



WHEN TRUST MATTERS

# A story of solving hidden challenges

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21 November 2023



## Born in 2010

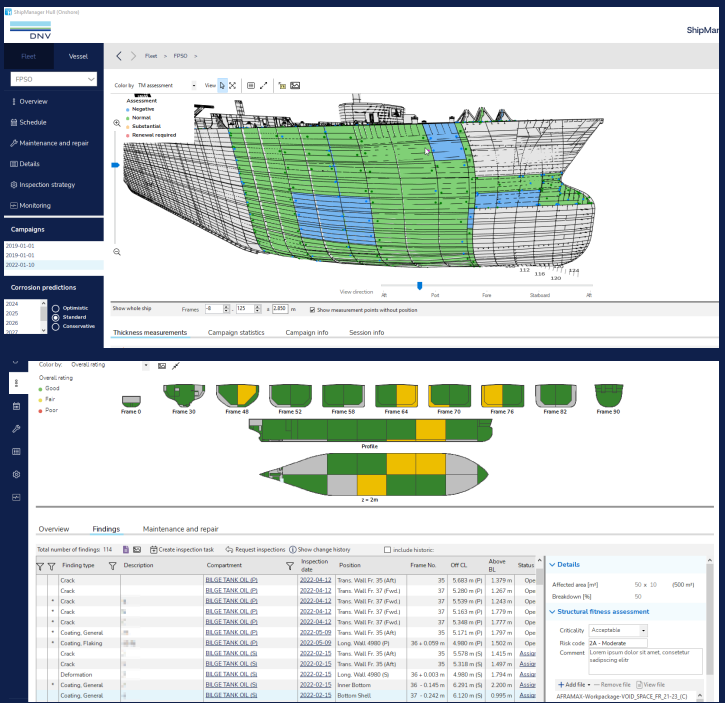
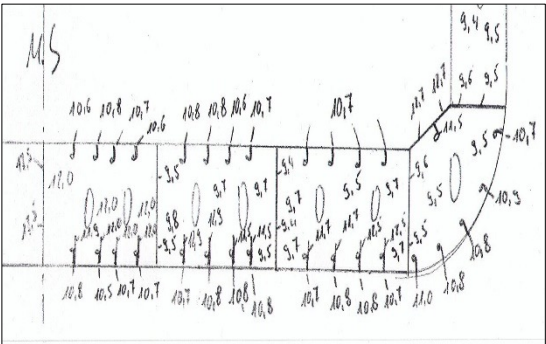
ship sizes and design complexity reached new levels

domain knowledge essential onboard and onshore

conventional tools for hull integrity became inadequate

# How to get from this ...

# ... to this



## Highly manual

## Digital workflow



## Superintendent / Naval Architect

- Domain knowledge of hull architecture
  - Inspection and maintenance strategy
- Safety and compliance
  - Collaboration with external professionals



## Crew

- Deck operations
- Navigation assistance
- Safety protocols
- Cargo handling
- Maintenance and repairs

# How to standardize hull inspection strategies across the fleet?

# Standardized Inspection Strategy



Fleet Vessel

Overview

Inspection strategy

Monitoring

Settings

Fleet inspection strategy

Compartment type	Interval (months)	Time window start (months)	Time window end (months)	Coating	Corrosion	Deformation	Crack	Pipes	Ladders	Valves	Heating coils	Anodes	Sediments
Shell / Weather Deck	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cargo Space	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hatch Cover	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ballast Water Tank	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Heavy Fuel Oil Tank	60	12	0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Diesel/Gas Oil Tank	60	12	0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lube Oil Tank	60	12	0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Exhaust Gas Cleaning Tank	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Fresh Water Tank	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Grey Water Tank	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Black Water Tank	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Laundry Water Tank	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Miscellaneous Tank	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Void Space	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Passage Way	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Access Way	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Machinery Space	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Store / Workshop	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Deckhouse	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Duct	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hotel Area	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Crew Area	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Staircase	12	3	3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Custom inspection subjects

