Can less than DP2 class vessels be accepted for more work close to platforms?

Required reliability efficiently
demonstrated by FMEA and sea trials tests

by

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MANAGING RISK

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Overview

- Standard for Position Keeping; PK
- Technical Redundancy
- FMEA
  - Block diagrams/ system description
  - Systems that shall be discussed
  - FMEA layout
- FMEA Trial test program
  - Contents
  - Layout

Work inside safety zone is restricted

- Loading / unloading operations
  - Technical redundancy is required for operations windward of platform
  - DP is not required, Joystick sufficient
- Documentation of Technical Redundancy / Letter of compliance
  - Vessels built and tested in compliance with the standard shall not lose PK ability in the event of any defined **single failure**
- DNV Standards for Certifications 2.16; *"Specification for Redundancy in Positioning Keeping Ability"*

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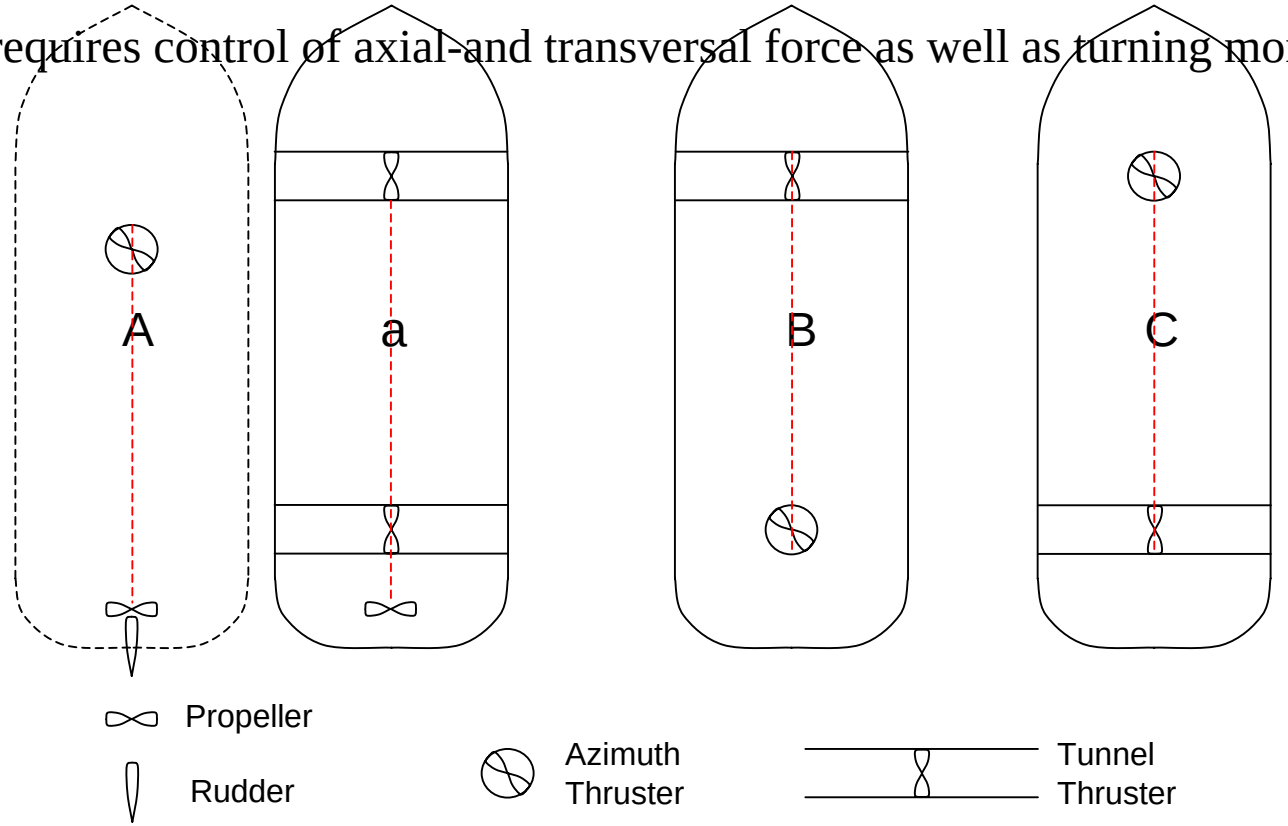
PK Technical redundancy

