NTSB Engineering Group (DCA24MM031)
Dali Shipboard Machinery Examination and Record of Electrical Testing, April 1–29, 2024

September 11, 2024

As part of the NTSB's investigation of the March 26, 2024, major marine casualty involving the contact of Containership *Dali* with the Francis Scott Key Bridge and subsequent collapse of the Francis Scott Key Bridge, the Office of Marine Safety formed an Engineering Group. This investigative group, which is led by a representative from the NTSB, consists of individuals from the following organizations and interested states:

- Grace Ocean Private Limited (owners of *Dali*)
- Synergy Marine Group (operators of *Dali*)
- HD Hyundai Heavy Industries Co., Ltd. (HHI)
- Nippon Kaiji Kyokai (ClassNK)
- Maritime & Port Authority of Singapore
- India (substantially interested State).

As part of the physical examinations of the vessel's engineering components, the Engineering Group examined the vessel's propulsion, mechanical, power management, and electrical systems to identify the nature of the electrical blackouts on March 25 and 26. Initial troubleshooting led to the Engineering Group narrowing their focus on the vessel's electrical switchgear.

HHI, the vessel's builder, also manufactured the vessel's switchgear, electrical generators, the integrated control and monitoring system (ICMS), as well as other onboard electrical components. Representatives of HHI were involved in developing and implementing troubleshooting procedures, and dispatched three separate envoys from their headquarters in Korea to assist in four separate examination sessions during April 2024.

Under the direction of NTSB and with input from all Engineering Group members, HHI produced examination and testing procedures following their initial examination session. HHI used these procedures to capture information and comments during sessions nos. 2, 3, and 4. After sessions nos. 2, 3, and 4 were completed, HHI produced a record of testing, which included the procedures carried out during each session and comments. These records of testing were titled "MV Dali – Hyundai Preliminary Report for NTSB," followed by the dates of each exam session. These records were shared with the Engineering Group for concurrence and have been included here in the tables below.

Examination dates and HHI's records of testing, as well as photographs taken by NTSB investigators to document the examinations, are provided on the following pages.

Session no. 1—April 1, 2024

Figure 1. *Left to right*: An NTSB investigator examines a circuit breaker on *Dali*'s low-voltage (LV) switchboard, and an NTSB Investigator applies tamper-evident preservation seals to the HV switchboard.

- HHI representatives visited the vessel.
- HHI representatives downloaded data from the ICMS, the main engine control system, and the high-voltage (HV) switchboard.
- HHI representatives attempted to change over from TR2 to TR1 (the redundant step-down transformers that connected the 440-volt low-voltage [LV] electrical bus to the HV bus), but HR1 (one of the breakers located on either side of the step-down transformers) failed to close.
- Troubleshooting of HR1's failure to close led to no results. HHI representatives contacted their headquarters, and the company agreed to arrange a second envoy to continue troubleshooting.

Session no. 2—April 9–10, 2024

Figure 2. *Left to right*: An HHI engineer examines HV switchboard control circuitry, and an HHI engineer inspects the HR1 HV vacuum circuit breaker (VCB).

Note: The following table has been formatted for legibility. However, the content of the text and any graphics remain unaltered from HHI representatives' records and may contain typographical errors. In addition, HHI representatives added information to comment sections in some cases after their initial examination period. Record of testing results were finalized and circulated shortly after the examination sessions were completed. Most of the listed document requests, and other "pending" actions that are documented, have since been completed.

Table 1. April 9–10, 2024

Procedures	Confirm Performed	Comments
Toolbox meeting as per ISM checklist and advise Resolve (salvage master) before commencing with the procedures set out below.	○	
In case of any deviation from the following protocol, all parties are to be invited to discuss amendments to the protocol. Unless noted otherwise, all procedures are to be performed by Hyundai Engineers.	○	
1. Request approval from NTSB to proceed with inspection procedures. Open panel.	○	
2. Layout Inspection		
2.1 Push the "Lamp Test" push button to check for indication lamp fault.	○	
2.2 Describe any lamp faults that are observed.	○	Lockout Relay Line Healthy button was dim.
2.3 If necessary, replace faulty lamp then repeat step 2.1.		Hyundai Recommends replacing the 'Lockout Relay Line Healthy' light.
3. Open top control panel door. Perform visual inspection and note any anomalies.	○	No anomalies were observed.