Subject

Initial ratings

- None
- Good
- Ratings from previous inspection
  - Can only be improved by technical inspector

Initial findings

- None
- Findings from previous inspection
  - Can only be deleted by technical inspector

Conditions to finish recording inspections

- Enter descriptions for FAIR or POOR ratings
- Create findings for FAIR and POOR ratings
- FAIR or POOR rating required if findings of this type exist
- Enter always finding's details or descriptions
- Assign at least one photo to a finding
- Assign at least one photo to an extra inspection task
- Assign at least one photo to an area of attention
- Assign at least one finding per photo
- Mark each photo in 3D graphic
- Mark each finding in 3D graphic
- Confirm that all areas of attention have been inspected
- Open inspection guidance documents

Conditions to create inspections

- Approve all requested inspections on shore
- Show warning (comprehensive inspections onboard)

Conditions to close maint./repair activities

- Close maint./repair activities only on shore
- Assign follow-up inspection before closing
- Assign at least one repair photo to a repaired finding

New custom subject

Remove selected subject

Reset strategy

Import strategy

Update ships



# How to harvest and visualize hull data?

# Easy-to-use 3D – Data Visualization

ShipManager Hull (Onshore) - □ ×

DNV ShipManager Hull | 🖨️ ↺ ☰ ⌚ ↻

Fleet > FPSO > ENGINE ROOM S. Eggert

Color by Walls View Findings Photos

View direction: Fore

**Display options**

Walls

- Transverse Web Fr 14
- Transverse BHD Fr 15
- Transverse Web Fr 16
- Transverse Web Fr 17
- Transverse Web Fr 18
- Transverse Web Fr 19
- Transverse Web Fr 20
- Transverse Web Fr 21
- Transverse Web Fr 22
- Transverse Web Fr 23
- Transverse Web Fr 24
- Transverse Web Fr 25
- Transverse Web Fr 26
- Transverse Web Fr 27
- Transverse Web Fr 28
- Transverse Web Fr 29
- Transverse Web Fr 30

Select all Clear

Element types  
Finding positions  
Other

View direction: Port Fore Starboard

Ratings Ratings (Outfittings) Findings Photos Documents Info 📄 In progress (shore) Inspection date: 2023-04-20 ⌚ Scheduled (comprehensive)

Overall rating: ■ Good

Position	Coating	Coating description	Corrosion	Corrosion description	Deformation	Deformations description	Crack	Cracks description
Stairs	<span style="color: green;">■</span> Good		<span style="color: green;">■</span> None/Light					

Settings

Finish recording
Print inspection form
Create report
Delete selected inspection
New inspection



# Easy-to-use 3D – Data Harvesting (simple reporting)

The screenshot displays the ShipManager Hull (Onshore) software interface. The main window shows a 3D model of an engine room with a photo overlay of a crack in a deck. The interface includes a left sidebar with navigation options like Overview, Schedule, Maintenance and repair, Details, Inspection strategy, Monitoring, Current status, and Inspections. The top navigation bar shows the current location: Fleet > FPSO > ENGINE ROOM. The main view area has a toolbar with options like Color by Walls, View, Findings, Photos, and Documents. A photo of a crack is shown in a window titled 'Crack...' with a zoom level of 46%. The right sidebar contains 'Display options' for Walls (listing Transverse Web Fr 14-24) and 'Photo details' (listing Crack (Deck 20275 AB) and Crack (Transverse Web Fr 25)). The bottom of the interface has buttons for 'Finish recording', 'Print inspection form', 'Create report', 'Delete selected inspection', and 'New inspection'.

