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HARNESSING DATA CENTRICITY SESSION

Data Centricity in DP Verification and Validation

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Abstract

The safety and reliability of DP station keeping, relies heavily on verifying the single fault tolerance of the DP system, by testing. The required testing is influenced by design choices and should demonstrate that the DP system operates and fails predictably and is free of hidden failures.

The format of DP trials has changed little in the last three decades. Despite developments in Data Driven Verification (DDV), the majority of initial and periodic verification still relies on the testimony of competent observers, much of which is unsupported by substantiating and corroborating evidence.

Concerns relating to the veracity and efficacy of DP trials led the DP community to seek methods of improving the level of confidence they derive from initial and periodic testing. Reliance on human observers is likely to continue well into the future and thus improvements need to focus on enabling observers to provide trials results in an assurable, data centric' format as one of several initiatives to address these concerns.

The term 'data centric' now features prominently in DP guidance [1,2]. Although there is a broad understanding of its meaning, guidance documents tend to focus on what is not acceptable rather than what is acceptable. This paper addresses this lack of information by providing practical guidance on:

- Data centricity as an enabler for verification and validation.
- What constitutes substantiating and corroborating evidence.
- What types of data centric evidence are most suitable for each type of test.
- Data centricity as part of Evidence Based Comprehensive Verification and Validation ($EBCV^2$).

Abbreviation / Definition

DDV	Data Driven Verification
DGPS	Differential Global Positioning System
DNV	Det Norske Veritas
DP	Dynamic Positioning
$EBCV^2$	Evidence Based Comprehensive Verification and Validation
FMEA	Failure Modes Effects Analysis
IMCA	International Marine Contractors Association
IT	Information Technology
JDP	Joint Development Project
MBT	Model Based Testing
NATO	North Atlantic Treaty Organisation
OCIMF	Oil Companies Intentional Marine Forum
OEM	Original Equipment Manufacturer
OT	Operational Technology
PLC	Programmable Logic Controller
PRS	Position Reference System
ROCK	Retention of Critical Knowledge

Introduction

General

This paper discusses the concept of data centricity as it applies to the DP community. Discussion focusses primarily on data centricity as a means to enhance the value of trials witnessed by a Trials Practitioner onboard the vessel. Methods and requirements (class notations) for the execution of remote trials (where the independent verifier is not on board the DP vessel) also exist [1].

What is data centricity?

Data is the plural form of the Latin word datum, which means "a single piece of information." In traditional usage, "data" refers to multiple pieces of information or facts, while "datum" refers to just one.

Different industries and organizations define data centricity to suit their needs and application:

- NATO '*The Data Strategy for the Alliance aims to accelerate NATO's transition into a data centric organization, leveraging quality data for seamless interoperability and integration across all domains*'.
- Amazon '*In a data-centric architecture, data is a core IT asset, and you design your IT systems and processes to optimize your data'*.
- OCIMF / IMCA / MTS '*Data Centric information is defined as that which is derived from independently verifiable data (including that gathered and or recorded by digital means). Note: The oft used term 'as expected', does not meet the definition of data centricity*'.

At a fundamental level, data centricity is a term that describes the concept of placing the use of data at the center of a process. In the process of managing station keeping risk, it means placing the collection and utilization of data at the heart of DP system verification, validation and assurance.

DP trials have always contained some elements of data centricity such as:

- Recording position overshoots to support a claim that the DP system is well tuned.
- Recording distance travelled during a move to confirm the DP control system is using the data from a PRS correctly.
- Thruster and generator full load testing, temperatures, UPS battery voltages and duration.

These data recordings are made manually by human observers from sources such as the DP Pos-plot, the front panel of a DGPS receiver or a PMS/IAS workstation screen, for example. More recently, it has become established practice to take a screen shot of the box moves to support the manually recorded data and take videos of blackout recovery in progress to be able to document thruster and generator connection times. These are all examples of data centricity.

Note: *Photographs and videos (image-based data) are not so easily interpretable by software but developments in artificial intelligence for verification and validation may eventually make such possibilities commonplace. For DP, image-data fills a gap between traditional methods and fully data centric methods based on digital data. Currently image data for DP is human-assurable but not machine-assurable.*

Case for action

The DP community recognised some years ago, that reliance on the testimony of human observers alone was not providing a consistent level of DP assurance. Abuse of the term ‘as expected’ led DP assurance stakeholders to question the veracity of the test results. In some of the most obvious cases of abuse, the expected results section of the test sheet listed a number of possible outcomes (or an instruction to note the system response), but the actual result was still listed as ‘as expected’.

Several complementary initiatives were initiated to address the variability:

- The International Marine Contractors Association (IMCA) developed an accreditation scheme for DP trials practitioners intended to boost technical competence and raise awareness of expectations for conduct of participants engaged in the trials process.
- DNV Maritime developed DP notations for Data Driven Verification (DDV) that facilitated the adoption of data centric methods for supervised, semi-automatic and automatic data collection of trials results [3].
- At least one DP control and automation system manufacturer developed advanced data collection and processing applications and hardware specifically for collecting data from DP trials on vessels with data logging functionality.
- Several third-party assurance providers developed IT applications aimed at facilitating the execution of tests and the collection of corroborating and substantiating evidence using image-based data.

Each of these initiatives are laudable, but all face various challenges related to:

- The extent of their adoption by industry.
- The usability / acceptability of the data they provided.

The adoption of data centricity does not of itself ensure that a DP system is comprehensively verified and validated. Other tools such as guidance on developing trials programs and gap analysis tools exist for that purpose but it does allow greater value and improved levels of confidence to be extracted from whatever trials program is being conducted.