4.	**Turn HR1 VCB switch clockwise to close the circuit.**		
4.1	Confirm HR1 VCB switch indicator is illuminated.	O	
4.2	Document whether HR1 VCB successfully closed.	O	
5.	**Perform the following protocol:**	O	
5.1	Confirm that VCB is in "Test Position" by racking out the breaker while door is closed. If in Service Position, change to Test Position.	O	
5.2	Move Earthing Switch to "on" position.	O	
5.3	Open the upper and middle panels. Note cycle count on breaker.	O	Cycle count indicates 510.
5.4	Open the front cover of VCB.	O	
5.5	Visually inspect VCB. If signs of damage are observed, describe observations to the NTSB and take photographs of damaged equipment. Engineers will confirm that it is safe to continue testing with the damaged equipment.	O	- No signs of damage were observed - Checked on cable connections condition (i.e., whether the cables were loose) and confirmed that no anomalies were observed.
5.6	Perform visual inspection of Control and Interlock Circuit of HR1 VCB Panel. Use voltage meter to confirm proper functioning.	O	Checked on voltage meter on VCB Undervoltage Relay, Motor Charging Circuit, and Indication Lamp Line. Confirmed voltage meter indicates a normal voltage - 113.9 DCV.

5.7	Perform visual inspection of Control and Interlock Circuit of LR1 ACB Panel. Use voltage meter to confirm proper functioning.	O	Checked with voltage meter on DC 24v Control Circuit and Indication Lamp Line. Confirmed voltage meter indicates a normal voltage - 24 DCV.
5.8	While in test position, close-open cycle breaker by manual switch board control and manual push buttons. (Two times in total)	O	Cycle count becomes 512.
5.9	Report results of test to NTSB and interested parties.	O	Confirmed all cleared.
5.10	Engineers to Re-engage breaker before moving to next step.	O	Safely re-engaged.
Procedure of Transformer Changeover **6. Test the changeover of transformer panel using the settings currently in use on the vessel, i.e., TR2 Auto, TR1 Manual.**		O	
6.1	Try to Changeover TR2 to TR1	O	Successfully completed changeover from Transformer No. 2 to Transformer No. 1.

	HR2	HR1
	Transformer No.2 (Auto Position)	Transformer No.1 (Manual Position)
VCB	Close	Open
ACB	Close	Open
	Change Over	
VCB	Closed	Closed Manually
ACB	Closed	Closed Manually
	After 1 or 2 Seconds	
VCB	Opened automatically	Closed
ACB	Opened automatically	Closed

6.2	Wait and observe conditions for 30 minutes before proceeding to step 6.3.	O No anomalies detected.
6.3	Try to Changeover TR1 to TR2	O Successfully completed changeover from Transformer No. 1 to Transformer No. 2.

	HR2	HR1
	Transformer No.2 (Manual Position)	Transformer No.1 (Auto Position)
VCB	Open	Close
ACB	Open	Close
	Change Over	
VCB	Closed Manually	Closed
ACB	Closed Manually	Closed
	After 1 or 2 Seconds	
VCB	Closed	Opened Automatically
ACB	Closed	Opened Automatically

6.4	Wait and observe conditions for 30 minutes before proceeding to step 6.5.	O No anomalies detected.

		- When attempting changeover from TR2 to TR1, HR1 VCB was closed manually. At this time, we observed a Differential Current Trip (87T), which resulted in the HR1 VCB opening.
	X	- Preliminary review of HIMAP-T data extracted on 4/10/2024, suggests that TR1 has not returned this error since the vessel was delivered in March 2015. After about five minutes, we tried to close HR1 VCB, and Differential Current Trip (87T) occurred again.
6.5 Repeat step 6.1, so that 440V switchboard is powered by TR1 at end of test.	O	- At this point, Hyundai engineers discussed troubleshooting options with NTSB, USCG, and Synergy. (*Note: at this time, TR2 was powering the vessel.*) All parties agreed to conduct the following procedures: 1) close and open the HR1 VCB in "Test Position" two times. This was subsequently completed (i.e., HR1 VCB closed and opened without failure). 2) conducted changeover Transformer 2 (closed HR2 VCB) to Transformer 1. This was successfully completed. 3) conducted changeover Transformer 1 (closed HR1 VCB) to Transformer 2. This was successfully completed; the vessel was powered by TR1 at the end of troubleshooting.
	-	- Hyundai proposed, and NTSB and interested parties agreed, that if the above troubleshooting plan were to fail, the next plan would be to discharge residual voltage in Transformer 1 by earthing. However, there was no need to discharge residual voltage because the changeover was successfully completed.
6.6 Wait and observe conditions for 30 minutes before proceeding to step 7.	-	