# Easy-to-use 3D – Touchable Data

ShipManager Hull (Onshore) ShipManager Hull | S. Eggert

DNV

Fleet > FPSO > ENGINE ROOM

Color by Walls

View [Icons]

Findings [Icon] Photos [Icon]

View direction: Fore/down

**Display options**

Walls

- Transverse Web Fr 14
- Transverse BHD Fr 15
- Transverse Web Fr 16
- Transverse Web Fr 17
- Transverse Web Fr 18
- Transverse Web Fr 19
- Transverse Web Fr 20
- Transverse Web Fr 21
- Transverse Web Fr 22
- Transverse Web Fr 23
- Transverse Web Fr 24
- Transverse Web Fr 25
- Transverse Web Fr 26
- Transverse Web Fr 27
- Transverse Web Fr 28
- Transverse Web Fr 29
- Transverse Web Fr 30
- Transverse Web Fr 31

Select all Clear

Element types  
Finding positions  
Other

Photo details  
Related findings

3 Photos + Add photo - Remove photo View photo

Settings

Finish recording Print inspection form Create report Delete selected inspection New inspection

**Plate**

Thickness: 15.00 mm  
Material: 235  
Extent: From FR 15 To FR 27  
Longitudinal: FR 15 FR 27 10.80 m  
Transversal: CL + 8.975 m (S) CL + 4.575 m (S) 4.40 m  
Vertical: BL + 20.275 m  
Member type: DECK  
subsl\_PL18513\_ENGINE ROOM(pw\_B2974427-033B-48B9-83C6-6BFC2A7C5BB1)

Inspection date: 2023-04-20 Scheduled (comprehensive)

Ratings Ratings (Outfittings) Findings

# Easy-to-use 3D – Integration

ShipManager Hull (Onshore) ShipManager Hull

DNV S. Eggert

Fleet > FPSO > ENGINE ROOM

Color by Walls View Findings Photos

**Display options**

Walls

- Transverse Web Fr 14
- Transverse BHD Fr 15
- Transverse Web Fr 16
- Transverse Web Fr 17
- Transverse Web Fr 18
- Transverse Web Fr 19
- Transverse Web Fr 20
- Transverse Web Fr 21

Select all Clear

Element types  
Finding positions  
Other

**Thickness Measurement Point**

Compartment: ENGINE ROOM  
Part: Plate  
Structural member: Deck 20275 AB  
Original thickness [mm]: 13.0  
Max. diminution [mm]: 2.6  
Measured thickness [mm]: 8.0  
Diminution [mm]: 5.0  
Diminution [%]: 38.5  
Assessment: Structural part to be renewed  
Frame No.: 15 + 0.355 m  
Off CL: 2.316 m (P)  
Above BL: 20.275 m

0AE7A43E603C44918616D3D4D65A4698

Part	Structural member	Original thickness [mm]	Max. diminution [mm]	Measured thickness [mm]	Diminution [mm]	Diminution [%]	Assessment	Frame No.	Off CL	Above BL
Deck 20275 AB	Deck 20275 AB	13.0	2.6	8.0	5.0	38.5	Structural part to be renewed	15 + 0.355 m	2.316 m (P)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	8.8	4.2	32.3		15 + 0.355 m	2.316 m (P)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	13.0	0.0	0.0		18 - 0.375 m	3.519 m (P)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	12.9	0.1	0.8		18 - 0.300 m	2.459 m (P)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	9.0	4.0	30.8		16 - 0.412 m	1.535 m (P)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	13.0	0.0	0.0		15 + 0.417 m	0.452 m (P)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	12.9	0.1	0.8		17 + 0.408 m	1.418 m (P)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	9.0	4.0	30.8		17 + 0.433 m	0.201 m (P)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	13.0	0.0	0.0		15 + 0.295 m	0.463 m (S)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	13.0	0.0	0.0		18 + 0.323 m	0.556 m (S)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	8.7	4.3	33.1		15 + 0.439 m	2.496 m (S)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	13.0	0.0	0.0		18 + 0.026 m	2.189 m (S)	20.275 m
Deck 20275 AB	Deck 20275 AB	13.0	2.6	8.1	4.9	37.7		16 - 0.417 m	2.470 m (S)	20.275 m

Session '2019-01-01 - 2019-01-13'