Data Centricity faces similar challenges to the other initiatives which are addressed as follows:

- The extent of its adoption is addressed by recommending its adoption in guidance and mandating its use in end user charter agreements (example: company standards).
- The usability of the data it provides is addressed by guidance and class rules (where applicable) on data driven verification, data integrity and methods for data collection.

Why data centricity?

Data centricity in DP is part of the ongoing evolution and integration of Information Technology (IT) and Operational Technology (OT) into every facet of human life. The ability to be more effective drives an expectation to be more effective. The ability to do more with fewer resources drives similar expectations and so the cycle of continuous improvement continues.

Collecting data in all its various forms:

- Allows other resources and disciplines to be engaged after the initial test activity.
- Reduces (but does not eliminate) reliance and burden on observers.
- Decouples execution and observation from analysis (in time).

Note: *Decoupling allows a human observer to focus on one (or a small group of) data sources without concern about missing something important from another corroborating source. It can also permit situational awareness allowing the human observer to pay attention to non-conventional data sources such as vibration, thruster wash and so.*

- Facilitates triangulation of data sources to improve confidence in a conclusion or finding.
- Can provide input to other processes – for example Digital Twins, fault finding, real time (algorithmic) verification etc.

Data Centricity as an Enabler for Verification and Validation

The complexity of DP systems has increased to the point where the number of simultaneous data points that must be collected to conclude that a system has performed to expectations exceeds the capability of a single human observer.

For some systems and some types of tests, confirmation that the end effect (often of a single test) is acceptable does not provide adequate levels of confidence that the system will perform and fail predictably. In such cases, observation of the end effect (no loss of position or heading) must be supported by various forms of data collection. This condition is most evident in power systems operating with closed busties or other means of power transfer where traditional methods of simulating failures do not adequately address the range of faults that power systems must be designed to tolerate without exhibiting an unacceptable degree of malfunction. Although the human observer can record the end effect, confirming that several layers of protective functions operated in coordinated manner, with adequate margins, requires post-test scrutiny and analysis of results. Model Based Testing (MBT) has been developed to answer these questions at DP FMEA proving trials. MBT is a highly data centric process which could eventually be extended to include the centralized storage and access requirements of wider industry definitions of digital data centricity.

Verification and validation using data centric methods will take various forms depending on the application. Data centricity for Annual DP trials may look quite different from data centricity for DP FMEA proving trials. Both of these use cases may differ from data centric methods used to establish a basis for confidence after a DP incident. Thus, there is no one-size-fits-all implementation of data centric methods, rather there are fundamental principles to be followed and tailored to each application.

The guiding principles for data centric verification and validation are:

- Test results (observer testimony) should be supported by substantiating and corroborating evidence (data).
- Data collected should satisfy the objective of the tests which should be to prove an element of performance, protection and detection upon which the single fault tolerance of the DP redundancy concept relies.
- Data should be presented in an assurable format. Images should be legible.

  Note: *An assurable format permits external users of the data to independently conclude on the validity of a test outcome, and the conclusions drawn from it, by reviewing the data.*

- Methods such as triangulation of several (preferably independent) data sources should be used to improve confidence in the results.
- An acceptable degree of Data Integrity should be assured.
- Information elements to be embedded to validate the evidence presented include:
  - Time and date stamps.

- Critical alarms and data points.
- Data quality indicators.

Notes:

1. *For annual DP trials, where vessel-time is critical, it is still the intention that the testimony of the human observer will form the primary basis for concluding that the DP vessel complies with the defined acceptance criteria. Data centric evidence collected during the trials will be used primarily in the assurance process to substantiate and corroborate the testimony of the DP trials practitioner.*
2. *For DP FMEA proving trials, return to work trials (following an incident) and to a slightly lesser extent 5 -Yearly revalidation trials, it is anticipated that the 'data centric' evidence will play a more significant role in reaching a conclusion of single fault tolerance.*
3. *Eventually, the data collection and processing practices of DP trials and DP FMEA proving trials will align more closely as adoption of digital data collection and processing methods continues. The adoption of data formats which are both human readable and machine verifiable may ease that transition.*

What Constitutes Substantiating and Corroborating Evidence?

The phrase 'substantiating and corroborating evidence' appears in DP guidance on verification and validation. The key words in this phrase have the following dictionary definitions:

- *'To substantiate a statement or a story means to supply evidence which proves that it is true'.*
- *'To corroborate an account, statement or idea, means to add additional or new information'.*

The supporting evidence provided with trials results includes the testimony of the observer(s) corroborated by the substantiating data. The term 'data' is often associated with its modern dictionary definition which is:

> *'the quantities, characters, or symbols on which operations are performed by a computer, which may be stored and transmitted in the form of electrical signals and recorded on magnetic, optical, or mechanical recording media.'*

However, in the context of DP verification and validation of DP, a broader dictionary definition is more appropriate:

> *'things known or assumed as facts, making the basis of reasoning or calculation.'*

The broader definition aligns with the concept of using identifiable and documented '*things*', collected during DP trials, as the basis of a conclusion.

So taken together, the act of providing '*data centric'* substantiating and corroborating evidence (data) means to add additional information that allows other stakeholders to conclude that the testimony and conclusion of the observer (trials practitioner) are valid.

What actual information is required to reach a conclusion depends on the test objective and the expected result and from these elements of the test it is possible to define the appropriate corroborating data to substantiate the testimony of the observer.

What Format and Types of Data Centric Evidence are Most Suitable for Each Type of Test?