7.	**Connect Hyundai laptop to HIMAP-T to extract voltage, current, short circuit, over current, ground, and differential protection data measured at the transformers (TR1 and TR2). Note: no data will be generated if incidents are not detected.**	O	
7.1	Discuss results with NTSB and interested parties.	O	
7.2	Furnish testing data to NTSB and interested parties.	-	
7.3	Hyundai will provide a copy of the same data to its headquarters staff for further analysis. The results of the analysis will be provided to NTSB and interested parties once complete.	O	
8.	**After initial data export is completed, vessel personnel to observe operation of TR1 breaker for 24 hours. Note: crew is permitted to respond to any developing issues during the observation period, as necessary, to ensure the safety of the vessel and its personnel.**	O	On 4/11/2024, after the 24-hour observation period, Synergy personnel reported no anomalies were detected on a group call with NTSB and interested parties.
8.1	During the 24-hour observation period, the vessel's watch engineer should record hourly readings of voltage, amperage, and kW from the low and high voltage switchboard meters, as instructed by Hyundai engineers and agreed upon by NTSB and the interested parties.	-	
8.2	After the 24-hour observation period, Captain Kumar to notify NTSB and interested parties of any anomalies and provide a copy of the hourly records created by the vessel's engineer.	-	
9.0	**If any anomalies are reported during the 24-hour observation period, Hyundai engineers to perform another data export, as described above in step 7.**	-	Not necessary per report from Synergy personnel.

Session no. 3—April 22–24, 2024

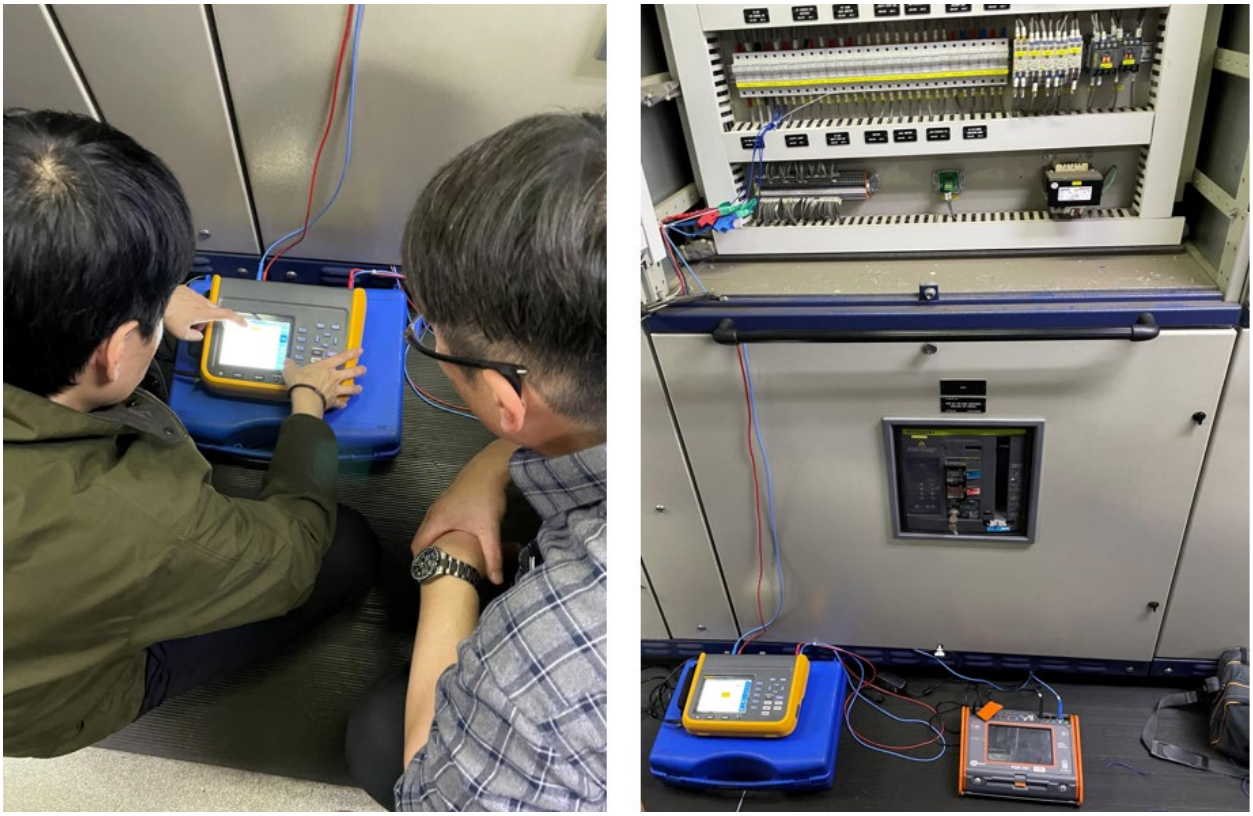

Figure 3. *Left to right*: HHI electrical engineers installing and monitoring the power analyzer connected to the LV switchboard. The power analyzer fully connected to and monitoring the LV switchboard.

