Appendix D:

Stability calculations carried out by the NSIA

Appendix D6:

Drawings used by NSIA as basis for stability calculations

APPENDIX D - STABILITY CALCULATIONS CARRIED OUT BY THE NSIA

D.1 INTRODUCTION

The frigate's stability manual was prepared by the marine consulting company Polarkonsult AS and approved on 24 June 2016 by the classification society DNV GL. The manual is based on DNV Rules for Ships (January 2010) Part 5, Chapter 14 Section 5 (Class Notation +1A1 NAVAL) and Part 3, Chapter 1 Section 5.

DNV GL's rules describe a range of loading conditions to be calculated both for intact and damage stability criteria. In principle, the loading conditions are meant to be representative of parts of the vessel's operating cycle, but the actual sailing condition will mostly deviate from the conditions in the rules. The rules therefore recommend developing curves for maximum allowable vertical centre of gravity (VCG) curves. The VCGmax curves shall be calculated based on both intact and damage stability requirements.

If the crew are in control of the actual loading condition at all times, and thereby also actual VCG, actual VCG can quickly and easily be compared with maximum allowable VCG to verify whether or not minimum stability requirements are satisfied at all times, including whether the vessel is capable of surviving a damage scenario corresponding to those that the vessel is designed to survive (rule damage cases).

The rules point out that operational recommendations shall be clearly described in the stability manual, including instructions for maintaining stability within the permitted range.

D.2 STABILITY REQUIREMENTS

D.2.1 Intact stability

Requirements for intact stability are set out in the above-mentioned rules from DNV GL, Section 5, C 400.

Rule C 402 (d) requires the GZ curve to be positive to at least 70 degrees. The Fridtjof Nansen class do not comply with this requirement since a flooding point[1] (starboard/port) will be submerged before 70 degrees of heel. This meant that the above requirement could not be met. In an application to DNV GL of 28 May 2015 concerning deviation from the regulatory requirement, the NDLO Naval Systems Division[2] and Polarkonsult AS explained that the matter had been assessed and accepted as a permanent deviation. DNV GL responded that the deviation would be entered in the appendix to the class certificate.

[1] Details regarding the flooding point is classified as 'Restricted' under the Security Act by the information owner Norwegian Armed Forced and Norwegian Defence Materiel Agency.
[2] Present the Norwegian Defence Material Agency

D.2.2 Damage stability

Section 5 D 200 concerns requirements relating to the extent of damage:

> *201 The damage is assumed to extend vertically without any limit. If damage of a lesser extent results in a more severe condition, such lesser extent shall be assumed (e.g. intact double bottom).*
>
> *202 The transverse penetration of damage is assumed to reach to the centre line of the vessel, but leaving any centre line bulkhead intact. If damage of a lesser extent results in a more severe condition, such lesser extent shall be assumed.*
>
> *203 c) The longitudinal extent of damage shall be 15 percent of the vessel's length or 21 m whichever is less. The vessel shall be capable of withstanding flooding wherever the damage is located. L = overall length of the underwater watertight envelope of the rigid hull excluding appendages, at or below the waterline in full load condition.*

The Fridtjof Nansen-class frigates are reported to have a length at waterline (LWL) of 121.39 m corresponding to the length between perpendiculars (LPP). The damage length is thus 18.209 m. This longitudinal extent of damage would affect up to three watertight compartments when 'placed' anywhere along the length of the hull.

Section 5 D 400 concerns survival criteria after damage:

> *401 Restrictions to limit flooding:*
>
> *a) The final waterline after flooding, taking into account sinkage, heel, and trim shall be at least 0.30 m below the lower edge of any opening through which progressive flooding may take place.*
>
> *b) Openings, the lower edge of which shall not be submerged, include such as air pipes and ventilators, with weathertight closing, and weathertight hatches and doors.*
>
> *c) Openings, which may be submerged, include manholes, watertight hatches, watertight doors, and side scuttles of the non-opening type.*
>
> *d) If pipes, ducts or tunnels are situated within the assumed extent of penetration of damage as defined in 200, arrangements shall be made so that flooding cannot thereby extend beyond the limits assumed for the calculation of the damaged condition in question.*
>
> *e) No unprotected openings shall be located within a distance of 1.5 m measured from the equilibrium waterline.*
>
> *402 The angle of heel (Point C in Figure 3) shall not exceed 15° in the final condition of equilibrium. When the damaged vessel is subject to a wind force calculated as outlined in C301, assuming a nominal wind speed of 40 knots, the following criteria shall be met: The available dynamic stability beyond point D in Figure 3 up to the angle θ1, i.e. the shaded area shall not be less than 0.025 mrad. The angle θ1 shall be taken as 45° or the angle at which*

