RULES FOR
CLASSIFICATION OF

SHIPS

NEWBUILDINGS

SPECIAL EQUIPMENT AND SYSTEMS
ADDITIONAL CLASS

PART 6 CHAPTER 7

DYNAMIC POSITIONING SYSTEMS

JANUARY 2008

CONTENTS PAGE

DET NORSKE VERITAS

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CHANGES IN THE RULES

General.

The present edition of the rules includes additions and amendments decided by the Board as of December 2007, and supersedes the January 2004 edition of the same chapter, including later amendments.

The rule changes come into force as indicated below.

This chapter is valid until superseded by a revised chapter. Supplements will not be issued except for an updated list of minor amendments and corrections presented in Pt.0 Ch.1 Sec.3. Pt.0 Ch.1 is normally revised in January and July each year.

Revised chapters will be forwarded to all subscribers to the rules. Buyers of reprints are advised to check the updated list of rule chapters printed in Pt.0 Ch.1 Sec.1 to ensure that the chapter is current.

Main changes coming into force 1 July 2008

- **General**

The following amendments have been undertaken:

— A new optional qualifier **(A)** requiring full annual survey scope equal to 5-yearly renewals for class notations **DYNPOS-AUTR** and **DYNPOS-AUTRO** has been introduced, i.e.:
  — full scope including technical condition, functional verification, failure response and FMEA testing
  — a DP sea trial is to be performed.

— Separation requirements concerning pneumatic systems have been introduced for notation **DYNPOS-AUTR**.

— For **DYNPOS-AUT**, the requirement for two different measuring principles for the position reference systems may (upon special considerations) be waived when considered not practicable during DP-operation.

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.

Comments to the rules may be sent by e-mail to *rules@dnv.com*
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SECTION 1
GENERAL REQUIREMENTS

A. The Rules

A 100 Rule application

101 The rules in this chapter apply to systems for dynamic positioning of ships and mobile offshore units, termed hereafter as, vessels. 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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102 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.

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A 200 Class notations

201 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	*Scope*
DYNPOS-AUTS	dynamic positioning system without redundancy
DYNPOS-AUT	dynamic positioning system with an independent joystick system back-up and a position reference back-up
DYNPOS-AUTR	dynamic positioning system with redundancy in technical design and with an independent joystick system back-up
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

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:

DNV class notation	*IMO equipment class*
DYNPOS-AUTS	Not applicable
DYNPOS-AUT	IMO equipment class 1
DYNPOS-AUTR	IMO equipment class 2
DYNPOS-AUTRO	IMO equipment class 3

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

Guidance note:

Example of notation: **DYNPOS-AUTR(A)**

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A 300 Environmental regularity number, ern

301 Vessels with one of the class notations listed in 201 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)** where **a, b, c** are integer numbers reflecting probable regularity for keeping position in a defined area. See Sec.6 for details on the **ern** concept.

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 F200.

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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 system (computer system)
— 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:

In this context transverse force generated by the combined use of propellers and rudders will not be considered. For **DYNPOS-**

AUTR and **DYNPOS-AUTRO** thruster force may include propulsion and steering (rudder) forces for back-up purposes only, see Sec.4.

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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** requirements, the definition of single failure has no exceptions, and shall include incidents of fire and flooding, and all technical breakdowns 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** 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 non-moving 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.

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

113 *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.

114 *Worst case failure:* Failure modes related to the class notations as follows:

— for **DYNPOS-AUTS** and **DYNPOS-AUT**, 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 B301
— for **DYNPOS-AUTRO**, loss of position is not to occur in the event of a single failure as specified in Sec.2 B302.

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.

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 200 to 700, as appropriate.

D 200 ern calculation

201 Calculation of the environmental regularity number evaluation, **ern**, shall be submitted for approval. The position holding performance shall be quantified according to the concept for **ern**, see Sec.6.