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Table 2. April 22, 2024

Procedures	Completed?	Comments
Convene toolbox meeting per ISM and advise Resolve (salvage master) before commencing procedures set out below.	Yes	
All parties are to be invited to discuss amendments to and the execution of the protocol. Unless noted otherwise, all procedures are to be performed by Hyundai Engineers.	Yes	Prior to commencing the inspection on April 22, 2024, NTSB shared the following: 1. The 1st blackout on March 25, 2024, prior to departure from Baltimore port, occurred when an engineer accidentally closed the damper of the scrubber, which blocked exhaust gas from being released from DG2, resulting in Diesel Generator No. 2 ("DG2") tripping due to a low frequency condition. 2. Synergy crew confirmed that the fuel injection pump for Generator Engine No. 1 was replaced by the crew on April 21, 2024. 3. Synergy's synchronization attempts failed during DG parallel operation on April 21 and 22, 2024. "Parallel operation" occurs when more than 2 DGs are supplying electricity to the same bus. 4. NTSB requested that HHI submit a separate explanation as to the cause of the HiMAP alarm (87T) and the synchronization failure, as well as the test plan for blackout. This was submitted on April 23.
1. Request approval from NTSB to proceed with the inspection procedures	Yes	

2. Electrical Lines in Dali			
2.1.	Identify final version of electrical line drawings and diagrams listed at 2.1.1-2.1.11 below, including all revisions since delivery of the vessel, with support from NTSB and other parties. NTSB to collect and distribute digital copies to interested parties so that HHI engineers may conduct a detailed analysis.	No	
	2.1.1. Electric Load Analysis (Dwg. No.2E-7830-101)	No	
	2.1.2. Wiring Diagram of Power System (Dwg. No.2E-7641-103)	No	
	2.1.3. Short Circuit Calculation (Dwg. No.2E-7641-105)	No	
	2.1.4. 6.6K Main Switchboard (Dwg. No.6E-2641-108)	No	NTSB will upload the latest version of electrical line drawings and diagrams listed in sections 2.1.1 - 2.1.11. to Kiteworks. Please note that HHI has corrected the drawing number for the electric load analysis in section 2.1.1 from 2E-7641-102 in the Third Protocol to 2E-7830-101.
	2.1.5. Low Voltage Switchboard (Dwg. No.6E-2641-109)	No	
	2.1.6. Emergency Switchboard (Dwg. No.6E-8641-109)	No	
	2.1.7. Main Generator (Dwg. No.6E-2831-101)	No	
	2.1.8. Emergency Generator (Dwg. No.6E-2838-105)	No	
	2.1.9. Transformer (Dwg. No.6E-2838-105)	No	
	2.1.10. Local Group Starter Panel & Individual Starter, Em'cy Stop Switchbox (Dwg. No.6E-7643-112)	No	
	2.1.11. Piping Diagram in Engine Room (3U-2400-103)	No	
2.2.	HHI will provide NTSB and interested parties with its written analysis once complete.	Pending	

3. Generator Engine("GE") Fuel Oil Supply Systems			
3.1.	Locate Electric MDO/MGO Flushing Pump on fourth floor of the engine room. HHI to perform visual inspection for apparent damage. If signs of damage are observed, describe observations to the NTSB and take photographs of damaged equipment. Engineers will confirm that it is safe to continue testing with damaged equipment, if applicable.	Yes	Parties identified the location of the Electric MDO/MGO Flushing Pump. No damage was observed.
3.1.1.	Check and Record Model Numbers of the Pump and Motor during visual inspection.	Yes	Parties confirmed the Model numbers of the Pump and Motor.
3.1.2.	Determine whether Electric MDO/MGO Flushing Pump is currently operating.	Yes	Parties confirmed that the Electric MGO/MDO Flushing Pump is operating.
3.1.3.	If the pump is in operation: Measure the motor current value as reported on the LGSP-4 during operation to ensure proper operation.	Yes	Parties measured the current value on the LGSP-4 to be 12A.
3.1.4.	If the Electric MDO/MGO Flushing Pump is not in operation: press "Start" button located in the pump starter panel on LGSP-4 in the purifier room, to test whether the pump is operational. Then, once activated, measure the motor current value as reported on the LGSP-4.	No	Parties agreed that this is not applicable because the MDO/MGO Flushing Pump was in operation.
3.1.5.	Record inlet and outlet pressure as displayed on local gauge at the Electric MDO/MGO Flushing Pump while running.	Yes	Parties agreed that the local gauge displayed the following measurements: Inlet Pressure : 0.5 Bar Outlet Pressure : 6.5 Bar Pump Pressure : 6.0 Bar