- The single failure criterion comprises:
  - Any active component or system
  - Static components which are not properly documented with respect to protections
  - 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
- PK standard is comparable with IMO DP2 equipment class, except for Dynamic Positioning (DP) control
- Dynamic heading control is mandatory

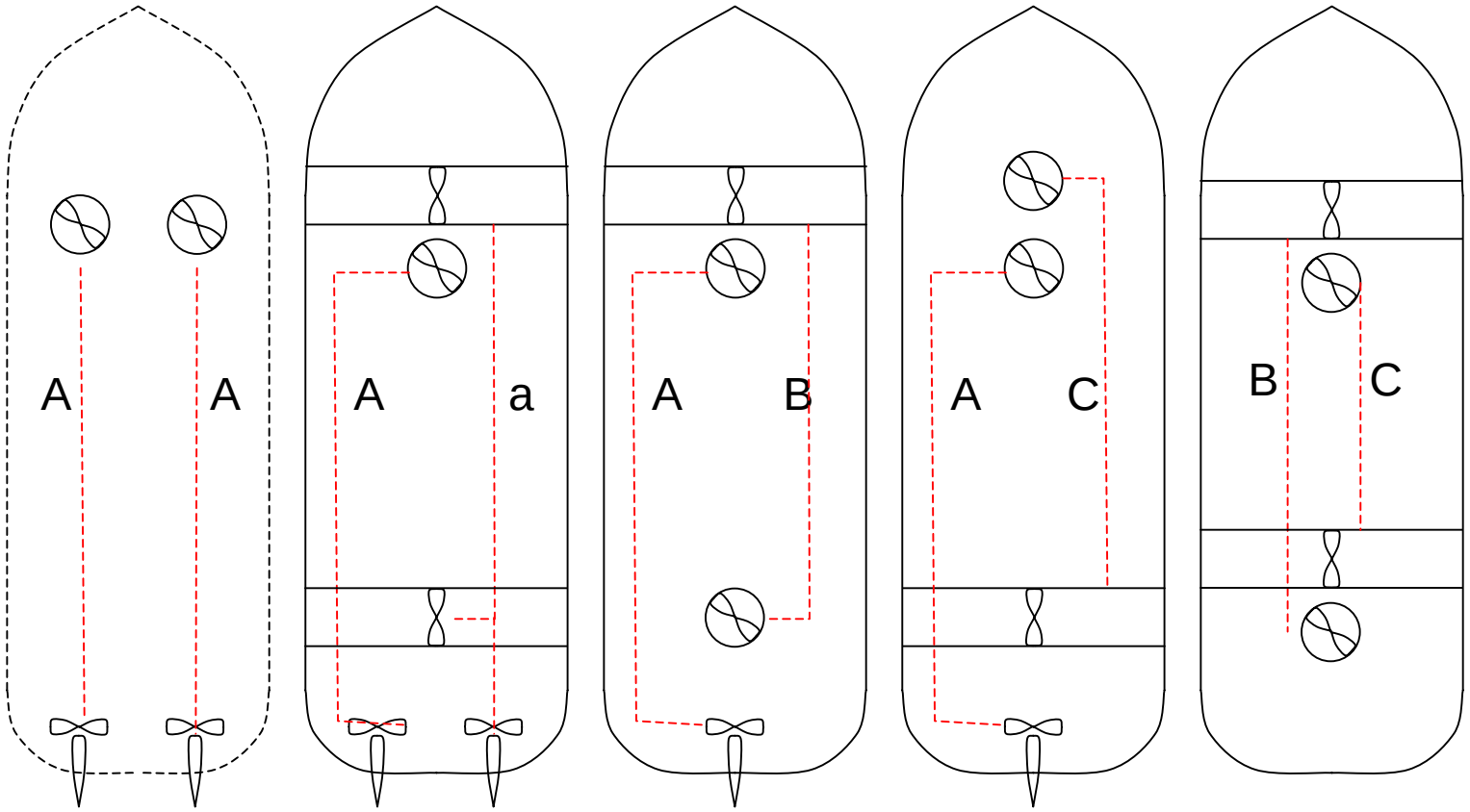
Minimum Thruster Configurations for PK

PK requires control of axial-and transversal force as well as turning moment



Possible minimum configurations with redundancy are:
AA, Aa, AB, AC, aa, aB, aC, BB, BC, CC

Some minimum configurations for PK technical redundancy



Possible minimum configurations are: AA, Aa, AB, AC, aa, aB, aC, BB, BC, CC

Systems that shall have redundancy

System	Arrangement
Power supply to main propeller and thrusters including power generation	Selectivity accepted
Fuel supply to propeller engine or generator engines	Redundant and separated (service tanks included)