D 300 Instrumentation and automation

301 For general requirements related to documentation of instrumentation and automation, including computer based control and monitoring, see Pt.4 Ch.9 Sec.1.

Guidance note:

For description of documentation types, see Pt.4 Ch.9 Sec.1. Table C1 and C2.

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302 For the control systems listed, documentation shall be submitted according to Table D1:

DYN Dynamic positioning control and monitoring system
JOY Independent joystick system
TCM Thruster control mode selection
PRS Position reference system(s)
VEO Wind, VRS and gyro
PMS Power Management System.

D 400 Thruster documentation

401 Documentation shall be submitted as required for main class.

402 The following shall be submitted for information:

— thrust output and power input curves
— response time for thrust changes
— response time for direction changes for azimuth thrusters
— anticipated thrust reductions due to interaction effects.

D 500 Electric power system documentation

501 Documentation shall be submitted as required for main class.

502 Electrical load calculation during dynamic positioning operation shall be submitted for approval. For vessels with the notations **DYNPOS-AUTR** and **DYNPOS-AUTRO** the load calculations shall also reflect the situation after the maximum single failure(s).

Guidance note:

This documentation may be a part of the power consumption balance as required in Pt.4 Ch.8 Electrical Installations.

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503 For vessels with the notation **DYNPOS-AUTRO**, the following shall be submitted for approval:

— cable routing layout drawing
— fire and flooding separation arrangement.

Guidance note:

For the cable routing layout drawing it is recommended that colours are used to indicate the cable routes that are designed and physically arranged to provide redundancy.

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Guidance note:

The cable routing layout drawing shall indicate all cables relevant to the DP system, e.g. power cables, control cables, cables used for indication etc.

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D 600 DP-Control centre arrangement and layout documentation

601 For notations **DYNPOS-AUTS**, **DYNPOS-AUT**, **DYNPOS-AUTR** and **DYNPOS-AUTRO** drawings showing the physical arrangement and location of all key components in the DP-control centre shall be submitted.

602 For notation **DYNPOS-AUTRO** drawings showing the physical arrangement and location of all key components in the emergency DP-control centre shall be submitted.

D 700 Failure mode and effect analysis (FMEA)

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

702 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 dynamic positioning system performance. The FMEA shall include at least the information specified in 703 to 705.

703 A breakdown of the dynamic positioning 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.

704 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.

705 A description of the effects of each failure mode alone on other items within the system and on the overall dynamic positioning 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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706 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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Table D1 Requirements for documentation of instrumentation systems

	D010	*D020*	*D030*	*D040*	*D050*	*D060* [3]	*D070*	*D080*	*D090*	*D100*	*D110*	*D120*	*D130*	*D140*	*D150*	*D160*
For class notation **DYNPOS-AUTS**:																
DYN	X	X	X	X	X	X	X			2)	2)	2)	2)	X	X	1),2)
TCM		X	X	X	X	X	X				2)	2)			X	
PRS				X	X		X						X		X	1),2)
VEO				X	X		X						X		X	
For class notation **DYNPOS-AUT**:																
DYN	X	X	X	X	X	X	X			2)	2)	2)	2)	X	X	1),2)
JOY		X	X	X	X		X						2)	X	X	1),2)
TCM		X	X	X	X	X	X				2)	2)			X	
PRS				X	X		X						X		X	1),2)
VEO				X	X		X						X		X	
For class notation **DYNPOS-AUTR**:																
DYN	X	X	X	X	X	X	X		X	2)	2)	2)	2)	X	X	1),2)
JOY		X	X	X	X		X						2)	X	X	1),2)
TCM		X	X	X	X	X	X		X		2)	2)			X	
PRS				X	X		X						X		X	1),2)
VEO				X	X		X						X		X	
PMS									4)							1),2)
For class notation **DYNPOS-AUTRO**:																
DYN	X	X	X	X	X	X	X	X	X	2)	2)	2)	2)	X	X	1),2)
JOY		X	X	X	X		X						2)	X	X	1),2)
TCM		X	X	X	X	X	X	X	X		2)	2)			X	
PRS				X	X		X	X					X		X	1),2)
VEO				X	X		X	X					X		X	
PMS									4)							1),2)