Print inspection form Create report Modify selected inspection New inspection

# How to make hull data smart?

# Smart Data – Prediction System / Machine Learning

The screenshot displays the ShipManager Hull software interface. On the left, a navigation sidebar includes options for Fleet, Vessel, Overview, Schedule, Maintenance and repair, Details, Inspection strategy, Monitoring, and Campaigns. The main area shows a 3D model of a ship's hull with a grid overlay representing corrosion prediction. The model is color-coded by TM assessment: Negative (blue), Normal (green), Substantial (orange), and Renewal required (red). A dialog box titled "Calculate corrosion prediction" is open, containing a "Corrosion prediction data" section with a "Disclaimer" and an "Important note". The disclaimer states that corrosion depends on many factors and that the model's results should be interpreted with limitations in mind. The important note emphasizes that the model's results should not be used as the sole source for repair decisions and that significant discrepancies should be reviewed and approved by the respective class society. The dialog box has "Accept" and "Cancel" buttons.

ShipManager Hull (Onshore)

DNV

ShipManager Hull | S. Eggert

Fleet > FPSO >

Color by: TM assessment

View

Assessment

- Negative
- Normal
- Substantial
- Renewal required

View direction: Starboard

Calculate corrosion prediction

Corrosion prediction data

Disclaimer

**Important note**

Corrosion depends on many factors such as temperature, salinity, humidity, cargo type, mechanical wear and tear, most of which can't be consistently monitored. It is state of the art to use corrosion models with a limited number of parameters. Hence, results of corrosion prediction should be interpreted with these limitations in mind. ShipManager Hull uses a nonlinear corrosion model with predefined corrosion rates based on compartment type, actual measurements and ratings.

By using the Corrosion prediction module of ShipManager Hull, the client acknowledges that results shall only be used in accordance to the methodology specified by DNV. Result from ShipManager Hull shall not be used as the only source for repair decisions. Instead, the client is obliged to cross-check the results with results obtained from other sources such as past operational experience. In case of significant discrepancies, results from ShipManager Hull shall not be used. Further, repair decisions are subject to review and approval by the respective class society.