3.2	Locate Air Driven MDO/MGO Flushing Pump on fourth floor of the engine room. HHI to perform visual inspection for apparent damage. If signs of damage are observed, describe observations to the NTSB and take photographs of damaged equipment. Engineers will confirm that it is safe to continue testing with damaged equipment, if applicable.	Yes	Parties identified the location of Air Driven MDO/MGO Flushing Pump. No damage was observed.
3.2.1.	Check and Record Model Number of the Pump	Yes	Parties confirmed the Model numbers of the Pump and Motor.

3.2.2.	Test the Air Driven MDO/MGO Flushing Pump while the jumper wire is connected to the terminal block in the bus tie of the low voltage switchboard to activate the Solenoid Valve Circuit of the Air Driven MDO/MGO Flushing Pump in lieu of forcing the vessel to experience a blackout. *Note: this test procedure requires a simulation of conditions that should not be destructive to other parts or otherwise cause the vessel to lose power. Since we are unable to re-create the conditions of a blackout, we can create a simulation of blackout conditions by using a jumper wire to activate the Solenoid Valve Circuit. The Solenoid Valve Circuit ordinarily activates only if each of the following conditions are met: (i) Blackout; (ii) FO Booster Pump Stop; and (iii) Shore MCCB Open.*	Yes	Parties confirmed that the Solenoid Valve Circuit was activated after connecting jumper wire to the terminal block in the bus tie of the low voltage switchboard.
3.2.3.	Check Solenoid Valve for Air Driven MDO/MGO Flushing Pump	Yes	
3.2.4.	Record inlet and outlet pressure as displayed on local gauge at the Air Driven MDO/MGO Flushing Pump while running.	Yes	Parties agreed that the local gauge displayed the following measurements: Inlet Pressure : 0.5 Bar Outlet Pressure : 3.0 Bar Pump Pressure : 2.5 Bar Measurements were taken while the Electric MGO/MDO pump was not running.

3.3.	Identify final version of procedures and records relating to fuel and changeover procedures, at 3.3.1-3.3.4, from last 6 months of vessel operation. NTSB to collect and distribute digital copies to interested parties so that HHI engineers may conduct a detailed analysis. If investigative records do not provide information on the following, HHI to discuss with NTSB and interested parties.	No	
3.3.1.	Records of fuel oil changeover procedure.	No	NTSB will upload records of the fuel changeover procedure to Kiteworks.
3.3.2.	Bunker change procedure managed by operator.	No	NTSB will upload the bunker change procedure managed by the operator to Kiteworks.
3.3.3.	Records about operability FO flow meter (FI).	No	Parties confirmed that the FO flow meter was not in use because it has been removed. Synergy orally informed HHI that Synergy removed the FO flow meter because the GE FO supply system was not in use.
3.3.4.	Records of MGO/MDO FO service tank level (4-LX-9).	No	NTSB will upload the operator's log book for MGO/MDO consumption pressure to Kiteworks.
3.4.	HHI will provide NTSB and interested parties with its written analysis once complete.	Pending	
3.5.	Confirm understanding of Generator Engine Operations at time of incident as described in NTSB Engineering Notes from April 10, 2024. NTSB Field notes state: -"they were running the flushing p/p because that is the way the plant was being operated when he boarded the vessel." -"the vessel only operates [Generator] #3 and #4 while within the US ECA and never burns anything other than MGO in those engines."	No	