Instrumentation systems:

DYN Dynamic positioning control and monitoring system
JOY Independent joystick system
TCM Thruster control mode selection
PRS Position reference system(s)
VEO Wind, VRS and gyro
PMS Power Management System [4]

Documentation types:

D010 System philosophy (T)
D020 Functional description
D030 System block diagrams (T)
D040 User interface documentation
D050 Power supply arrangement (T)
D060 Circuit diagrams
D070 Instrument and equipment list (T)
D080 Cable routing layout drawing (T)
D090 Failure mode and effect analysis (FMEA) and redundancy test procedure (T)
D100 Software quality plan, based upon life cycle activities
D110 Installation manual
D120 Maintenance manual
D130 Data sheets with environmental specifications
D140 Test program for testing at the manufacturer (T)
D150 Test program for quay/sea trial (T)
D160 Operation manual

(T) Required also for type approved systems.
1) One copy shall be submitted to approval centre for information only.
2) Shall be available during certification and trials. Reference is made to Pt.4 Ch.9. Not to be submitted to the approval centre.
3) For essential hardwired circuits (for emergency stop, shutdown, interlocking, mode selection systems, back-up selection systems, etc.). Details of input and output devices and power source for each circuit.
4) FMEA for PMS systems is in addition to requirements given in Pt.4 Ch.9.

D 800 Operation manuals

801 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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802 They 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, in-

cluding 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.

D 900 Programme for tests and trials

901 A programme for tests and trials including redundancy tests shall be submitted for approval. The requirements for the programme are described in E.

E. Survey and Test upon Completion

E 100 General

101 Upon completion, the dynamic positioning 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 dynamic positioning 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
- "ready" signals
- failure in thruster command/feedback signals
- communication systems
- main alarm system as for main class and **E0** (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 Electric power supply

401 The capacity of the UPS batteries shall be tested.

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.

602 Positioning shall be performed on all possible combinations of position reference systems (PRS), and on each PRS as a single system. Selecting and de-selecting of PRS shall also be tested.

603 During sea trials the offset inputs for each position reference system and relevant sensors in the dynamic position 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.

604 Manual override, as required by Sec.3 B202 and Sec.4 A302 shall be demonstrated during normal operation and failure conditions.

605 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 operational tests may normally be deducted from the time required for the duration test.

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606 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 required.

Guidance note:

The test described in 606 is dependent on weather conditions and may be omitted if satisfactory results were obtained from the test described in 605.

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607 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 at the quay and 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 and DYNPOS-AUTRO

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** 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.

F. Alterations

F 100 Owner obligations

101 The owner shall advise the Society of major alterations to the DP-system hardware or software.

The owner may, however, assign the task of advising the Society to a responsible body, representing the owner, e.g. the manufacturer.

The Society will consider the need for documentation, re-survey or test.

Guidance note:

In addition to renewal of the DP-controller, a major alteration might also be:

- installation of a new position reference system
- installation of new thrusters
- software changes
- structural changes
- changes in power system.

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SECTION 2
GENERAL ARRANGEMENT

A. General

A 100 General

101 The general requirements for DP-system design are presented in Table C1.

102 For **DYNPOS-AUTR** and **DYNPOS-AUTRO**, 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).

B. Redundancy and Failure Modes

B 100 General

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

B 200 Redundancy

201 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 F200 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 Redundancy shall be based upon running machinery. Automatic or manual intervention arranged to improve the position keeping ability after a failure will be accepted. 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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B 300 Failure modes

301 For class notation **DYNPOS-AUTR** the loss of position shall not be allowed to occur in the event of a single failure in any active component or system. Normally static components will not be considered to fail if adequate protection is provided. Single failure criteria for **DYNPOS-AUTR** include:

— any active component or system
— 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.