progressive flooding (submersion of unprotected opening) would occur, whichever is less.

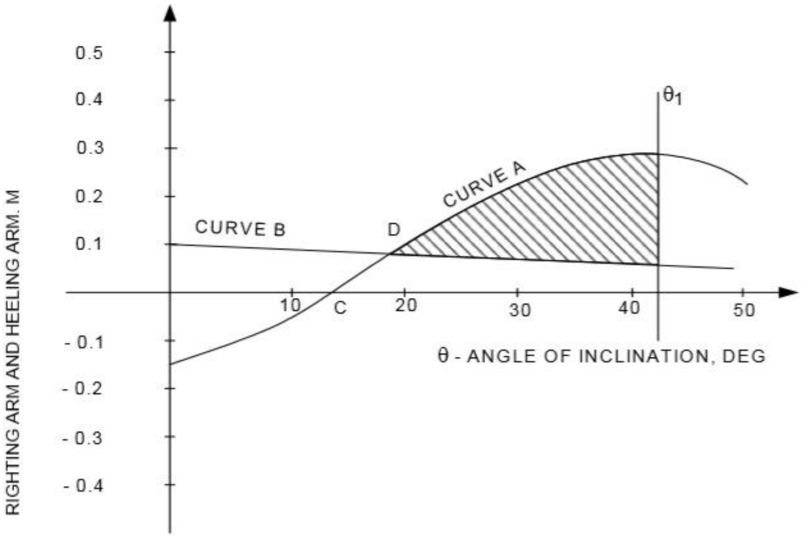

Figure 3 Stability criteria for flooded condition

403 The stability in the intermediate stages of flooding is considered satisfactory if: — the angle of heel does not exceed 20° — all openings through which progressive flooding of assumed intact spaces may occur, are above any intermediate damaged waterline — the residual area requirements in excess of the wind heeling arm are as in 402.

D.3 STABILITY CALCULATIONS

The purpose of the calculations has been to understand and verify the sequence of events and assess the frigate's survivability after the collision. The NSIA has also considered the consequences of the hollow propeller shafts, the effect of the grounding and the effect of the Q deck as a buoyancy volume. Finally, the NSIA has considered the potential effect of a complete shutdown of the frigate and how this would have changed the sequence of events.

Table D.1 shows an overview of the different load conditions calculated by the NSIA.

Table D.1: Load conditions

Conditions	Purpose	Conclusion/comment	Damaged	Closed down	Q deck	Shaft	Cross-flooding	Displ.	Capsize
Verification conditions									
At time of collision	Verification of the vessel's intact condition and basis for further calculations	The condition indicates the vessel's probable trim/displ. based on observations (including fouled waterline, revision of IPMS data)	No	No	N/A[3]	N/A	N/A	5,013	No
At 04:07:40	Verification of the vessel's intact condition and sequence of events based on observations	Calculations correspond to actual observations relating to damaged waterline	N/A*	N/A*	N/A*	N/A*	N/A*	5,104	N/A*
At 04:10:40	Verification of the vessel's intact condition and sequence of events just before the grounding, based on observations	Calculations correspond to actual observations relating to damaged waterline	N/A*	N/A*	N/A*	N/A*	N/A*	5,191	N/A*
At 04:10:40G	Verification of sequence of events immediately after grounding	The calculations show reasonable correspondence with actual observations relating to damaged waterline	N/A*	N/A*	N/A*	N/A*	N/A*	5,191	N/A*