3.6.	Check the Status of Fuel Oil Valve Line Up at the Time of Accident and at Present. For example, NTSB and parties to confirm the following at time of the incident and at Present:	Yes	NTSB confirmed that all settings in the Fuel Oil Valve Line Up are the same on the MVSB compared to those settings at the time of accident, except for the operation mode of main transformers No. 1 and No. 2. The actual valve line ups are confirmed by the test procedure in sections 3.7 and 3.8.
3.6.1.	Types of fuel (e.g., MGO, HFO) supplied to Diesel Generators 1-4 and Main Engine at the time of the accident to present.	Yes	NTSB confirmed that only MGO has been used in DG1, DG2, DG3 and DG4 since March 21, 2024.
3.6.2.	How fuel was delivered to Generator Engine and Main Engine (i.e., which fuel supply lines were used).	Yes	NTSB and Synergy noted that the fuel supply system for DG3 and DG4 has been modified since the delivery of the vessel as follows: 1. At delivery: Supplied by G/E FO Supply System 2. Present: Supplied by electric G/E MGO/MDO Flushing pump and Air Driven Motor Pump when power to the electric G/E MGO/MDO Flushing pump fails Fuel supply system for DG1 and DG2 has been modified since the delivery of the vessel as follows: 1. At delivery: Supplied by GE FO Supply System 2. Present: Supplied by ME FO Supply System Parties noted that the GE FO supply system for DG1, DG2, DG3 and DG4 is not in use. Nippon Kaiji Kyokai ("NK") had approved such modifications to the Fuel supply system for DG1 and DG2, including installation of flow meters on G/E MGO flushing line.

3.6.3.	Was the F-142V valve open or closed.	Yes	Parties observed and agreed that the F-142V valve was open but was not being used to feed fuel to the Generator Engine Fuel Oil Supply pumps. Although the F-142V valve was originally designed to control MGO fuel feed to the Generator Engine Fuel Oil Supply pumps, the Synergy crew confirmed that the Generator Engine Fuel Oil Supply system was not in use. Rather, the Synergy crew opened the F-142V valve so the ECR would indicate that the MGO Flushing pumps were supplying MGO to DG3 and DG4.
3.6.4.	Ask NTSB to provide data and results of its fuel oil samples that were taken from storage tanks, settling tanks, day tanks, and manifolds on March 28.	Pending	NTSB will upload the data and results of its fuel oil samples to Kiteworks. Parties agreed not to collect fuel at this time because NTSB agreed to share results of their collection and analysis.
3.6.5.	Ask NTSB to provide data and results of its fuel oil samples that were taken from storage tanks, settling tanks, day tanks, and manifolds on March 28. Collect sample from diesel generator engines No. 1 and No. 3 (or No. 2 and No. 4).	Pending	
3.6.6.	Request that NTSB obtain copy of the bunker delivery note (BDN) which was submitted by fuel oil supplier.	Pending	NTSB will upload the bunker delivery notes to Kiteworks.
3.7.	Inquire about No.3 & No.4 G/E operating condition:	Yes	

3.7.1. - Request information about arrangement of the following valves at the time of the accident and at present: F-142V, F-173V, F-176V, F-179V, F182V, F-186V, F187V, F-188V, F-189V.	Yes	NTSB confirmed that all valve settings in the Fuel Oil Valve Line up are the same as compared to those settings at the time of the accident. The operation mode for main transformers No.1 and No. 2 on the 6.6kW Switchboard are different than those at the time of accident. Parties observed and agreed that the valve settings at present are as follows: Valve Open for DG3 : 182V, 176V Valve Close for DG3: 173V, 179V Valve Open for DG4 : 189V, 187V Valve Close for DG4: 188V, 186V
3.7.2. - Perform visual inspection of the valve condition; note observations for the record.	Yes	No damage observed in valve conditions.
3.7.3. - If Flushing Pump is not currently operating, start operation: Record the pressure of MGO as displayed on local gauge of return regulating valve (196V).	Yes	Flushing pump is operating. Pressure is not confirmed because pressure gauge was not operating properly. The pressure gauge indicates 4 bar although the actual pump discharge pressure was 6.5 bar. In addition, the pressure gauge continued to read 4 bar even after being isolated from the fuel system. An oil leak was observed on the gauge.
3.8. Inquire about No.1 & No.2 G/E operation condition:		

3.8.1.	Request information about arrangement of the following valves at the time of the accident and at present for the following valves: 141V, 159V, 160V, 171V, 174V, 177V, 180V, 172V, 175V, 178V, 181V	Yes	NTSB confirmed that all settings in the Fuel Oil Valve Line up are the same as compared to those settings at the time of the accident. The operation mode of the main transformers No. 1 and No. 2 on the 6.6kW Switchboard are different than those at the time of accident. Parties observed and agreed that the valve settings at present are as follows: Valve Open for DG1: 177V, 171V Valve Close for DG1: 174V, 180V Valve Open for DG2: 172V, 178V Valve Close for DG2: 175V, 181V
3.8.2.	- Perform visual inspection of the valve condition; note observations for the record.	Yes	No damage observed in valve conditions.
3.8.3.	- Measure the set pressure of FO return regulating valve (197V).	Yes	Synergy crew noted and NTSB acknowledged that the pressure gauge is out of order. The pressure gauge indicates zero despite having the gauge isolation valve open to line pressure. An oil leak was observed on the gauge.

