboard arrangement shall be such that no single failure will give a total black-out. For **DYNPOS-AUTR** and **DPS 2** this means equipment failures. For **DYNPOS-AUTRO** and **DPS 3** this means failure of all equipment in any fire and/or watertight subdivision.

202 When considering single failures of switchboards, the possibility of short-circuit of the bus-bars has to be considered.

203 A main bus-bar system consisting of at least two sections, with bus-tie breaker(s) or inter-connector

breaker(s), shall be arranged. When the system is designed to be operated with closed bus-tie breaker in DP mode, this breaker shall be a circuit breaker capable of breaking the maximum short circuit current in the system, and which is selective in relation to generator breakers to avoid total loss of main power (black-out).

204 For **DYNPOS-AUTR** and **DPS 2** it is accepted that the bus-bar sections are arranged in one switchboard. For **DYNPOS-AUTRO** and **DPS 3** it is required that each bus-bar section is isolated from the other(s) by watertight A-60 partitions according to Sec.2 B500. There shall be a bus-tie breaker on each side of this partition.

205 Bus-bar control and protection systems shall be designed to work with both open and closed bus-tie breakers.

206 The online power reserve, i.e. the difference between online generator capacity and generated power at any time, shall be displayed in the DP-control centre. The indication shall be continuously available. For split-bus power arrangements, indications shall be provided for individual bus sections.

E. Control System Power Supply (applies to DYNPOS-AUT, DYNPOS-AUTR, DYNPOS-AUTRO, DPS 1, DPS 2 and DPS 3)

E 100 General

101 The controllers and measuring systems shall be powered from uninterruptible power supplies, (UPS). The arrangement and number of UPS shall be in accordance with Table C1 in Sec.2.

102 The power supply for the independent joystick system shall be independent of the DP-control system UPSs.

103 The battery installed for each UPS shall be able to provide output power at maximum load for 30 minutes after loss of charger input power. Loss of charger input power and UPS on bypass power shall initiate an alarm in the DP-control system.

Guidance note:
Reference is given to main electrical rules. See Pt.4 Ch.8 Sec.7 for relevant rules for UPSs.

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104 For **DYNPOS-AUTR** and **DPS 2**: The input power supply to the redundant UPSs shall be derived from different sides of the main switchboard.

105 For **DYNPOS-AUTRO** and **DPS 3**: The input power supply to the redundant UPSs for the main DP-control system shall be derived from different sides of the main switchboard.

SECTION 6
AUXILIARY SYSTEMS

A. For DYNPOS-AUTR, DYNPOS-AUTRO and DPS 3

A 100 General

101 The auxiliary systems, serving machinery, thrusters, electrical components and all other systems and components necessary for supplying the DP system with power and/or thrust, shall be arranged in accordance with the redundancy requirements as given for these notations. See Sec.2 B.

102 Failure shall be considered for all active components as specified in Sec.2 B.

103 For **DYNPOS-AUTR**: Unless otherwise specified in these rules, fixed piping may be shared by components designed with redundancy. See A200 and Sec.2 B300.

104 For **DYNPOS-AUTRO** and **DPS 3**: Piping for all systems relevant for DP shall be arranged with A-60 separation for systems providing required redundancy. Cross-over pipes are acceptable provided these can be closed at both sides of separating bulkheads. Ventilation ducts shall not have cross-over facilities.

A 200 Specific requirements for fuel oil

201 The fuel oil supply shall be arranged with full separation between systems providing required redundancy, in view of the risk of fuel oil contamination.

202 There shall be at least one service tank serving each dedicated system. Cross-over facilities may be arranged, but must, if arranged, be kept closed in normal operation.

203 If the fuel system requires heating, then the heating system shall be designed with the appropriate level of redundancy unless fuel which do not require heating, are arranged so that the requirement in 201 is fulfilled. Separation by A-60 class division is required for **DYNPOS-AUTRO** and **DPS 3**, see A104.

A 300 Specific requirements for fresh water cooling

301 For **DYNPOS-AUTR**: Fresh water cooling systems providing the required redundancy shall be arranged as separated systems, in view of the risk of severe loss of water or accumulation of gas due to leakage.

Guidance note:

Redundant systems for air conditioning and control of ambient temperature, e.g. air condition units, chillers and HVAC, may share common piping for notation **DYNPOS-AUTR**.

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A 400 Specific requirements for pneumatic systems

401 For **DYNPOS-AUTR**: Pneumatic systems providing the required redundancy shall be arranged as separated systems, in view of the risk of leakage.

