TECHNICAL NOTE

DATE:	**6th Nov 2023**	**MRT REF:**	**GRT_11202306**
PROJECT:	**NON-SPECIFIC**	**BUSINESS:**	**ALL**
ATTN:	**GENERAL**		
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SUBJECT:	**ANNUAL DP TRIALS - GROUP REDUNDANCY TESTS AND ROLLING TRIALS - CLARIFICATION**		

EXECUTIVE SUMMARY

Shell requires annual testing to prove elements of Performance Protection and Detection upon which Single Fault Tolerance of DP System depends.

> *Note: It is acknowledged that Industry guidance has been published with various nomenclature such as rolling trials, continuous trials, cumulative trials etc. However, these do not align with the stipulations for annual testing as described in IMO MSC 645 and 1580.*

The concept and conduct of Group Redundancy Tests (GRT) are not being carried out in a standardized or consistent manner. This Technical Note (TN) provides clarifications regarding Group Redundancy Test and stipulates what it should achieve.

INTRODUCTION

Document reference

- **Code of Practice for Developing and Conducting DP Annual Trials Programmes IMCA M 190 Rev. 3.1 August 2023**
- Example Redundancy Concept and Annual DP Trials for Vessels of IMO DP Class 2 & 3, November 2021
- https://www.imca-int.com/information-notes/imca-clarification-of-test-requirements-for-dp-annual-trials-programmes/

Objective of this Technical Note

The objective of this technical note is to provide background on the origins of Group Redundancy Tests and Rolling Trials as described in various industry guidance documents (In particular, IMCA M190) so that Vessel Technical Operators (VTOs) can better understand their obligations and Shell MRT's expectations when Annual DP trials for DP vessels are presented for review, as it pertains to Group Redundancy Tests and Rolling Trials.

GROUP REDUNDANCY TESTS

The concept of the Group Redundancy Test (GRT) evolved from the work done to create DNV RP-D102 Recommended Practice for 'FMEA of Redundant Systems' (2012). Its origins date back to 2007 when the work done to develop RP-D102 brought renewed focus to the concept of Redundant DP Equipment Groups and concepts such as Single Failure Propagation Analysis (SFPA) Redundancy Design Intent (RDI) and Worst-Case Failure Design Intent (WCFDI). It is also a useful tool in proving the essential elements of performance, protection and detection upon which any redundant DP system relies for its single fault tolerance.

The GRT concept was developed to align with the purpose of the Annual Survey and testing in Section 5 of IMO MSC 645 and 1580 which is to confirm that the DP system is in good order. The GRT concept was developed as one element of an Annual DP Trials program that could assist vessel owners in satisfying this objective in a more **efficient and effective** manner. This was achieved by combining several power-distribution failure tests with position reference / maneuvering tests to demonstrate that each of the vessel's redundant DP equipment groups was capable of developing surge, sway and yaw and thus maintain position and heading.

It is important to recognize that the GRT is primarily a PERFORMANCE TEST for the equipment that remains running, when a redundant DP equipment group is shut down (without reliance on the equipment that has been shut down). It is not a failure test of the equipment that is shut down. However, the opportunity can be taken to observe essential alarms and indications for the equipment that is shut down and so on. It should be noted that this is a task that can be made much easier leveraging data logging equipment configured with requisite capability.

It is emphasized that GRT was never intended to be a proscriptive concept. It was developed to assist vessel owners and charterers achieve efficiencies. Published guidance acknowledges that GRT can be performed in several ways to suit a particular DP vessel design and redundancy concept.

> Note: *Not all classification society DP notations require or result in redundancy concepts with well defined redundancy groups.*

Fundamental to the concept of the GRT is that an entire redundancy group should be shut down as described in the first extract from IMCA M190 below. This would include all stored energy sources such as UPSs and battery rectifier / charger units in recognition of the requirements that there be no time constraint on the vessel's ability to hold station following a failure (in practice this is determined by the fuel supply in the service tanks in conventional DP vessel designs) and/or time to safely terminate an ongoing activity in order to executed remedial actions.

"The redundant groups to which DP related equipment belongs – redundant groups should be identified to create the group redundancy test. This should simulate ***the total failure of an entire redundant group*** *to simulate worst case failures. Satisfactory positioning should be demonstrated using the remaining redundant group/s in accordance with the defined WCFDI;"*

Extract from IMCA M190[4.6.3(4)]

IMCA M190 goes on to state that:

"…This test may be combined with the failure of the ***UPS (and other battery systems) distributions associated with the redundant group that has been shut down*** *such that redundant vessel control, DP control and power are failed at the same time.* ***Alternatively, failure of UPS distribution may be a separate test.*** *In any case, endurance tests of UPS and battery systems (30 minutes) should be carried out at some point;"*

Extract from IMCA M190 [4.6.5.1]

Including the UPS and battery system distribution shutdowns in the GRT gives the highest level of confidence that only the surviving redundant DP equipment group(s) are participating in positioning the vessel and contributing to station keeping performance.

Notes:

1. ***Whatever approach is taken, it is expected that the reason for choosing one method or the other will be clearly documented and any gaps in proving the essential elements of performance, protection and detection are closed with effective validation testing.***
2. *Note: Leaving tests involving shutdown of the UPSs that power the alarm and monitoring system to last can assist in collecting alarms from equipment as it is shut down.*

ROLLING TRIALS

It is emphasized that there is no mandate for testing the DP system at intervals of more than one year in IMO MSC 645 or 1580. This is clarified in IMCA notice https://www.imca-

int.com/information-notes/imca-clarification-of-test-requirements-for-dp-annual-trials-programmes/

The concept of rolling trials, in which some equipment is tested at intervals of more than one year, (but not less than every five years) was introduced when IMCA M190 was first developed with a very limited purpose of:

- Allowing vessel owners to include periodic tests, exceeding one year, of non-critical redundancy in their annual DP trials programs – i.e redundancy over and above that required to ensure the DP system is single fault tolerant.
- To acknowledge the very infrequent occurrence of Thruster VFDs ever failing to anything other than zero speed. Speed control loop wire break testing was being done but adding little value because it was traditionally expected and not based on a full understanding of what was actually being tested in terms of performance, protection and detection.