(See also Appendix B) The format of evidence favored (digital or image) will vary from one subsystem to another, one configuration to another and from one type of trials to another. For vessels operating **with open busties**, the format of evidence favored for power and propulsion systems test at DP FMEA proving trials and that employed at annual DP trials will be different with greater use of digital data being used at DP FMEA Proving trials. Greater reliance can be placed upon image data at Annual DP trials in recognition of more limited facilities.

For power system configurations based on **closed busties**, or other forms of power transfer, digital data will be favored for DP FMEA Proving trials and Annual DP trials. Although the use of digital data is beneficial and encouraged, its use for systems other than power and propulsion is not quite so essential though this view may change over time. The above is summarized in Table 1.

Table 1 Choice of substantiating and corroborating evidence format.

Configuration	DP FMEA Proving Trials		Annual DP Trials	
	Power System	Other Systems	Power Systems	Other Systems
Isolated power systems	Digital Data	Image Data	Image Data	Image Data
Coupled power systems	Digital Data	Image Data	Digital Data	Image Data

Data centricity at DP FMEA proving trials will benefit from the specialist data logging facilities of OEMs involved in the vessel build or conversion (examples include data loggers, digital oscilloscope, history stations, applications for interrogating protection relays and PLCs etc.). It will also benefit from the skill of OEM personnel in setting up data collection and analysis formats such as trends with appropriate magnitude scaling, time resolution and data storage / retrieval. These facilities may not be present, to the same extent, in many annual DP trials and therefore data centricity may rely more heavily on other methods such as:

- Screenshots of pos-plots, and other screens.
- Print outs of trends, alarm views.
- Images from phones and cameras.

These imaged based methods:

- Lack the flexibility and post processing opportunities of digital data and therefore even greater care, and preparation is required to ensure the necessary data points are captured.
- Have the benefit of providing near instantaneous confirmation that the required data has been captured.
- Do not require extensive post processing to confirm or use their content but do add to the burden of creating a trials report.

  Note: This is less of an issue when a fully digital and comprehensive data centric approach is used as the data is always available – It is therefore less important to know what is needed before hand and therefore less important to remember to gather it at the time. This assumption does however rely heavily on the data collection process being ***comprehensive****.*
- Are limited to the data that can be viewed. Not all data points are accessible for viewing without additional measuring instruments. Useful data could be missed unless limitations are recognized and planned for.

The only course of action, if there is a significant amount of missing data, may be to repeat the test. Thus, the sooner a deficiency can be identified the better, preferably before the end of trials. This is a risk if substantiating and corroborating evidence collected by data logging systems is not interrogated before trials conclude.

Notes:

- *Data capture for report development must be clearly planned before trials and well-executed during trials. This may be challenging to do under pressure and requests for repeat testing (because human observers witness a successful test, but the substantiating and corroborating evidence was not correctly gathered) will be unwelcome.*
- *For the purposes of this paper, the term 'digital data' refers to numeric machine-readable data. The term 'image data' is used to mean digital images which are created for the purpose of viewing by humans such as photographs, videos, printouts etc.*

Reducing the Burden of Data Centricity

Initial investment of time and resources into data centric methods has potential to reduce the ongoing / periodic verification and validation (V&V) burden. Integration of fully data-centric systems on vessels to meet other objectives would allow easier adoption of data centric verification and validation as an added benefit. Therefore, planning to include or enhance V&V facilities in any upgrade of the DP system may be beneficial.

- Many DP trials programs already include elements of data centricity, so the additional burden is associated with extending its use to the rest of the trials program.
- Planning and preparation can reduce the impact on trials time and will produce returns on the initial investment.
- The most effective way to reduce the impact of data centric requirements **during execution** of the trials is to make maximum use of data logging facilities but care has to be taken to ensure the required information is actually being captured.
- There are many possible sources of digital data that can be exploited. Making best use of them does require preparation and practice. Typical sources include:
  - History stations in integrated VMS systems.
  - Protection relays. Standalone relays and those designed for GOOSE networks.
  - Advance Power System Protection and its HMI.
  - Drives (thruster and industrial mission)
  - Power management systems. Even basic PMS now offers the ability to log and export digital data.
- Data logging systems which can also perform algorithmic / automatic verification offer even greater advantages and time saving but are not yet widely implemented.

Data Centric Evidence Types and Formats

Appendix A shows two examples taken from an early attempt at a fully data centric trials program from a DP FMEA Proving trials on a DP class 3 vessel operating with closed busties. Lessons learned from the execution of this trials program have informed developments in the theory and practice of 'data centricity' as it applies to DP system verification and validation. The principles applied at the time this exercise was conducted are still generally valid.

In this example, the trials test objectives, methods expected results, and actual results are presented on the familiar (industry standard) test sheet. However, in a data centric trials program these instructions and expected results are supplemented by instructions to the trials practitioners to collect selected data points by identified methods to provide the necessary substantiating and corroborating evidence. An additional benefit of this format is the ability to include requests from authors of the DP system FMEA to the trials team onboard to collect information needed to complete the FMEA which cannot be obtained by other methods.

Appendix B shows part of a spreadsheet (developed by the School for Retention of Critical Knowledge (ROCK)) in which the types of evidence that must be collected are identified for a range of typical tests including what information should be collected, what format it should be in and also what barriers might be experienced in collecting such data so that facilities on the vessel can be cross checked for compatibility.