Accept Cancel

View direction: Aft Port

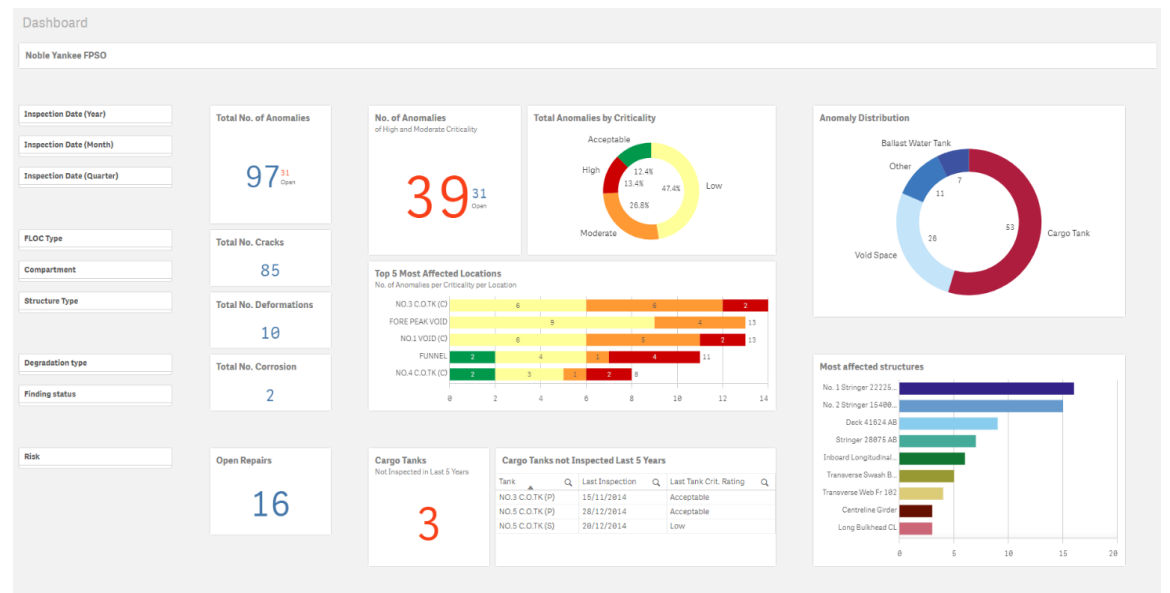
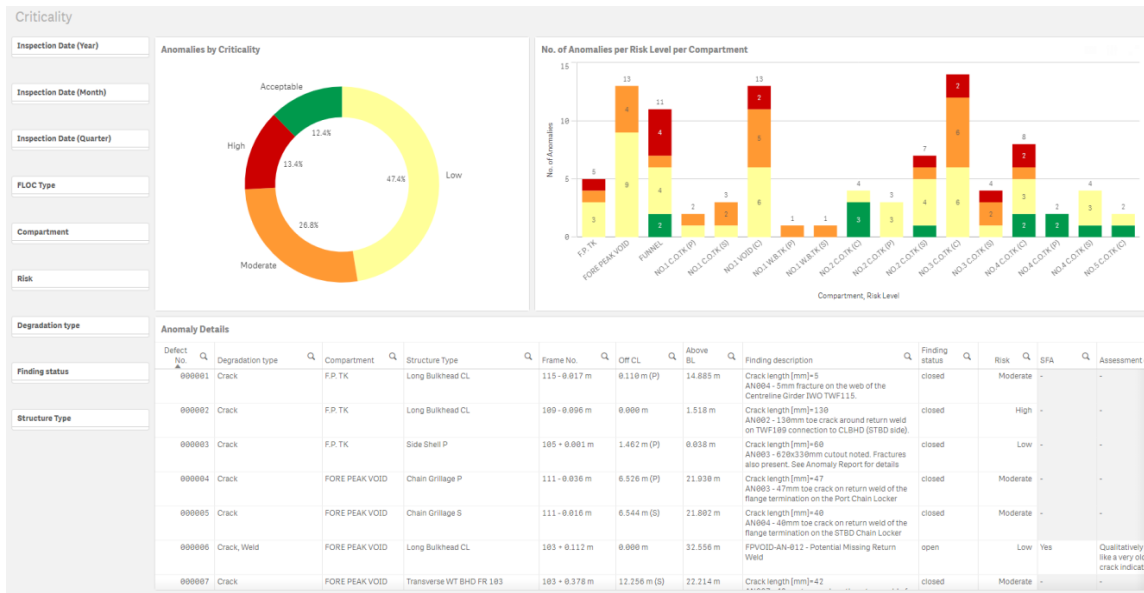
Show whole ship Frames: -8 - 125 ± 2.850 m  Show measurement points without position

Thickness measurements Campaign statistics Campaign info Session info

Show all sessions

Calculate corrosion prediction Merge measurements Export measurement files Remove measurements Import measurements

# Smart Data – Advanced Reporting



# Smart Data – Simplified Onboard/Office Reporting

ShipManager Hull (Onshore)

DNV

Fleet Vessel

Overview

Inspection strategy

Monitoring

Settings

Fleet >

### Report contents

Select contents to be included in the report

Report settings

Report type:  File Type: Pdf files (\*.pdf)

Compartment type:

Summary (Status including the latest results only)

Pending inspections

Main data

Ship status (Including overall compartment information and due dates)

Upcoming inspections

overdue  due  due soon

Ship inspection results (All inspection results recorded for all compartments)

Latest scheduled comprehensive inspection and subsequent partial inspections

Inspection date:  -

with photos  with hcfWall views  with photo coordinates

Maintenance and repair

Status:

Due date:  -

include activities without due date

Findings

Findings of the latest scheduled comprehensive and subsequent partial inspections

Inspection date:  -

Only new findings

Include status:  Open  Assigned  Closed

Include criticality:  No assessment  Acceptable  Low  Medium  High  Severe  Unacceptable

- (Select all)
- AFRAMAX
- FPSO
- Linda 1
- Linda 2
- Linda 3
- MS Linda
- WIND

ShipManager Hull

S. Eggert

Ship status report - Adobe Acrobat Reader (32-bit)