Lubrication and hydraulic systems	Redundancy in active components
Cooling systems	SW: redundancy in active components, FW: redundant systems
Reference system	Redundant gyro
Power supply to auxiliaries	Redundant systems: fuel, lubrication, cooling and control

Control system independence

- One control system: Heading and Joystick
- Alternative: Manual control levers for each thruster
- Heading reference: Redundant Gyros

Power Management System (PMS)

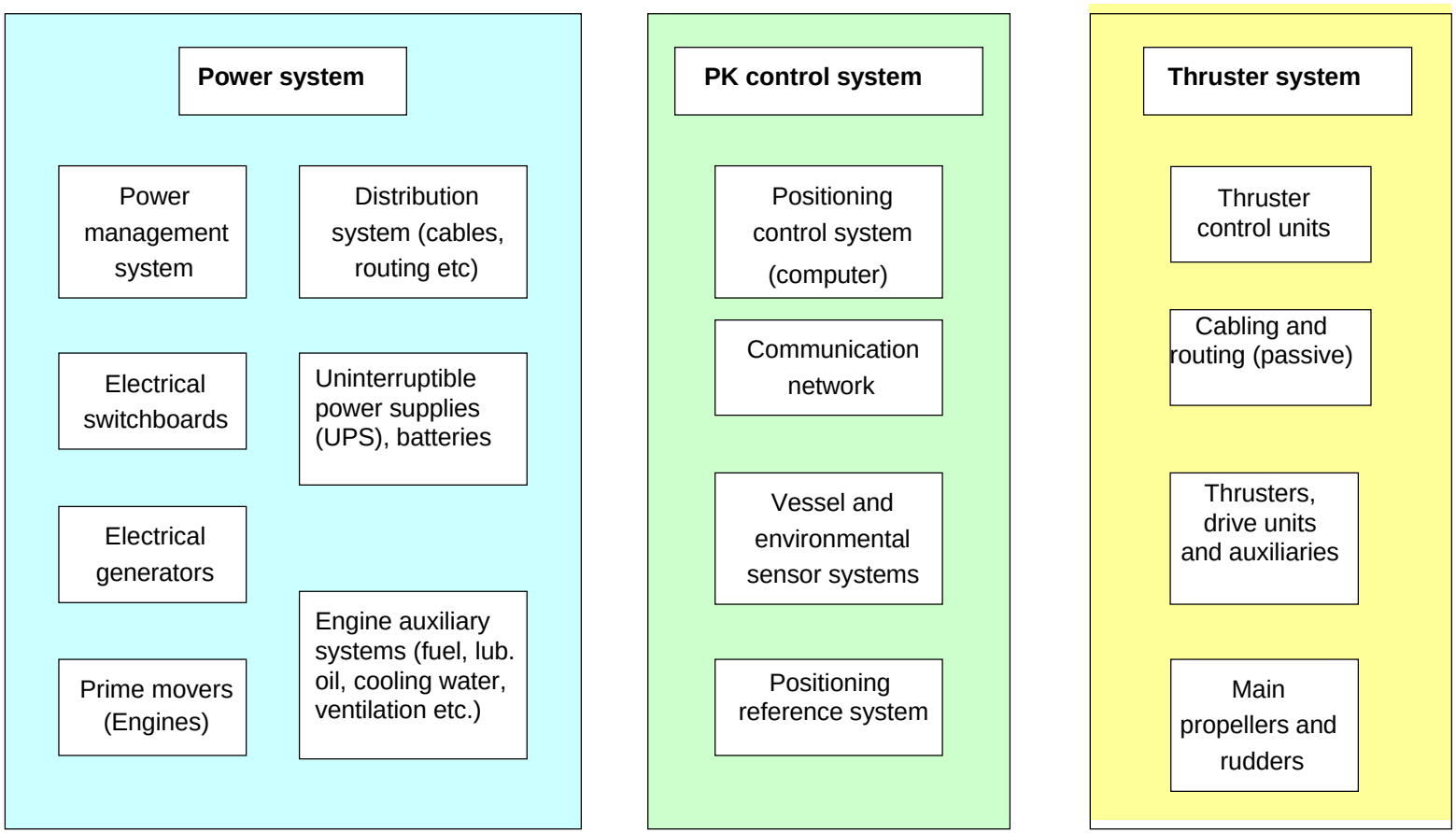
- An automatic PMS is to be arranged for operation with both open and closed bus-bar breakers.
- A failure in the PMS shall not cause alteration to the power generation, and shall initiate an alarm in the position keeping control centre.
- It shall be possible to operate the switchboards in manual, with the PMS disconnected.
- Exemption to have PMS may be accepted if a PMS will give small, if any, contribution to improved regularity.