Note: *The need for such guidance should be reduced as the industry progresses towards fully digital implementation of data centricity. After which, the primary requirement would be selection of data / evidence to meet test objectives. However, it's likely there will always be a need for limited use of digital media / images and / or manually captured data.*

Data Centricity as Part of Evidence Based Comprehensive Verification and Validation

The publication of JDP01 'A Unified Approach to the Verification, Validation and Assurance of Single Fault Tolerance in DP Systems' further emphasized the importance of data centricity in the process of delivering Evidence Based Comprehensive Verification and Validation ($EBCV^2$). $EBCV^2$ is the primary process withing JDP01 and relies heavily on data centricity to fulfil requirements for EVIDENCE and transparency in the verification, validation and assurance process. Expectations for data centricity in $EBCV^2$ align more closely with expectation for DP FMEA proving trials described in this paper. Mathematical modeling of power systems, the use of model based testing and live testing drive requirements for extensive use and processing of digital data to conclude upon the single fault tolerance of coupled power systems.

What is next for Data Centricity in DP?

Industry initiatives to move towards data centric and remote verification (verifier not onboard) have shown that such methods are practical and possible, but the pace of uptake is modest. Currently, this practice only satisfies the requirements of DP industry guidance for Annual DP trials when the methods used have been approved by the appropriate classification society for that purpose.

In the fullness of time, remote verification and algorithmic verification using built-in test equipment will become mainstream. Until that time, variations in data types and formats for data centric trials will continue to be the norm. Currently, image-based data is used as substantiating and corroborating evidence to enhance the value of Annual DP trials, but the use of digital data is likely to increase because of the benefits of collecting it and reductions in the cost of deploying technology to collect and store it. In order to categorize the variations in type and format of evidence collected it is possible to conceive of a six-point scale to describe the data centric content of a trials program:

Level 0 - No data centricity.

Level 1 - Manually recorded variables and alarms.

Level 2 - Photographs and videos.

Level 3 - Proprietary data collection software with manual test execution and review.

Level 4 - Industry standardised data formats stored in a cyber-secure, widely accessible location, in line with wider industry definitions of data-centricity.

Level 5 - As for level 4 but with partial / full automation of test execution and review. Automatic production of human assurable reports.

Currently there are no plans to use such a categorisation scheme for any purpose, but it seems likely that assurance stakeholders will want some form of quality indicator by which to gauge the data centric content of a trials program.

Note: *Although the automated use of digital data has many advantages, the fact that a process is digital and automated does not necessarily make it better than a manual acquisition process unless proven to be so. As the primary objective is to derive a conclusion from the data, the source or format of the data is not the deciding factor. Rather, the suitability of the data points to confirm the test objective has been achieved is a more suitable metric. For example, taking three photographs might be a better and more transparent way of drawing a conclusion than a proprietary data stream indicating that a provided data point proves a result. From that perspective, a more useful or complementary scale would be one based on a data quality metric such as the extent to which the data supports the conclusion . In summary, 'automatic' is only better than 'manual' when there is evidence to demonstrate how it improves data centricity.*

Conclusion

DP trials are an essential element of proving the single fault tolerance of DP systems, initially, during the build phase, and periodically over the DP vessel's life cycle. Data Centricity means championing transparency in the execution of all types of DP trials. It is one of several initiatives in recent years to address concerns expressed by the DP community regarding the veracity and efficacy of DP trials results, findings and conclusions. It is compatible with, and integral to, these other initiatives and intended to form part of their execution protocol. Methods presented in this paper are intended for use when the trials are being supervised / witnessed by one or more DP trials practitioner (human observers) onboard the DP vessel.

Type of trials, DP vessel configuration and DP subsystem (to be tested) will all influence the selection of evidence types and formats. There is no one size fits all formula for data centricity rather there are guiding principles which if followed will allow developers of trials programs to identify the corroborating evidence that substantiates observations made by the trials practitioner(s) and the format in which that evidence will be collected.

Acknowledgements

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References

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2. OCIMF 'Unified Approach to Verification, Validation and Assurance of Single Fault Tolerance in Dynamic Positioning Systems' 7th July 2025.
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Appendices

Appendix A – Extracts from an Early Attempt at a Fully Data Centric DP FMEA Proving Trials Program

DNV

Conventional Test Sheet

EQUIPMENT SUBSYSTEM	DP CONTROL SYSTEM
Test No. 30	**DP Performance (Cross and Circle)**
Purpose:	To compare performance using each position reference system.
Assumption:	DP control system fully commissioned and tuned.
Document reference:	N/A

Method: Vessel in full auto DP, all thrusters online.

1. **Cross:** Use each position reference in turn as the sole source of position information to the DP system. Move the vessel along a 40m cross maintaining the same heading throughout and record the distance moved and the overshoot from PME not connected to DP. Note any significant deviation from the carrot during the move and any change of heading. Record the gain, draught and speed settings used and the environmental conditions at the time of the test. Use UTM Coordinates on the independent position reference to confirm number of metres moved. The vessel may be orientated North–South for ease of recording ΔL.
2. **Drifting:** Select all reference systems into the DP control system. Allow 20 minutes for the model to stabilise and observe if any position references appear to be drifting.
3. **Circle:** With all reference systems selected to DP, rotate the vessel through 360 degrees. Note the maximum divergence and confirm there are no dead zones.
4. **HPR Noise Rejection:** With the vessel on full auto DP, rotate the vessel through 360 degrees at high turning rate to create thruster noise and note whether HPRs drop out of DP.

Expected Results:

1. Vessel moves accurately along specified track - complete tables below.
2. No observable position reference drift.
3. There are no dead zones.
4. HPRs remain selected to DP.