[3] N/A=Not applicable

Conditions	Purpose	Conclusion/comment	Damaged	Closed down	Q deck	Shaft	Cross-flooding	Displ.	Capsize
Bilge	Determine submersion of damage in shell in the aft generator sets room to assess the possibility to bilge the room.	The the damage is located 750 mm below the waterline equilibrium, and hence bilging of the room would not be possible. After the grounding the damage would be located even lower, and the condition is therefore assessed to be conservative.	I/R*	I/R*	I/R*	I/R*	I/R*	5508	I/R*
Damage conditions									
Evacuated 1	Assess the vessel's survivability in actual damage and shutdown state on evacuation	First iteration in which flooding points are submerged. The final state shows that more flooding points are submerged. See 'Evacuated 2'	Yes	No	Open	Open	N/A, but No	N/A	No
Evacuated 2 and Evacuated 2 G	Assess the vessel's survivability in actual damage and shutdown state on evacuation, compared with the effect of the grounding	Second iteration in which flooding points from 'Evacuated 1' are submerged. The final state shows that more flooding points are submerged. See 'Evacuated 3'. 'Evacuated 2 G' shows that the vessel comes afloat.	Yes	No	Open	Open	N/A, but No	N/A	No
Evacuated 3	Assess the vessel's survivability in actual damage and shutdown state on evacuation	The vessel capsizes. 'Capsize' is not indicated in 'Evacuated 1', 'Evacuated 2' and 'Evacuated 2G' because these conditions do not include submergence of all flooding points. More flooding points	Yes	No	Open	Open	N/A, but No	N/A	Yes

Conditions	Purpose	Conclusion/comment	Damaged	Closed down	Q deck	Shaft	Cross-flooding	Displ.	Capsize
		are submerged in 'Evacuated 3', but capsizing is in any case already a fact in this condition.							
Damage conditions with vessel in maximum shutdown state									
Closed 4	Assess the vessel's survivability in actual damage state and maximum shutdown state	First iteration in which flooding points are submerged. The final state shows that more flooding points are submerged. See 'Closed 5'.	Yes	Yes	Closed	Open	No	N/A	No
Closed 5	Assess the vessel's survivability in actual damage state and maximum shutdown state	Second iteration in which flooding points from 'Closed 4' are submerged. The final state shows that more flooding points are submerged. See 'Closed 6'.	Yes	Yes	Closed	Open	No	N/A	No
Closed 6	Assess the vessel's survivability in actual damage state and maximum shutdown state	Third iteration in which flooding points from 'Closed 5' are submerged. The final state shows that no new flooding points are submerged.	Yes	Yes	Closed	Open	No	N/A	No
Closed 6 X	Assess the vessel's survivability in actual damage state and maximum shutdown state, but with cross-flooding between interconnected tanks	The vessel's final state deteriorates, but the vessel does not capsize.	Yes	Yes	Closed	Open	Yes	N/A	No

Conditions	Purpose	Conclusion/comment	Damaged	Closed down	Q deck	Shaft	Cross-flooding	Displ.	Capsize
Closed 6 G	Assess the vessel’s survivability in actual damage state and maximum shutdown state, grounded.	Shows that the vessel would come afloat (‘Closed 6’). In other words, the vessel will in any case not capsize in this condition, whether she runs aground or not.	Yes	Yes	Closed	Open	No	N/A	No
Closed 6 G X	Assess the vessel’s survivability in actual damage state and maximum shutdown state, grounded and with cross-flooding between interconnected tanks.	Shows that the vessel would come afloat (‘Closed 6 X’). In other words, the vessel will in any case not capsize in this condition, whether she runs aground or not.	Yes	Yes	Closed	Open	Yes	N/A	No
Other (hypothetical) calculated conditions									
Evacuated 3 P	Assess the vessel’s survivability in actual damage state and shutdown state on evacuation, without flooding through the propeller shafts	The vessel capsizes	Yes	No	Open	Closed	N/A, but No	N/A	Yes
Closed 6 Q	Assess the vessel’s survivability in actual damage state and maximum shutdown state, but with compartment 13 excluded from the buoyancy volume.	The vessel’s final state and stability deteriorate significantly, but the vessel does not capsize.	Yes	Yes	Open	Open	No	N/A	No
Closed 6 Q X	Assess the vessel’s survivability in actual damage state and maximum shutdown state, but with compartment 13 excluded	The vessel’s final state and stability deteriorate further, but the vessel does not capsize.	Yes	Yes	Open	Open	Yes	N/A	No