Guidance note 1:

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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Guidance note 2:

In these rules the following are also considered active:

- coolers
- filters
- motorised valves
- fuel oil, 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 and vessel control systems).

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302 For class notation **DYNPOS-AUTRO** loss of position shall not be allowed to occur in the event of a single failure. In addition to the single failures listed under B301, the single failure criteria for **DYNPOS-AUTRO** 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 B501).

303 Based on the single failure definition in 301 or 302, worst case failures shall be determined and used as the criterion for the consequence analysis.

Guidance note:

For detailed information and requirements to the consequence analysis function, see Sec.3 F200.

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304 In order to meet the single failure criteria in 301 or 302, redundancy of components will be necessary as follows:

— for notation **DYNPOS-AUTR**, redundancy of all active components
— for notation **DYNPOS-AUTRO**, redundancy of all components and physical separation of the components.

B 400 Independence

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

Guidance note:

Common operator controls for command inputs will be accepted for **DYNPOS-AUTR**, when utilising the redundancy mode, but may not be accepted for **DYNPOS-AUTRO** due to the additional requirement for physical separation. 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.

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

B 500 General separation requirements for DYNPOS-AUTRO

501 Systems that forms the designed redundancy requirement shall be separated by bulkheads, 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.

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

Guidance note 2:

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

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

Guidance note 3:

Cabling to equipment that forms part of the designed redundancy requirement shall neither run along the same route, nor in the same compartment as the cabling for other parts of the designed redundancy. 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.

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

Guidance note 4:

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

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

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.

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

C. System Arrangement

C 100 General

101 The requirements for system arrangement for the different notations **DYNPOS-AUTS**, **DYNPOS-AUT**, **DYNPOS-AUTR** and **DYNPOS-AUTRO** 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**
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	Yes	Yes
Thrusters	Arrangement of thrusters		No-redundancy	No-redundancy	Redundancy in technical design	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 station
	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 station
	External sensors	Wind	1	1	2	2 whereof 1 in alternate control station
		Gyro compass	1	1	3 [1]	3 [1] whereof 1 in alternate control station
		Vertical reference sensor (VRS)	1	1	3	3 whereof 1 in alternate control station
UPS			0	1	2	2 + 1 in separate compartment
Printer			Yes	Yes	Yes	Yes
Alternate control station 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** this is not to be the gyro placed in the alternate control station.
[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.

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 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 thrusters levers, and joystick control system).

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

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 normally 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.

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

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

203 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.

204 For vessels with **DYNPOS-AUTRO** 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.

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

205 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.

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

C 300 Arrangement of positioning control systems

301 Automatic control mode shall include control of position and heading.

302 Setpoints for control of position and heading shall be independently selectable.

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

304 Notation **DYNPOS-AUT** shall include:

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

Guidance note:

The automatic positioning control system used for notation **DYNPOS-AUT**, **DYNPOS-AUTR** and **DYNPOS-AUTRO** may include a joystick, which will not replace the independent joystick system.

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

305 Notation **DYNPOS-AUTR** 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.

306 Notation **DYNPOS-AUTRO** 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.

307 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 306.

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:

Relevant parts of Pt.4 Ch.9 Sec.6 should be complied with.

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

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

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

504 For **DYNPOS-AUTR** no failure mode, as specified in B301 and B304, and for **DYNPOS-AUTRO**, as specified in B302 and B304, shall not have an effect on the functionality of both networks.

Guidance note:

For **DYNPOS-AUTR** control cables and communication links from the bridge to engine room should be separated as far as practically possible.

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

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

D. Internal Communication

D 100 General

101 Requirements for internal communication are given in Pt.3 Ch.3 Sec.10 C.

SECTION 3
CONTROL SYSTEM

A. General Requirements

A 100 General

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

— "available for DP"
— "in DP operation"
— "not in DP operation".