Actual Results:

1. **Cross**

Settings and Environment during DGPS Test

Gain = (M) Speed: 0.2 Knot Draught: 19 M Water depth: 1000 M
Wind Speed/direction: 11 k @105° Heading: 82° Current/direction: 9.5 T @ 015°
Wave height/direction: <1m 82°
Rotation Centre: Centre Thrust Allocation Mode: Non Biased

DGPS-1 – DGPS 2 as Reference

DP	North	East	Deviation from Carrot	Stability	Heading	ΔL (m)	Over/under shoot
Start	2478437.7	688723.8					
20m As	2478434.3	688704.1	<1m	Good	<1°	19.9	<1m
40m Ah	2478440.5	688742.5	<1m	Good	<1°	38.9	<1m
20m As	2478437.6	688724.3	<1m	Good	<1°	18.43	<1m
20m P	2478456.3	688720.6	<1m	Good	<1°	19.06	<1m
40m S	2478418.0	688726.4	<1m	Good	<1°	38.73	<1m
20m P	2478437.6	688723.9	<1m	Good	<1°	19.7	<1m

DNV

EQUIPMENT SUBSYSTEM **DP CONTROL SYSTEM**

Test No. 30 **DP Performance (Cross and Circle)**

DGPS 2 – DGPS 1 as Reference

DP	North	East	Deviation from Carrot	Stability	Heading	ΔL (m)	Over/under shoot
Start	2478437.6	688724.4					
20m As	2478434.3	688704.6	<1m	Good	<1°	20.07	<1m
40m Ah	2478440.3	688743.0	<1m	Good	<1°	38.86	<1m
20m As	2478437.6	688724.3	<1m	Good	<1°	18.89	<1m
20m P	2478457.1	688721.0	<1m	Good	<1°	19.77	<1m
40m S	2478417.8	688726.6	<1m	Good	<1°	39.69	<1m
20m P	2478437.4	688723.9	<1m	Good	<1°	19.78	<1m

Note: Stability is considered acceptable if the vessel settles on or near the target, does not continue oscillating, does not exceed the maximum speed set by the operator, follows the carrot smoothly, no sudden deviations, does not delay and then run past the carrot, wander far from the carrot or far from the axis of movement.

Note: Deviation from carrot is any significant deviation that occurs during the move

Settings and Environment during HPR Test

Gain = (M) Speed: 0.3 knots Draught: 19m Water depth: 1208m

Wind Speed/direction:12 kts @ 080° Heading: 45° Current/direction: 10.4T @ 165°

Wave height/direction: 1 to 2 meters @ 45°

Rotation Centre: yes Thrust Allocation Mode: No Bias

HPR 1 – HPR 2 as Reference

DP	North	East	Deviation from Carrot	Stability	Heading	ΔL (m)	Over/under shoot
Start	2478618.7	688578.5					
20m As	2478606.0	688565.2	<1m	Good	<1°	18.38	<1m
40m Ah	2478632.0	688591.5	<1m	Good	<1°	36.98	<1m
20m As	2478619.8	688579.8	<1m	Good	<1°	16.9	<1m
20m P	2478631.8	688564.8	<1m	Good	<1°	19.2	<1m
40m S	2478605.5	688591.4	<1m	Good	<1°	37.4	<1m
20m P	2478618.9	688579.1	<1m	Good	<1°	18.2	<1m

HPR 2 – HPR 1 as Reference

DP	North	East	Deviation from Carrot	Stability	Heading	ΔL (m)	Over/under shoot
Start	2478618.9	688579.1					
20m As	2478605.6	688565.3	<1m	Good	<1°	19.16	<1m
40m Ah	2478631.5	688591.2	<1m	Good	<1°	36.62	<1m
20m As	2478619.4	688579.6	<1m	Good	<1°	16.76	<1m
20m P	2478631.9	688565.6	<1m	Good	<1°	18.76	<1m
40m S	2478605.2	688591.5	<1m	Good	<1°	37.19	<1m
20m P	2478618.2	688580.2	<1m	Good	<1°	17.22	<1m

DNV

EQUIPMENT SUBSYSTEM	DP CONTROL SYSTEM

Test No. 30 **DP Performance (Cross and Circle)**

Step 2

	Easting	Northing	Heading	ΔL (m)
Start	688578.4	2478606.2	005°	
1 min	688578.6	2478612.0	005°	5.8
2 min	688579.7	2478615.2	005°	3.38
3 min	688580.2	2478619.0	005°	3.83
4 min	688580.1	2478618.5	005°	0.50
5 min	688580.5	2478618.2	005°	0.50

Note: Stability is considered acceptable if the vessel settles on or near the target, does not continue oscillating, does not exceed the maximum speed set by the operator, follows the carrot smoothly, no sudden deviations, does not delay and then run past the carrot, wander far from the carrot or far from the axis of movement.
Note: Deviation from carrot is any significant deviation that occurs during the move

2. Drifting: 5 meters over 5 minutes
3. Circle: No dead zones and satisfactory divergence.
4. HPR Noise Reduction: HPRs are not lost and operate throughout the range of headings.