Failure Mode Effect Analysis (FMEA)

The FMEA shall include :

- A breakdown of the position keeping system into functional blocks.
- 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.
- 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 is to be furnished.

Functional blocks



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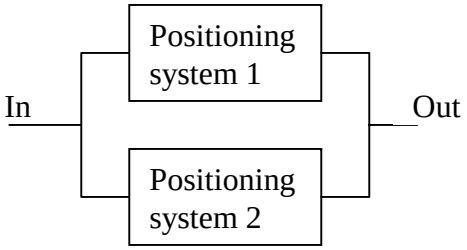
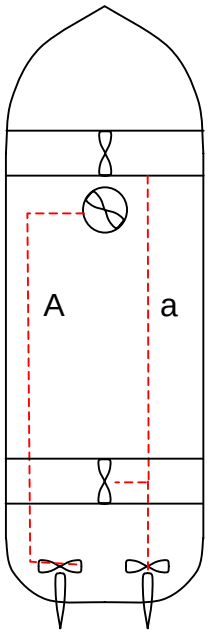
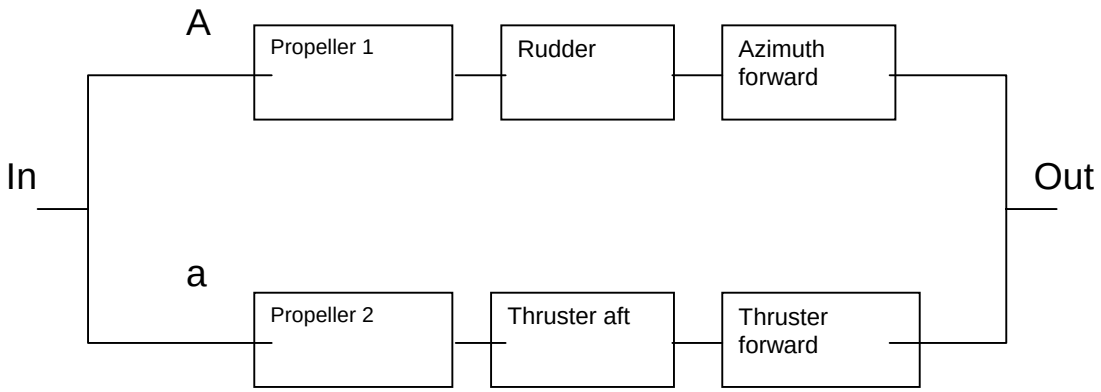
Position-Keeping System, block diagram