File Edit View Sign Window Help

Home Tools Ship status report x

9 / 52 52,6%

2.3 Inspection results

Inspection results: 2023-11-19 – 2023-11-20 | with photos

2.3.1 AFT PEAK TK (C)

Scheduled (comprehensive) inspection 2023-09-19

Inspected by	Approved (onshore)
P. Wittevoort	P. Wittevoort
Inspected by	Approved (onshore)
P. Wittevoort	P. Wittevoort

Findings

- 2 Findings (2 new)
- Coating, General: Affected area (11x2): Breakdown (N)40; Coating on soot
- Anodes

Comment

Instructions from shore

Wall	Area	Coating	Rating	Description	Information	Measure	Reception
Side Shell (S)		Good	Good				
Side Shell (S)		Good	Good				
Trans. Wall P1 - S(30) (AH)		Good	Good				
Trans. Wall P1 - S(2) (Peak)		Good	Good				
Bottom		Good	Good				
Deck 100 (100%)		Good	Good				
Deck 100 (100%)		Good	Good				
Deck 100 (100%) (T10)		Good	Good				

Face	Rating	Description
Face		
Labels		
Welds		
Anodes	Good	
Electronics		

Item	Problem/Defect	Description	Position	Area/No.	Off. Co.	Area/No.	Status	Criticality	Reference
1	Coating, General	Affected area (11x2): Breakdown (N)40; Coating on soot	Trans. Wall P1 - 12 (Peak)	12	5.747 m (S)	9.862 m	Open	Medium	Fig. 2.9
2	Anodes			11 - 0.390 m	4.828 m (S)	9.123 m	Open		Fig. 2.2

Report generated by ShipManager Hull 2.1.0 2023-11-20 Page 9

Generate report





WHEN TRUST MATTERS

# A story of solving hidden challenges

21 November 2023



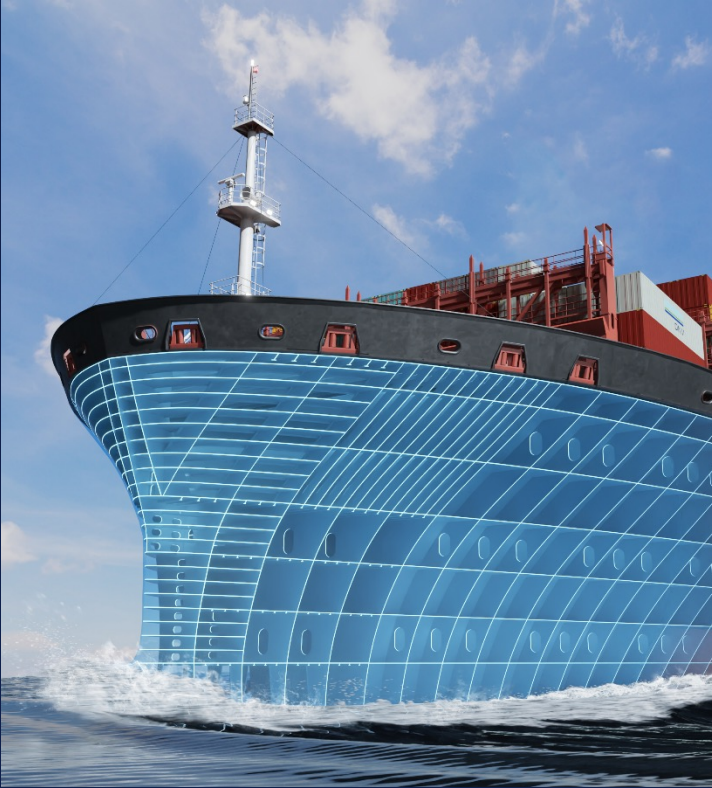


WHEN TRUST MATTERS

# A story of creating digital solutions

21 November 2023

# DNV digital solutions



Hull inspection



Port clearance



Fleet management

# Let's connect

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**DNV**