Comments:

Start date:	21 Dec. 2020	**Start time:**	Various
End date:	25 Dec. 2020	**End time:**	Various
NDms:		**Date:**	25 Dec. 2020
Class:		**Date:**	25 Dec. 2020
Trials Manager:		**Date:**	25 Dec. 2020
Owner:		**Date:**	25 Dec. 2020

SUBSTANTIATING EVIDENCE				
Please record the following data points from available data monitoring and capture devices.				
ID No.	**Data Point**	**Evidence**	**Reference**	**Remarks**
1.	DP/VCS Alarm list during testing window	See Test Sheet Folder 30	Evidence for Test No. 30	
2.	DP System Posplot	See Test Sheet Folder 30	Evidence for Test No. 30	
3.	DP System Plot of Thruster and Current forces	See Test Sheet Folder 30	Evidence for Test No. 30	
4.				
5.				
6.				
7.				
8.				
9.				
	This column records the parameter under observation (Position, Current, Voltage, Angle etc.) This column is to be filled by FMEA / Trials author.	This column records the type of evidence and its source. For e.g. PMS Alarm List File, DP Alarm List Printout, DP Position plot Screenshot etc. This column is to be filled by	Reference / Cross reference to figure and page number that provides the evidence logged (E.g. Appendix B Page 21, Figure 11). The data under review and the results from the testing should be observable from the evidence. The reader should be able to come to the same conclusions as the author. This column is to be filled by Trials Surveyor.	Remarks on whether the evidence supports the analysis, or the analysis needs to be updated. This column is to be filled by Trials Surveyor.
Note: Substantiating evidence in detail may not be required for single component failure testing. Witness observation and recording is sufficient in some cases, these will be highlighted on a per test basis.				

The substantiating and corroborating evidence that the trials team were asked to collect

Guidance to the trials team on how and why to collect the information

INFORMATION REQUEST FOR FMEA			
Please check / request the below information from the vessel.			
ID No.	**FMEA Reference**	**Information Requested**	**Surveyor Response**
TBC 1.			
TBC 2.			
TBC 3.			
TBC 4.			
	This column refers to the FMEA reference that is lacking the subject information.	Type / detail of information requested.	Surveyor response including references to substantiating documentation / evidence.
Note: Surveyor response can refer to available documentation / Pictures / Screenshots.			

No additional evidence was required to complete the DP System FMEA from this particular test

First of several images provided as substantiating and corroborating evidence for Test 30

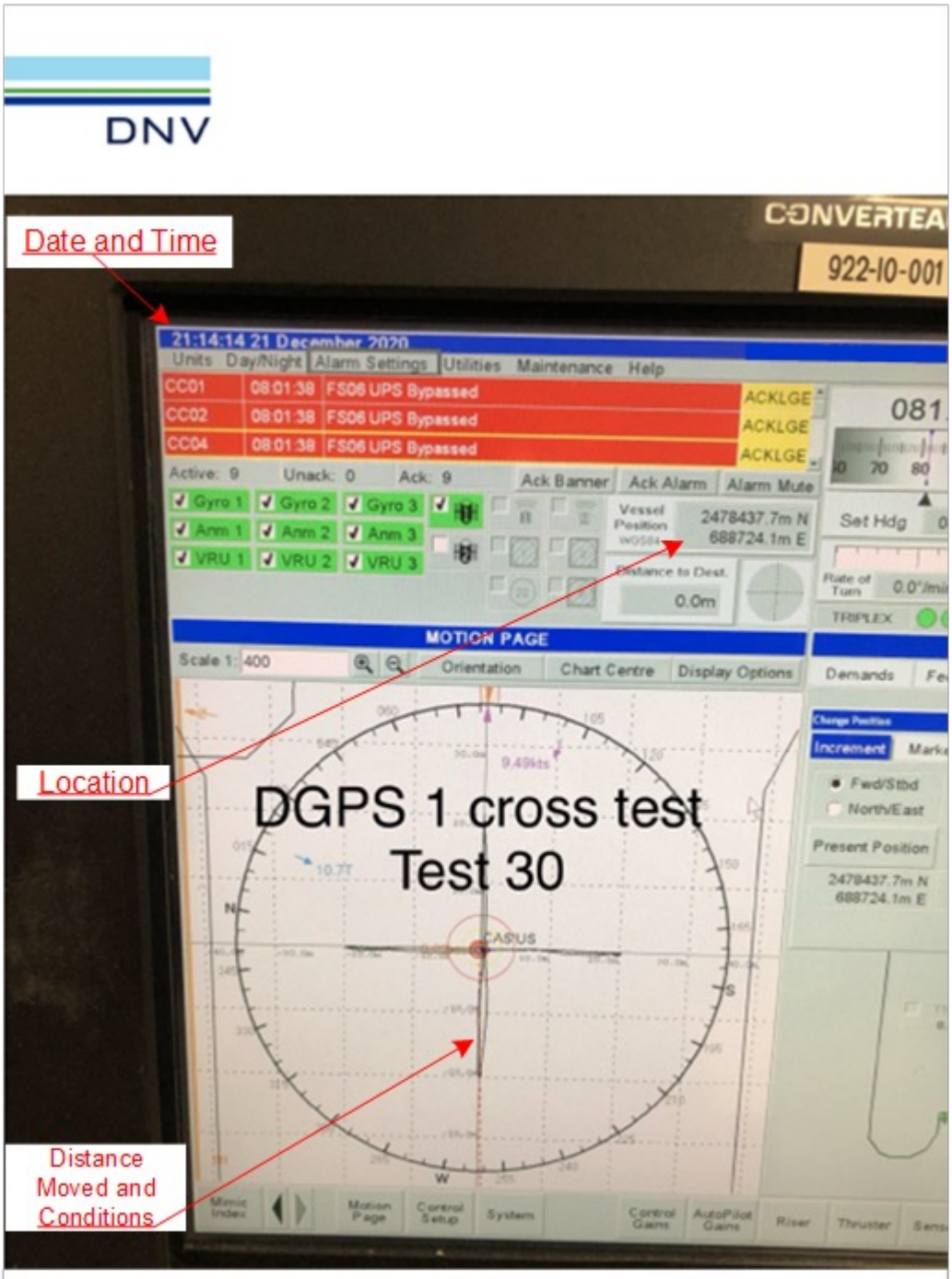


Image Data From Smart Phone Camera

DNV

Conventional Test Sheet

EQUIPMENT SUBSYSTEM	POWER MANAGEMENT
Test No. 78	**Thruster Phaseback – Power Plant Stability**
Purpose:	To demonstrate that standby generators are able to connect during thruster phase back – no problem with synchronization during thrust reduction. To prove that the thrust reduction measures are able to cope with a generator which has not yet been able to share load. -
Assumption:	DP / IAS (PMS) / power plant and thrusters fully commissioned and operational.
Document reference:	

Method: With the vessel under manual control HV busties closed all thrusters online. Two generators connected. Make sure all offline generators are assigned as not standby but be ready to make a standby generator available. Use thrusters in opposition such that the generators are loaded to about 85%.