Principal reliability block-diagram of redundant system

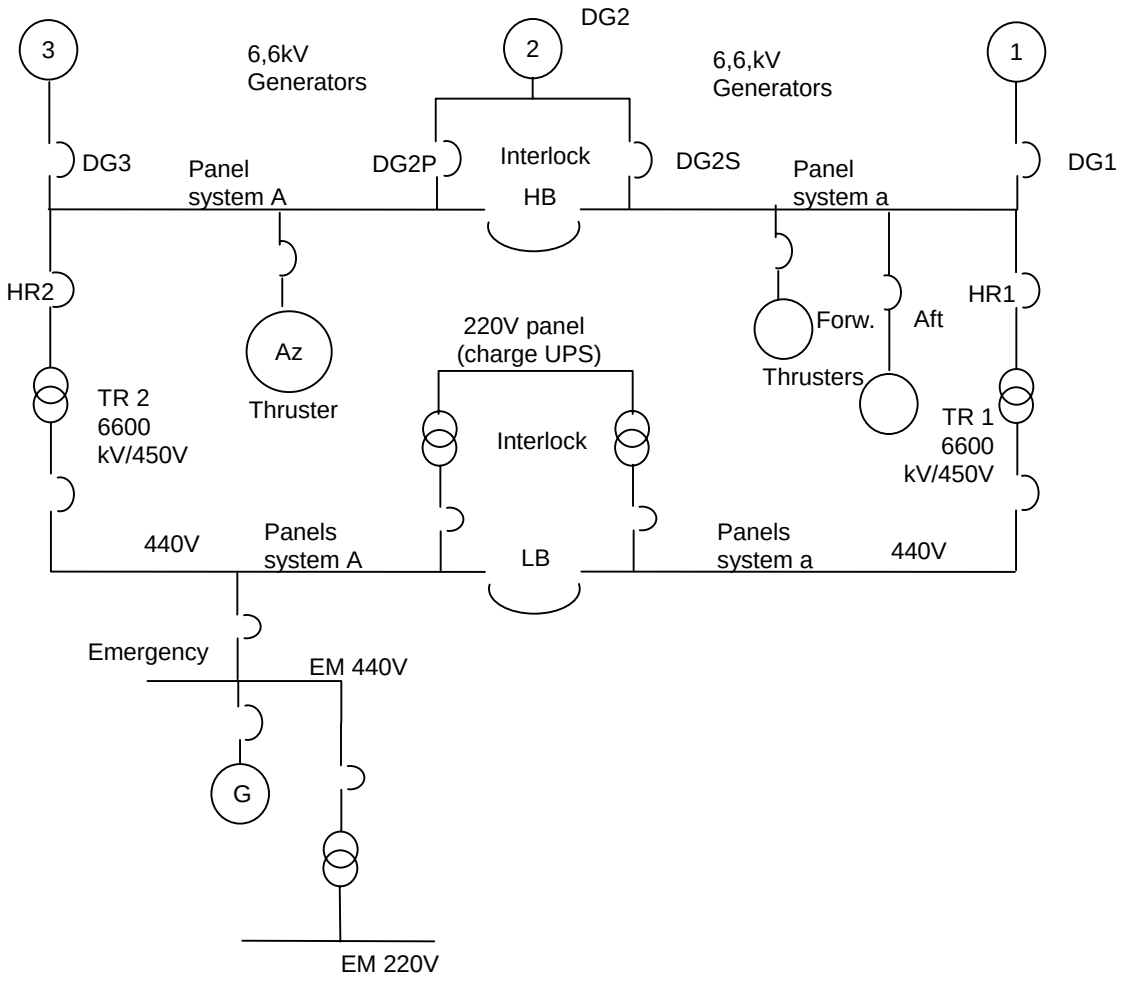






Reliability block-diagram of minimum technical redundancy configuration Aa

One line power distribution diagram



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Systems that should be contained in FMEA