Conditions	Purpose	Conclusion/comment	Damaged	Closed down	Q deck	Shaft	Cross-flooding	Displ.	Capsize
	from the buoyancy volume, and with cross-flooding between interconnected tanks.								
Closed 6 P	Assess the vessel's survivability in actual damage state and maximum shutdown state, without flooding through propeller shafts.	Improved final state, the vessel does not capsize	Yes	Yes	Closed	Closed	No	N/A	No
Closed 6 P X	Assess the vessel's survivability in actual damage state and maximum shutdown state, without flooding through propeller shafts and with cross-flooding between interconnected tanks.	Improved final state, the vessel does not capsize	Yes	Yes	Closed	Closed	Yes	N/A	No

*Flooding of the various damaged areas has been added manually based on observations and IPMS data, and verified by calculations, for the sole purpose of verifying the vessel's load condition before the collision and understanding the sequence of events. Adjacent spaces to the damaged part of the vessel have been excluded from the buoyancy volume, but without further flooding of the vessel. The condition "bilge" is calculated for damage to section 11 and 12, however all other sections are intact.

X = with cross-flooding, G = grounded, P = without flooding through propeller shafts, Q = with flooding of compartment 13

The NSIA has adjusted the calculation model that formed the basis for the frigate's approved stability calculations, including by adding more stern cross-sections and defining rudders, propellers, propeller shafts with brackets, stabiliser fins, bilge keel and azimuth thruster trunk. Among other things, this lowered the lightship centre of gravity by 46 mm.

In the following, the frigate's 13 watertight compartments are referred to as compartments 1 to 13, with number 13 being the aftermost.

D.4 ASSUMPTIONS

The calculations are based on the following:

- The frigate’s load condition at the time of the accident; see Appendix D2
- Actual damage after the collision; see also sections 2.2.1 and D.11
- Downflooding points and shutdown state of the frigate at the time of evacuation; see Appendix C
- Cross-flooding between interconnected tanks; see section D.10

D.5 VERIFICATION CONDITIONS

The condition ‘At the time of collision’ shows the vessel immediately before the hull damage arose (intact damage condition). The displacement was 5,012.5 tonnes. In this condition, the lowest point at which the frigate sustained shell damage in the aft generator sets room would be 260 mm above the waterline (flooding point no 150 in the load conditions).

The condition ‘At 04:07:40’ shows the condition at the time when one of the crew members in the aft generator sets room saw that the waterline was more or less on level with the edge of the damage to the shell. The condition shows that the ‘damage freeboard’ was approximately 100 mm. The calculations correspond well with observations. The displacement was 5,104.2 tonnes. The difference of 91.7 tonnes from the condition described above is derived from draught sensors in the IPMS and represents water that entered the vessel. In this condition, the volume of water is distributed equally between compartments 11 and 12. It is assumed that section 12 was filled slower than section 11, however this has no effect on the main conclusions. At that point in time, the amount of water in the aft generator sets room was minimal, and the hollow propeller shafts had not yet caused flooding in the reduction gear room. The buoyancy volumes have been removed from compartments 8 to 12 on 1 and 2 decks to reflect the fact that the ship side was ripped open in this area.

The condition ‘At 04:10:40’ shows the condition immediately before the vessel ran aground. In principle, it is the same as at 04:07:40, but the displacement has increased to 5,190.5 tonnes as a result of the vessel having taken aboard 178 tonnes of water, based on the draught change registered in the IPMS. The damage to the aft generator sets room extends 50 mm below the waterline. Observations correspond well with the calculations.