B. System Arrangement

B 100 Independent joystick thruster control system

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.

B 200 DP-control system

201 An alarm shall be initiated when the vessel exceeds preset position and heading limits.

202 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.

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

204 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.

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

205 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.

206 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 Table C1.

207 *Notation* **DYNPOS-AUTR** *and* **DYNPOS-AUTRO**

208 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.

209 One of the 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. In case of automatic change over upon failure detection, the system that was online shall remain unavailable after repair until manually reselected as the online (or standby) system.

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

211 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.

212 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.

213 There shall be an identification of the online positioning control system at the operator panel.

214 *Notation* **DYNPOS-AUTRO**

215 If three independent positioning control systems 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.

216 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.

217 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.

218 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.

219 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 station. The nature of the switching shall be such that no single failure will render the back-up inoperable together with the main system.

B 300 Thruster control mode selection

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

302 The control mode selector shall be arranged so that it is always possible to select manual controls after any single failure in the DP-control mode.

Guidance note:

If the selector system is based on relays, manual control should be accessible after power failure to the selector relays.

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

303 For **DYNPOS-AUTR** and **DYNPOS-AUTRO** notations, the mode selector shall not violate redundancy requirements.

Guidance note:

A common switch will be accepted, but each system should be electrically independent.

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

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

C. Positioning Reference System

C 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** special considerations may be given where the use of two different measuring principles would not be practicable during DP Operation.

---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 DP-vessels, 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.

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

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, and 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.

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

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

112 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** and **DYNPOS-AUTRO**:
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---

113 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.

114 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.

115 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 control station.

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---

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

Guidance note 1:

For **DYNPOS-AUTR** and **DYNPOS-AUTRO**:
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.

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

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. HPR 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---

D. Sensors

D 100 General

101 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** and **DYNPOS-AUTRO** arrangement of power supply shall be in accordance with the overall redundancy requirement.

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

103 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---

104 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.

Guidance note:

Sensors and reference systems that are separated electrically are regarded as fulfilling the requirement in 104.

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

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

106 For the notation **DYNPOS-AUTRO** 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 control system.

Guidance note:

Wind sensor, GPS antenna, tautwire or hydro acoustic transducer, cannot possibly be located in the same fire zone as the back-up control room. The independence between main and back-up positioning control systems should be ensured when such equipment is connected to the back-up system.

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

E. Display Units

E 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 independent position displays.

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.

F. Monitoring

F 100 Alarm system

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

F 200 Consequence analysis

201 For **DYNPOS-AUTR** and **DYNPOS-AUTRO** notations, the dynamic positioning 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 requirements for steering gear under DP control, see Pt.4 Ch.14.

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

A 200 Thruster configuration

201 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:

Reference is 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, but should not be taken into consideration when calculating the first **ern** number, and should be proven on trials.

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

A 300 Thruster control

301 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 the ability to stop the prime mover, azimuth and pitch or r.p.m. control.

Guidance note:

For vessels with notation **DYNPOS-AUTRO**, manual control will not be required for the back-up DP-station.

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

302 Manual thruster control shall be available at all times, also during all failure conditions in dynamic positioning or independent joystick control systems.

Guidance note:

Manual thruster control shall be understood as manual control of main propulsion, auxiliary thrusters and rudders.

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

303 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---

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

305 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 **DYNPOS-AUTS** and **DYNPOS-AUT**, see Pt.4 Ch.8 Sec.2.

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

A 400 Indication

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

402 The displays of 401 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.

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

404 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** and **DYNPOS-AUTRO** additional requirements will apply in regard to redundancy and with respect to maximum single failure. 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".

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

A 200 Number and capacity of generators

201 For notation **DYNPOS-AUTS** and **DYNPOS-AUT** 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 undervoltage 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.