3.9. Record inlet and outlet as displayed on local gauge at the No. 1 and No. 2 Booster Pumps.		
3.9.1. - Determine which Booster Pump is in operation and state for the record; record total pressure as displayed on the local gauge.		Synergy crew noted and NTSB acknowledged that the fuel supply system for DG3 and DG4 has been modified since the delivery of the vessel as follows: 1. At delivery: Supplied by Generator Engine FO Supply System 2. Present: Supplied by Electric Generator Engine MGO/MDO Flushing Pump and Air Driven Motor Pump when power to the Electric Generator Engine MGO/MDO Flushing pump fails
3.9.2. - Request crew to changeover the operation of the Booster Pump.		
3.9.3. - record total pressure as displayed on the other Booster Pump's local gauge.		
3.10. Record inlet and outlet pressure as displayed on local gauge at the No. 1 and No. 2 Generator Engine Fuel Oil Supply Pumps.	No	Fuel supply system for DG1 and DG2 has been modified since the delivery of the vessel as follows: 1. At delivery: Supplied by Generator Engine FO Supply System 2. Present: Supplied by Main Engine FO Supply System
3.10.1. - Determine which Generator Engine Fuel Oil Supply Pump is in operation and state for the record; record total pressure as displayed on the local gauge.		
3.10.2. - Request crew to changeover the operation of the Generator Engine Fuel Oil Supply Pump.		Parties noted that Generator Engine FO supply system for DG1, DG2, DG3 and DG4 is not in use. NK had approved such modifications to the Fuel supply system for DG1 and DG2 as well as installation of flow meters on G/E MGO flushing line.
3.10.3. - Record total pressure as displayed on the other Generator Engine Fuel Oil Supply Pump.		
3.11. - Discuss whether additional procedures are needed.		

4.	**Essential Pump (Automatic Sequential Starting during power recovery) Control Mode**		
4.1.	Visual inspection of the following pumps and fans to include notation of current operating status (i.e., auto/manual) and identify and collect records that describe state of operation at the time of the incident.	Yes	NTSB confirmed that all settings for the pumps listed in section 4.1 are the same now as they were at the time of the accident. The operation mode on main transformers No.1 and No.2 are different than those at the time of the accident. The current status of the pumps are listed below.
4.1.1.	- No.1/2 Stern Tube LO Pump	Yes	Pump motor current within expected limits. Control mode is set to Auto.
4.1.2.	- No. 1/2/3 Main Cooling Sea Water Pump	Yes	Pump motor current within expected limits. Control mode is Auto except No.1 Central Cooling Fresh Water Pump, which was in manual mode.
4.1.3.	- No. 1/2/3 Central Cooling Fresh Water Pump	Yes	Pump motor current within expected limits. Control mode is set to Auto.
4.1.4.	- No.1/2 Main Engine Jacket Cooling Fresh Water Pump	Yes	Pump motor current within expected limits. Control mode is set to Auto.
4.1.5.	- No.1/2 Boiler Feed Water Pump	Yes	Pump motor current within expected limits. Control mode is set to Auto.
4.1.6.	- No.1/2 Boiler Water Circulation Pump	Yes	Pump motor current within expected limits. Control mode is set to Auto.
4.1.7.	- No.1/2 Main Engine Fuel Oil Circulation Pump	Yes	Pump motor current within expected limits. Control mode is set to Auto.
4.1.8.	- No.1/2 Main Engine Fuel Oil Supply Pump	Yes	Pump motor current within expected limits. Control mode is set to Auto.
4.1.9.	- No.1/2 Generator Engine Fuel Oil Booster Pump	Yes	Pump motor current within expected limits. Control mode is set to Manual.
4.1.10.	- No.1/2 Generator Engine Fuel Oil Supply Pump	Yes	Pump motor current within expected limits. Control mode is set to Manual.
4.1.11.	- No.1/2 Forward Seal Pump	Yes	To be inspected on Apr. 26, 2024.
4.1.12.	- No.1/3/4 E/R Room Ventilation Fan	Yes	Pump motor current within expected limits. Control mode is set to Auto.