The condition ‘At 04:10:40 grounded’ shows the condition when the frigate had stopped with her bow on the shore. The water depth/forward draught is calculated based on differences in draught/trim data from the IPMS. The condition shows that the reactive force from the seabed is 171.5 tonnes. It is assumed that the force arose longitudinally at frame 6 and in the steel keel/baseline (the sonar dome was flattened; see seabed description). The damage to the aft generator sets room extends 150 mm below the waterline. The person in the aft generator sets room observed that, after the grounding, the waterline was just over half a metre above the edge of the damage. The calculation finds equilibrium with a 0.3-degree list to starboard. With an additional list of 3.5 degrees, the edge of the damage would extend 516 mm below water. The list may therefore have been heavier after the grounding than the calculated condition shows.

D.6 DAMAGE CONDITIONS

Damage cases ‘Evacuated 1’, ‘Evacuated 2’ and ‘Evacuated 3’ show how the flooding developed, based on the frigate’s shutdown state at the time of evacuation. ‘Evacuated 1’ is defined with the volumes of compartments 12 through 8 available for flooding. The definition of ‘Evacuated 2’ is based on submerged flooding points in ‘Evacuated 1’ that lead to volumes not defined in ‘Evacuated 1’. The same method was used to define ‘Evacuated 3’ based on the results of ‘Evacuated 2’. Additional flooding volumes in ‘Evacuated 2’ and ‘Evacuated 3’ are primarily located in compartments 13 and 7.

The damage cases are calculated with and without grounding. ‘Evacuated 2’ and ‘Evacuated 2 grounded’ are identical because, at that stage, the degree of flooding caused such a heavy aft trim/starboard heel that the vessel came afloat. There is no longer any reactive force from the seabed and the frigate is presented as free-floating in both cases. The vessel capsizes in damage case ‘Evacuated 3’. In addition to the volumes damaged in the condition ‘Evacuated 3’, additional three sections were not shutdown and hence exposed to flooding.

D.7 DAMAGE CONDITIONS WITH VESSEL IN MAXIMUM SHUTDOWN STATE

In the ‘Closed’ damage cases, the frigate is closed down insofar as the NSIA found this to be an option, given the extent of damage to the vessel; see Appendix C2 Description of flooding and shutdown state. The same method was used as for ‘Evacuated’, which resulted in ‘Closed 4’, ‘Closed 5’ and ‘Closed 6’. The damage case ‘Closed 6’ finds equilibrium at a 35.4-degree angle of heel without ‘new’ submerged flooding points. GZ increases steadily to 0.49 m at an angle of heel of 60 degrees. Nor were any ‘new’ flooding points submerged as a result of reckoning with ‘Closed 6 X’ and ‘cross-flooding’ of bottom tanks. The latter damage case finds equilibrium with a 39.1-degree angle of heel, and GZ increases steadily to 0.50 m at an angle of heel of 60 degrees. ‘Closed 6 G’ and ‘Closed G X’ are damage cases in grounded condition with and without cross-flooding. At the final stage of flooding, the vessel comes afloat and does not capsize. In ‘Closed 6’, account has been taken of the consequence of possible damage to air ducts in the collision.

D.8 OTHER (HYPOTHETICAL) CALCULATED CONDITIONS

Hypothetical damage case ‘Evacuated 3 P’ (with watertight propeller shafts), i.e. without flooding of the reduction gear room below 2 deck, shows capsizing.

Hypothetical damage cases ‘Closed 6 Q’ and ‘Closed 6 Q X’ (flooding of compartment 13 with and without ‘cross-flooding’) result in an angle of heel of 55.6 and 55.9 degrees, respectively. In this condition, the helideck is completely submerged under water, but the vessel does not capsize. The GZ is 0.08 m at 60 degrees, 0.308 m at 80 degrees and zero at approximately 87 degrees.

Hypothetical damage cases 'Closed 6 P' and 'Closed 6 P X' (with watertight propeller shafts) result in an improved buoyancy position and the vessel does not capsize.

D.9 SUMMARY

The 'Evacuated' damage cases show that the frigate would have capsized if progressive flooding had been allowed to develop in the shutdown state that prevailed at the time of evacuation, regardless of whether or not she had run aground. However, tugboats pushed the frigate sideways towards the shore before the flooding became critical. The NSIA considers the frigate to have been lost at this point and has not calculated the effect of the tugboat operation on the vessel's sinking. Nor has the NSIA considered the salvage operation.