1. When stable at high load, stop one generator to give the thrust reduction system a thorough test and observe that thrust is immediately phased back to prevent the single generator overloading and vessel continues using the remaining power. Put all thruster levers to full thrust during this time (No Blackout).
2. Make a standby set available and observe that it connects.
3. As soon as the standby set connects, but before it has a chance to load-share, trip the generator which is in parallel with it. Observe that thrust reduction operates again to prevent over-load and allows the generator to follow its load-up ramp.
4. Make another standby set available and observe that it connects – thrust demand can be reduced after connection.

Expected Results:

1. Thrusters phase back and thereafter ramp back up without overloading online generator. Vessel power plant can stabilise without a blackout. Alarm received on DP / VCS for thrust reduction.
2. Standby set connects to the bus.
3. Thruster phase back operates without causing a vessel black out. Thrusters ramp back up without overloading the online generator.
4. Standby set connects to the bus.

Actual Results:

1. Phase back operated to prevent overload. Alarm received for activation of phaseback. Power plant stabilised and thrusters ramped up as necessary.
2. Standby set connects to the bus and just about to start load sharing.
3. Standby set tripped; phase back operated to prevent overload. Power plant stabilised and thrusters ramped up as necessary.
4. Standby set connects to the bus and starts load sharing.

Comments:

Start date:	09 Jan. 2021	**Start time:**	Various
End date:	11 Jan. 2021	**End time:**	Various
NDms:		**Date:**	11 Jan. 2021
Class:		**Date:**	11 Jan. 2021
Trials Manager:		**Date:**	11 Jan. 2021
Owner:		**Date:**	11 Jan. 2021

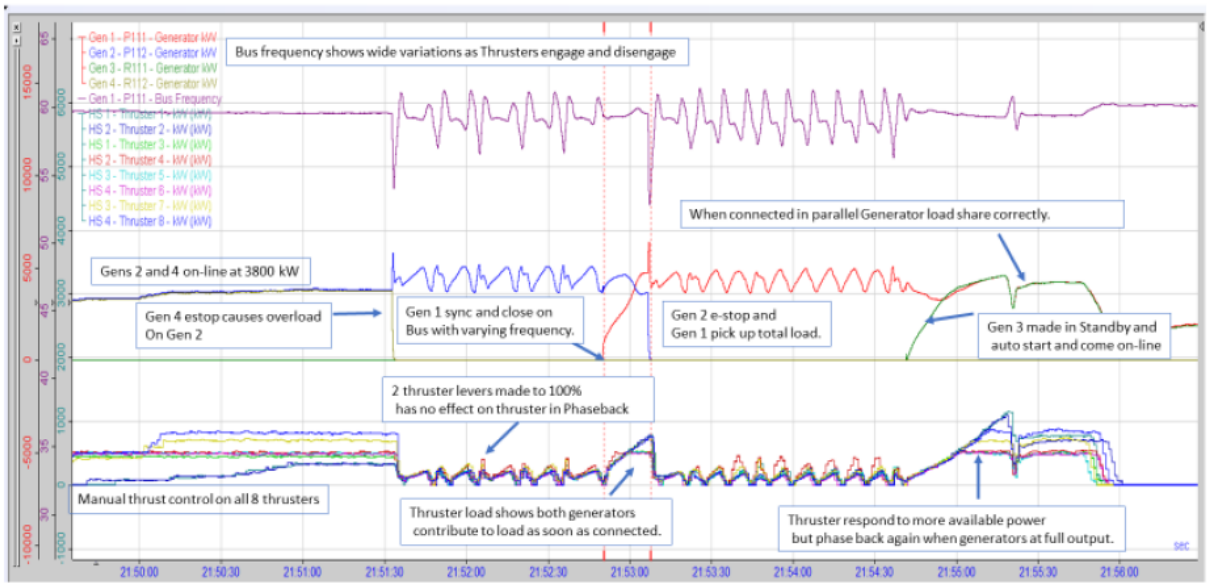
SUBSTANTIATING EVIDENCE				
Please record the following data points from available data monitoring and capture devices.				
ID No.	**Data Point**	**Evidence**	**Reference**	**Remarks**
1.	Alarm list during testing window		NA	
2.	Effect on Generators and Thrusters		Evidence for Test No. 78	
3.	Effect on DP Station Keeping		Evidence for Test No. 78	
4.				
5.		The substantiating and corroborating evidence that the trials team were asked to collect		
6.				
7.				
8.				
9.				
	This column records the parameter under observation (Position, Current, Voltage, Angle etc.) This column is to be filled by FMEA / Trials author.	This column records the type of evidence and its source. For e.g. PMS Alarm List File, DP Alarm List Printout, DP Position plot Screenshot etc. This column is to be filled by Trials Surveyor.	Reference / Cross reference to figure and page number that provides the evidence logged (E.g. Appendix B Page 21, Figure 11). The data under review and the results from the testing should be observable from the evidence. The reader should be able to come to the same conclusions as the author. This column is to be filled by Trials Surveyor.	Remarks on whether the evidence supports the analysis, or the analysis needs to be updated. This column is to be filled by Trials Surveyor.
Note: Substantiating evidence in detail may not be required for single component failure testing. Witness observation and recording is sufficient in some cases, these will be highlighted on a per test basis.				