  NOTE: *Shell does not support Rolling Trials for elements of performance, protection, and detection upon which the redundancy concept and single fault tolerance of the DP System depends. Shell requires these attributes to be validated by testing annually.*

IMCA M190 states… 'it is accepted that there may be some components of the DP system which, provided their reliability has been proven throughout the year or they do not provide critical redundancy, may after review be subject to rolling tests such that they are not tested every year'.

> *Note: Proof of reliability alone is not sufficient to satisfy the requirements of IMO MSC 645 or 1580, the requirements are for proof of single fault tolerance through the provision of redundant systems. Reliable operations itself does not confirm that elements of performance, protection and detection are proven. Performance and detection are 'on demand' functions and so may never have been exercised unless a system is tested or malfunctions. Performance may never have been proven unless a system was forced to compensate for the loss of another redundant equipment group.*

The purpose of thruster wire break tests is to demonstrate that the thruster does not fail to excess thrust magnitude or wrong thrust direction (with appropriate alarms). They do not prove conclusively that the thruster will fail safe, but they are historically taken as sufficient to prove this. Evidence from trials and incidents confirms that CPP type propellers and DC drives do fail this way with some regularity and the wire break tests on this type of thruster proved that protective functions, designed to detect control loop failure, were working.

When VFD based thrusters began to replace CPP thrusters there were very few cases of failure to excess speed and there was a widely held belief that it was not possible for them to fail this way and thus the wire break test had no purpose. The DP Assurance community could not categorically determine if this was true or not and classification societies allowed the residual risk of this type of failure (drive off) to be controlled by use of the thruster emergency stop which is not strictly in accordance with the requirements of IMO MSC 645 and 1580 but was considered to be a pragmatic response to lack of analytical capability in the DP assurance providers and verifiers. See also IMCA M190 Section 5.9.2 on Thruster control loop tests.

The views of the classification societies are now changing and requirements for independent protective functions to monitor thruster performance (and take action in response to thruster malfunction) have been introduced. Early work on this is being demonstrated with rudder control system faults in the DP shuttle tanker community.

In recognition of this shift in industry attitudes to proving thruster fail-safe, exemption from annual speed control loop failure testing of VFDs will only be accepted if it can be demonstrated analytically, and confirmed by validation testing, that the thruster drive is inherently incapable of failing to excess speed / thrust. That is to say, there are no protective functions responsible for the fail-safe response which may become hidden failures.

- This allowance, granted to VFD speed control loops, does not extend to the azimuth control loops on thrusters with VFDs. These hydraulic systems have protective functions which must be tested annually.
- Tests of thruster emergency stops and prediction error alarms (for thrust magnitude and direction) must be performed, even if VFD speed control loop testing is not carried out.

- All other supporting systems on VFD thrusters must be tested in accordance with the requirements for annual testing to prove elements of performance protection and detection upon which single fault tolerance depends.

RELUCTANCE TO TEST (TEST ANXIETY(?))

Some vessel operators have reported issues with equipment failures occurring on control power restoration including when carrying out group redundancy tests. While it is appreciated that this may be disruptive to vessel operations (particularly when there are also issues of equipment obsolescence) it is not, of itself, justification for not carrying out testing annually where such testing is required to prove elements of performance, protection and detection. Methods other than electing not to test, should be found to understand and mitigate the risks of equipment failure. It is a reasonable expectation that equipment must be capable of experiencing power failure and restoration of power without suffering permanent damage. Underlying, causal and contributory factors must be identified and addressed effectively.

CONCLUSIONS

Group Redundancy Tests

- When conducting a Group Redundancy Test, total shut down of all energy sources (including battery systems and UPSs) in a DP redundancy group provides the highest confidence that the redundant equipment groups, which are expected to continue to operate, are capable of maintaining position and heading.
- In line with established guidance including IMCA M190, VTOs may choose how they configure and perform group redundancy tests and which distributions systems they choose to include. The reasons and engineering basis for any decision not to shut down all energy sources in a redundancy group, such as battery systems and UPSs, should be documented as part of the test.
- Any energy sources or power distribution systems not tested as part of the group redundancy test must be tested annually if required to prove elements of performance protection and detection upon which the DP system relies for its single fault tolerance.
- Any gaps in proving elements of performance, protection and detection created by carrying out UPS battery or other distribution tests separately (i.e. not as part of GRT in accordance with this TN) must be closed.

Rolling Trials

- Use of rolling trials to prove that non-critical redundancy is in good order may be accepted subject to comprehensive and competently executed analysis and documentation supporting/substantiating the same.
- Exemption from annual testing on the basis of '*apparent reliability'* will not be accepted for elements of performance, protection and detection upon which Single Fault Tolerance depends.
- Exclusion of thruster VFD speed control loops from annual testing may be accepted if it can be proven by analysis and validation testing that there are no elements of performance, protection and detection that are not being tested (by omission of this test from the annual DP trials program).

- Use of rolling trials to reduce the risk of damage to equipment which is intolerant of power failure and restoration is not, of itself, a reason not to test annually (particularly, if elements of performance, protection and detection are not being tested annually as a result).