The NSIA believes that the 'Closed' damage cases show that, if the frigate had been closed down in accordance with the description of shutdown provided above, i.e. all closing options had been used, she would have survived the collision damage and stayed afloat, regardless of whether or not she had run aground. See section D.11 concerning the NSIA's assessment of possible damage resulting from the grounding.

D.10 CROSS-FLOODING BETWEEN INTERCONNECTED TANKS

The frigates are arranged with a total of 11 interconnected bottom tanks, including three pairs of starboard/port fuel oil tanks and one pair of starboard/port water ballast tanks. The three latter are fuel oil tanks arranged as starboard/centre/port tanks. The cross-connections are open, without closing devices, and arranged as reverse Ø 300 mm U-shaped pipes with varying heights over the tank top.

In accordance with Izar's stability calculations for the Nansen-class from 2003, the bottom tanks as mentioned above, are equipped with cross filling connection to reduce heel in case of damage to the bottom tanks at one side.

In the approved stability manual, cross-flooding between the three fuel oil tanks DFM has been reckoned with in that the three fuel oil tanks are treated as one large tank. The other tanks with cross-connections are reckoned to be separate tanks in the calculation of intact stability, however. In the load conditions, both water ballast tanks are reckoned to be either full or empty. The other three pairs of interconnected fuel oil tanks are reckoned to be either 95% or 5% full on both starboard and port tanks.

In the approved damage stability calculations, cross-flooding is reckoned with by defining interconnected tanks as full in the damage cases. Corresponding damage cases before cross-flooding are calculated separately as 'intermediate stages'.

The investigation has shown that transverse cross-flooding of adjacent tanks can start at a approx. 13 degrees' heel. The NSIA has performed calculations with the interconnected tanks calculated as separate and combined tank, respectively. The results show that the righting arm (GZ) in the damage condition is reduced by up to 23% when the tanks are interconnected transversely (one tank). Water ballast tanks are reckoned to be empty in the damage condition (according to the revised tank volume, the IPMS showed 62% and 29% flooding of the starboard and port tank, respectively). It should be specified, however, that calculations based on the above-mentioned tanks not having longitudinal bulkheads in the centreline (being one tank) are highly conservative, so that calculations of actual cross-flooding are of less consequence for the remaining GZ than described above.

In the approved intact stability calculations, account has not been taken of the fact that 8 of 11 bottom tanks have cross-connections. Furthermore, in the damage stability calculations, cross-flooding is only reckoned with for tanks within the defined damage areas. The NSIA has not looked into whether this would have compromised the approval of the stability calculations.

The NSIA is aware that the NMDA aims to revise the stability calculations for the Fridtjof Nansen-class frigates following the most recent inclination test of one of the frigates in June 2019. It has been said that the revised calculations will include calculations of actual cross-flooding. On this basis, the NSIA will not discuss the cross-flooding issue any further.

D.11 ASSESSMENT OF SEABED CONDITIONS AND DAMAGE

Based on IPMS data on the frigate’s position, course as well as draught and trim changes when she ran aground, the NSIA has considered the vessel’s buoyancy profile in relation to the seabed profile below. The seabed profile was determined based on depth data from ordinary sea charts, i.e. with reference to the hydrographic zero.

The sonar dome below the keel line (baseline) at the bow was made of fibre-composite material. The dome delaminated and was flattened when the frigate ran aground but was not torn off. Based on this, and on witnesses describing a ‘soft’ grounding, it is assumed that the vessel hit a relatively evenly rising soft seabed, for example sand.

The forward draught immediately before the grounding and the water depth forward of the bow when the frigate stopped are calculated to have been 4.853 m and 4.205 m, respectively. This generated a reactive force from the seabed of just over 171.5 tonnes. The frigate’s buoyancy profile in relation to the described seabed profile showed good clearance between the seabed and the keel aft of the point of impact at the bow. No ingress of water was observed in the forebody.