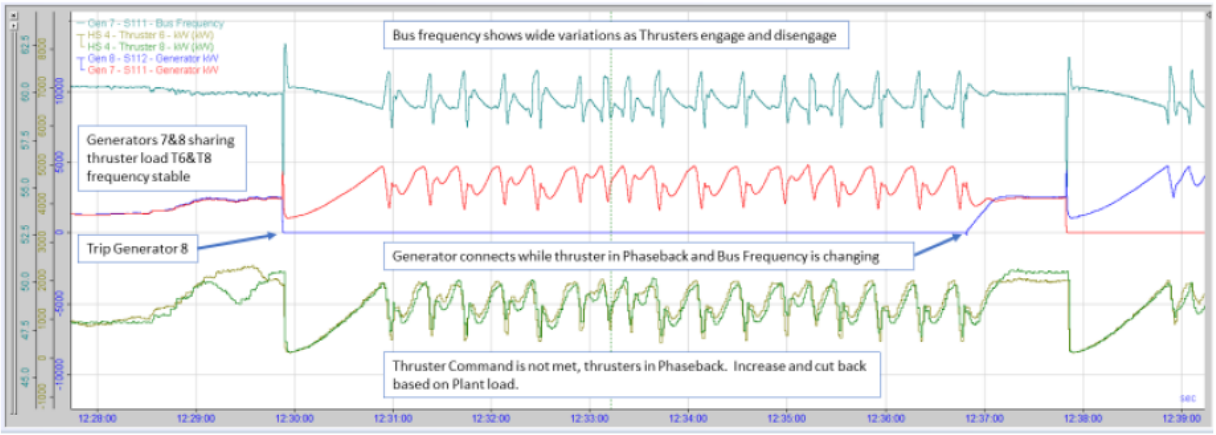
DNV

INFORMATION REQUEST FOR FMEA			
Please check / request the below information from the vessel.			
ID No.	**FMEA Reference**	**Information Requested**	**Surveyor Response**
TBC 1.			
TBC 2.			
TBC 3.			
TBC 4.			
	This column refers to the FMEA reference that is lacking the subject information.	Type / detail of information requested.	Surveyor response including references to substantiating documentation / evidence.
Note: Surveyor response can refer to available documentation / Pictures / Screenshots.			

No evidence was required to be collected on this subsystem during this test to complete the DP system FMEA

First of several images provided as substantiating and corroborating evidence for Test 78 – Processed and annotated output from Digital Data collected by closed bus upgrade OEM





Appendix B – Extracts from Table Defining Evidence Types and Formats to be Collected - for Typical Tests

Table 2 Extract from Developing Evidence Types to be Collected (Courtesy School for ROCK)

DP TRIALS DATA CENTRIC EVIDENCE - ALLOWING CONCLUSIONS TO BE DRAWN					
CATEGORY	**PERFORMANCE ATTRIBUTES**	**PROTECTION ATTRIBUTES**	**DETECTION ATTRIBUTES**	**POTENTIAL BARRIERS**	**REMARKS**
MARINE AUXILIARY SYSTEMS	Data logging and / or trends of temperature / pressure parameters for the duration of the test.	Survey element: Photo / video evidence.	Alarm Log - IAS. Screenshot of system mimic.	Lack of data logging or trend facility.	Trend templates with relevent IO to be prepared.
GENERATORS	ENGINE PARAMETERS: Data logging and / or trends of temperature / pressure parameters for the duration of the test. ALTERNATOR PARAMETERS: Data logging and / or trends of alternator temperature, power and frequency parameters for the duration of the test. LOAD ACCEPTANCE / REJECTION / STABILITY: Trends showing all generator power and frequency parameters, thruster power limitation signals for the duration of the test. At IAS and DP.	ENGINE Data logging and / or trends of temperature / pressure parameters as applicable. Alarm Log - IAS. ALTERNATOR Data logging and / or trends of temperature parameters as applicable. Protection relay log. Alarm Log - MSB / IAS.	Alarm Log - MSB / IAS / DP.		
THRUSTERS	THRUSTER PARAMETERS: Trend data for ramps time / rate of turn and speed / pitch / steering performace. Data logging and / or trends of temperatures / pressures parameters for the duration of the test. Alarm Log: IAS and DP. MOTOR / DRIVE PARAMETERS: Data logging and / or trends of temperature parameters for the duration of the test.	CONTROL LOOPS: Trend data for speed / pitch / steering damand and feedback. Trend data for vessel heading and position set points with measured offset. Alarm Log - DP and IAS. EMERGENCY STOPS: Alarm Log - DP and IAS.	CONTROL LOOPS: Trend data for speed / pitch / steering damand and feedback. Trend data for vessel heading and position set points with measured offset. Alarm Log - DP and IAS. EMERGENCY STOPS: Alarm Log - DP and IAS.		
GENERATOR SPEED CONTROL	ENGINE PARAMETERS: Data logging and / or trends of speed parameters for the duration of the test. ALTERNATOR PARAMETERS: Data logging and / or trends of active power and frequency parameters for the duration of the test. Alarm Log: MSB / IAS.	ALTERNATOR PARAMETERS: Data logging and / or trends of active power and frequency parameters for the duration of the test. Alarm Log: MSB / IAS.	Alarm Log: MSB / IAS.		