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

202 For **DYNPOS-AUTS**, **DYNPOS-AUT**, **DYNPOS-AUTR** and **DYNPOS-AUTRO**.

To prevent overloading the power plant, interlocks or thrust limitations shall be arranged.

Guidance note:

This arrangement may be integral to the DP-control or part of the vessel's power management system.

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

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

A 300 Power management (for DYNPOS-AUTR and DYNPOS-AUTRO)

301 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
- if functionality for disconnection of generator breakers, bus-tie breakers or thruster breakers 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.

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

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

Guidance note:

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

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

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

304 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.

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

A 400 Main and distribution switchboards arrangement

401 For **DYNPOS-AUTS** and **DYNPOS-AUT** notations the main class requirements are applicable and adequate. For **DYNPOS-AUTR** and **DYNPOS-AUTRO** notations additional requirements will apply, see 402 to 407.

402 For notations **DYNPOS-AUTR** and **DYNPOS-AUTRO** the switchboard arrangement shall be such that no single failure will give a total black-out. For **DYNPOS-AUTR** this means equipment failures. For **DYNPOS-AUTRO** this means

failure of all equipment in a fire and watertight subdivision, when required.

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

404 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 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).

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

Guidance note:

If the power system is installed in a compartment above the damaged waterline, then watertight partitions will not be required.

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

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

407 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.

B. Control System Power Supply (applies to DYNPOS-AUT, DYNPOS-AUTR and DYNPOS-AUTRO)

B 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 shall initiate an alarm in the DP control system.

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

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

C. Auxiliary Systems (Applies to DYNPOS-AUTR and DYNPOS-AUTRO)

C 100 General

101 For **DYNPOS-AUTR** and **DYNPOS-AUTRO**

The auxiliary systems shall be arranged in accordance with the redundancy requirements as given for these notations. See Sec.2 B.

102 For **DYNPOS-AUTR** and **DYNPOS-AUTRO**

Failure shall be considered for all active components as specified in Sec.2 B. Unless otherwise specified in these rules, fixed piping may be shared by components designed with redundancy, for the **DYNPOS-AUTR** notation.

103 For **DYNPOS-AUTRO**

Separate piping shall be arranged for systems providing required redundancy. Cross-over pipes are acceptable, except in ventilation ducts, provided these can be closed at both sides of separating bulkheads.

C 200 Fuel oil

201 For **DYNPOS-AUTR** and **DYNPOS-AUTRO**, the fuel oil supply shall be arranged with full separation between systems providing required redundancy, in view of the risk of fuel oil contamination.

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.

For **DYNPOS-AUTRO**, each service tank shall be in separate compartments, and the valves in the cross-over facilities, if arranged, shall be located as close as possible to the bulkhead and operable from both sides.

202 For **DYNPOS-AUTR** and **DYNPOS-AUTRO**

If the fuel system requires heating, then the heating system shall be designed with the appropriate level of redundancy unless diesel oil tanks, which do not require heating, are arranged as required in 101.

C 300 Cooling water

301 For **DYNPOS-AUTR** and **DYNPOS-AUTRO**

Fresh water cooling systems shall be arranged with full separation between systems providing required redundancy, in view of the risk of severe loss of water or accumulation of gas due to leakage.

C 400 Pneumatic systems

401 Pneumatic systems shall be arranged with full separation between systems providing required redundancy, in view of the risk of leakage.

SECTION 6
ENVIRONMENTAL REGULARITY NUMBERS

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.

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

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".

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

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.

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

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 3 numbers, ranging from 0 to 99. The **ern** will be given in the register as information: **ern (a, b, c)**.

The first number shall represent optimal use of all thrusters. The second number shall represent minimum effect of single-thruster failure, and the third figure shall represent the maximum effect single-thruster failure.

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**, except for the first number, when this control mode is included in the DP controller. See Sec.4.

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