B. Auxiliary Systems for DPS 2

B 100 General

101 For class notation **DPS 2** the auxiliary systems shall be based on the same requirements as given for **DYNPOS-AUTR** in A. above. However, based on proper FMEA, static components like coolers, filters and piping/tanks may be considered as not failing, and hence common static components may be accepted in fuel oil systems, fresh water cooling systems and pneumatic systems.

Guidance note 1:

Reference is made to IMO MSC/Circ.645 “Guidelines for vessels with dynamic positioning systems”, part 2.2.2, dated 6 June 1994:

For equipment class 2, a loss of position is not to occur in the event of a single fault in any active component or system. Normally static components will not be considered to fail where adequate protection from damage is demonstrated, and reliability is to the satisfaction of the Administration. Single failure criteria include:

.1 Any active component or system (generators, thrusters, switchboards, remote controlled valves, etc.).

.2 Any normally static component (cables, pipes, manual valves, etc.) which is not properly documented with respect to protection and reliability.

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Guidance note 2:
Reference is made to Sec.2 B400.

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Guidance note 3:
Main class requirements to auxiliary systems are found in Pt.4 Ch.6.

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SECTION 7
ENVIRONMENTAL REGULARITY NUMBERS
(THIS SECTION APPLIES TO THE DYNPOS- SERIES)

A. Concept Description

A 100 General

101 The position keeping ability of the vessel shall be calculated according to the concept of the environmental regularity numbers, hereafter called **ern**.

Guidance note:

Vessels that in their operation adjust the heading automatically to give minimum environmental forces, may be exempted.

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Guidance note:

The **ern** represents the static balance of environmental forces and thruster output. **ern** is quantified with its basis in the weather statistics of a chosen location in the North Sea, the location of the weather ship "M".

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102 The environmental forces caused by wind, waves, and current shall be calculated by recognised methods. Alternatively, environmental forces established by model testing will be considered.

Table A1 ern wind and wave statistics

$P\ (H_s)$	$H_s(m)$	$V_1\ (m/s)$
2.5	0.66	1.40
5.0	0.79	2.19
10.0	1.0	3.30
20.0	1.35	4.95
30.0	1.7	6.21
40.0	1.9	7.48
50.0	2.3	8.74
60.0	2.6	10.01
70.0	3.0	11.39
80.0	3.5	13.11
90.0	4.2	15.53
95.0	4.9	17.60
97.5	5.3	19.32
98.0	5.6	19.90
98.5	5.8	20.59
99.0	6.1	21.51

The relationship between significant wave height H_S and 1 minute average wind speed V_1 shall be used for computation of the **ern**.
$P(H_S)$ is based on data from the reference ocean area.

103 The **ern** shall assume coincident forces of wind, waves, and current. Wind and waves shall be considered at magnitudes of equal probability, see Table A1.

The current shall be taken as a constant value of 0.75 m/s, without differentiation of wind-induced and tidal components.

104 The **ern** is evaluated at the incidence angle of forces which causes the maximum load on the vessel.

Guidance note:

The **ern** is intended to reflect a «worst case situation», which for monohull vessels normally will be the situation with the weather on the beam. The **ern** will be based on this situation regardless of the vessel's ability to select other headings in operation.

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105 The **ern** is evaluated for a balance of forces while the vessel is maintaining both position and heading.

Thus there shall at the same time be a balance of forces and a balance of moments, i.e. including all moments generated by the thrusters, and those caused by environmental forces.

106 The format of the **ern** shall be a series of 4 numbers, ranging from 0 to 99. The **ern** will be given in the register as information: **ern (a, b, c, d)**.

Where:

— **a** : The first number shall represent optimal use of all thrusters
— **b** : The second number shall represent minimum effect of single-thruster failure
— **c** : The third figure shall represent the maximum effect single-thruster failure
— **d** : The fourth number shall represent the effect of the worst case single failure(s)

Guidance note:

The fourth number **d** shall represent the case where stop of the redundancy group resulting in the largest reduction of position and heading keeping capacity has occurred. For notations not requiring redundancy, the fourth number **d** will be given as zero, 0.

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107 The **ern** shall be based upon the thrust output that is under control, in the most efficient control mode.

Guidance note:

The side thrust balance may be optimized by generating a suitable yawing moment. An example of this is using the main propellers for generating a moment couple with opposing thrust outputs. This is accepted for the **ern**, provided that the control is executed automatically, with satisfactory balance of longitudinal thrust.

Side force generated by the combined use of a rudder and a propeller will be taken into account for the **ern** when this control mode is included in the DP-control system, except for the first number. See Sec.4.

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