- Control system (computer, signal transmission/network, reference system, displays and consoles)
- El. power distribution system (one line power distribution diagram)
- Low voltage power supply to control system and pilot systems (valves, breakers etc.)
- Fuel supply system (from- and including the service tanks)
- Lubrication and hydraulic systems
  - Propeller shaft, gear, pitch control
  - Thruster lubrication
  - Engine lubrication
- Cooling systems
  - Lubrication/hydraulic cooling
  - Thruster cooling
  - Engine cooling
- Ventilation systems (if essential for some of the PK units)
- Control air (if used e.g. for governor control, closure of dampers, operation of valves), “fail to safe” function

Recommended outline of a FMEA worksheet

Item/ Active component	The name or identification of the item being analysed for failure
Failure mode	Mode of failures that is relevant for the PK
Cause	Various causes (if more) for each failure mode
Consequence	Failure effect on the function of the item and totally on PK.
Detection	List detection means. Can the failure remain undetected?
Safeguards	List existing provisions that shall prevent this failure to occur or that mitigate the effect
Consequence rating	1. Critical, may not be able to keep position/heading 2. Maximum, PK redundancy lost 3. Degraded, reduced operational capacity on one of the redundant PK systems 4. Not relevant or Insignificant for PK operation
Comments	Recommendations assumptions or other relevant remarks
Test method	Information on how the failure can be simulated

FMEA Worksheet

Subsystem: **Control system**	**Vessel Name, Project**					**Date xx xx** **Recorder: nn.Mm**
System equipment failure (Item)	**Cause**	**Consequence A: Local/immediate B: Overall**	**Detection**	**Mitigation/ Compensation/ System response**	***Criticality*** **Comments**	**Test Y/N**
Main controller	Processor failure, power failure	A: Main controller dead B: All thrusters, propellers rudders and engines to be operated manually	Alarm	Positioning and manoeuvring can be done by manual control. Automatic changeover to "manual"	*Maximum*	Y Disconnect power
Signals and supply to controller	Line, card or power failure	A: Main Controller dead B: All thrusters, propellers rudders and engines to be operated manually	Alarm	Positioning and manoeuvring can be done by manual control	*Maximum*	(Y) (See above, disconnect power)
Data to remote controller	Line or card failure	A: Remote stations not usable B: Main controller working as well as manual controls	Alarm	Main console should be useable, "manual" operation is backup	*Maximum (Degraded)* Test will show criticality **FMEA to be updated after test**	Y Disconnect line

Etc.

Trial test program

- FMEA shall be verified by tests
- Test program shall be approved
- Program shall include:
  - operation condition (technically) before initiating the failure
  - how to simulate the failure (cross check with the FMEA)
  - description of anticipated effects (shall be described in the FMEA)

Test Program format

Example description for testing positioning main controller

Method:	1. Keep vessel in position using the joystick, all thrusters running 2. Cut power to the main controller (disconnect line xxx) 3. Use manual control for positioning 4. Reconnect line xxx and establish joystick positioning at remote station 5. Disconnect data signal line to remote (yyy) 6. Use main station joystick for positioning 7. Reconnect yyy, continue joystick positioning 8. Disconnect serial data signal line (zzz) 9. Check reactions on joystick, change to manual control for positioning and check functionality		
Results expected:	2. Joystick inoperable 3. Automatic change to “manual” mode 5. Remote operation not possible, but control from main station still possible 8. Possibly the joystick operation is jeopardised. Manual control shall be possible.		
Results found:			
Comments:			
Witness:		**Date:**	

Summary

Comparable reliability with DP2 may be mandatory for operation within the safety zone

When Joystick operation is sufficient for positioning, DP and position reference system is not necessary

To obtain comparable reliability with DP2, “Technical Redundancy” is to be demonstrated

With proper “Technical Redundancy” the vessel shall not lose Position Keeping ability in the event of any defined single failure