Based on tidal sea level data, the actual clearance between the seabed and the bottom of the vessel up until the time of evacuation was at least 38 cm and no more than 158 cm greater than described above. During this period, a tugboat was pushing on the stern of the frigate. It is assumed that the frigate may have been pushed closer to the shore with the rising tide, without this having had any noteworthy consequences for the clearance between the seabed and the bottom of the frigate. This movement of the frigate is also assumed to have had minimal consequences for the change in forward draught and hence also for the NSIA’s stability calculations with respect to the reactive force from the seabed at the bow.

After the frigate was refloated, shell penetrations were observed in and just above the bilge from midship and forward on the starboard side. This damage is assumed to have been sustained at a later point in time, however, as only one of the tugboats that pushed on the stern, more or less in parallel with the frigate’s longitudinal centreline, was active.

APPENDIX D6 - DRAWINGS USED BY THE NSIA AS BASIS FOR STABILITY CALCULATIONS

Izar no.	NDMA / Pb No.	Title	Rev.	Sheet
131.1.01.100	BAZ-ABB2-DR-00097	Block 131 Sections Fr. 42, Fr. 41 & Fr. 40	C	4B
		Block 131 Bhd Arrangement under 3 Deck	C	5A
		Block 131 Sections Fr. 45 & Fr. 43	D	4A
211-7.02.504	BAZ-ABB9-DR-00034	Block 211 Instruments Arr. on 4 Deck stb.	B	1C
331-7.03-504	BAZ-ABB9-DR-00036	Block 331 Instrumentation Arr. on 4 Deck & below	I	1A
		Block 331 Installation Details of Level Transm. Type «A»	G	2A
611-6.04.201		Propellers & Shaft Mounting		1A
		Propellers Mounting Arrangement		5A
562-6.04.201	ABB4-DR-00084	Rudders Arrangement & Details Outlines	D	1A
161.1.04.001	BAZ-ABB2-DR-00013	Strut Arm	G	1A
		Strut Arm	F	2A
		Strut Arm	G	3A
		Strut Arm	G	4A
802-8.00.011-0S	BAZ-ABB_DR-00004	Tank Capacities Drawing	A	1-A
		Tank Capacities Drawing	C	1-A
221.1.02.100	BAZ-ABB2-DR-00101	Shell Expansion Port Side	C	1A
		Bilge Keels Block 221	C	1B
		Bulkhead Frame 77 Block 221	C	3A
		Bilge Keel Details Block 221	C	
		Bilge Keel Details Block 221	O	
231.1.02.100	BAZ-ABB2-DR-00103	Shell Expansion & Longs. Stbd. Side Block 231	D	1A1
		Sect. Fr. 79 Block 231	E	4A1
311.1.103.100	BAZ-ABB2-DR-00076	Shell (port)	F	1A1
		Shell (stbd.)	E	1B1
		Bhd. Frame 88 Block 311	F	3A1
		Details Bilge Keels Block 311	C	6A1
		Details Bilge Keels Block 311	C	6D1
		Bilge Keels Block 311	D	6A1
		Bilge Keels Block 311	E	6D1
802.8.00.003	BAZ-ABB-DR-00003	Body Plan	A	1-A
012302 [1]		External Watertight Integrity Plan	A3	1 / 2
		External Watertight Integrity Plan	A3	2 / 2
		Internal Watertight Integrity Plan	A3	1 / 2
		Internal Watertight Integrity Plan	A3	2 / 2
-	-	Draft Marks & Load Line Marks		
565-6.00.001	BAZ-ABB4-DR-00029	Fin Stabilizer Gen. Arr. – Tank Top		1A
		Fin Stabilizer Gen. Arr. – First Platform	A	2A

		Fin Stabilizer Gen. Arr. – Section	A	3A
111.1.100.001	BAZ-ABB2-DR-00011	Shell Expansion	F	1A2
802-8.00.001	BAZ-ABB1-DR-00001	General Arrangement Drawing	K	2A
		General Arrangement Drawing	K	3A
Report from	Navantia 25.11.2019	Critical Flooding Points		
Report from	Navantia 31.08.2020	IPMS data – Doors, Hatches & HVAC Valves Status		

[1] Drawings number from Polarkonsult AS