5. Sailing			
5.1.	Test operation of helm during normal operating conditions (i.e., Diesel Generator(s) are operating and providing sufficient power for the vessel).	Yes	
5.1.1.	- Check whether the steering gear is capable of putting the rudder from 35 degrees on one side to 35 degrees on the other side	Yes	Pushed the start button on bridge control console in the wheel house to start Hyd. Pumps 1, 2, and 3 for steering gear operation. Test-operated steering wheel and rudder from 35 degrees on one side to 35 degrees on the other side. Steering wheel and rudder operated as normal.
5.1.2.	- Check whether the steering gear is capable of putting the rudder from 35 degrees on either side to 30 degrees on the other side within 28 seconds.	Yes	Pushed start button on bridge control console in the wheel house to start Hydraulic Pumps 1, 2, and 3 for steering gear operation. Test-operated steering wheel and rudder from 35 degrees on either side to 30 degrees on the other side within 28 seconds. This test was completed within 18 seconds.
5.2.	Test emergency steering operation (i.e., when helm and steering system is powered by the Emergency Generator Running Condition).	Yes	
5.2.1.	- Operate the steering device in the wheel house all the way from port (left) to starboard (right). Check whether the steering gear is capable of putting the rudder from 15 degrees on one side to 15 degrees on the other side.	Yes	Low Speed Hydraulic Pump No. 3 for steering gear operation was automatically started successfully by the emergency generator ACB close signal. Test-operated steering wheel and rudder from 15 degrees on one side to 15 degrees on the other side. Steering wheel and rudder operated as normal.
5.2.2.	- Check whether the steering gear is capable of putting the rudder from 15 degrees on the other side to 15 degrees on the other side within 60 seconds.	Yes	Operated steering wheel and rudder from 15 degrees on the one side to 15 degrees on the other side within 60 seconds. This test was completed within 38 seconds.

Table 3. April 24, 2024

Procedures		Completed?	Comments
1. Main Engine ("ME") and BMS data collection and analysis			
1.1	Collect and Analyze event log of ME Control System		
1.1.1.	- Export alarm history of ME from the Main Operating Panel (MOP) using a USB memory stick. Alarm history of ME is recorded in the MOP.	Yes	
1.1.2.	- Request that parties view time on ME Control System and concur on time offset, if different than local time.	Yes	
1.1.3.	- Memorialize the difference between local time and BMS.	Yes	
1.2	Collect and Analyze BMS Event Log		
1.2.1.	- Export event history of BMS from the AutoChief Control Panel (ACP) using a USB memory stick. Event history of BMS is recorded in the ACP.	Yes	
1.2.2.	- Request that the Dali crew create an Event on the BMS event log for purposes of reconciling machine time settings against actual local time. Request that parties concur on time offset.	Yes	
1.2.3.	- Memorialize the difference between local time and BMS.	Yes	

1.3	On Monday (4/22), confirm that engine conditions will permit the following procedures. On Wednesday (4/24), check the buzzer and cancellation function when ME shutdown pre-warning occurs.	Yes	
1.3.1.	- On bridge panel of BMS, locate the buzzer and shutdown cancel buttons.	Yes	
1.3.2.	- Provoke Jacket Cooling Fresh Water inlet low pressure shutdown (which is cancellable) when the engine stops.	Yes	
1.3.3.	- Verify that there are not any shutdown conditions except for the Jacket Cooling Fresh Water inlet low pressure shutdown condition.	Yes	
1.3.4.	- Check whether buzzer is activated from bridge panel.	Yes	
1.3.5.	- Push "Cancel SHD" button on bridge panel within 6 seconds; confirm that shutdown was cancelled.	Yes	Pressing the "Cancel SHD" button once cancels the shutdown of the main engine (i.e., the engine does not shutdown), and pressing the "Cancel SHD" button twice stops the cancellation of the shutdown of the main engine (i.e., the engine shuts down) according to the engine manual.
1.4	NTSB is to upload SmartShip Data from April 1st	Pending	NTSB is to upload it along with Synergy's list of all equipment and machinery that is not in working order and the list of equipment and machinery that is in use.

2. Electrical Power Health Check			
2.1	Open No. 1/2 incoming panel on low voltage switchboard in the engine control room and perform visual inspection inside switchboard, including UVT controller.	Yes	
2.2	If signs of damage are observed, describe observation to the NTSB and take photographs of damaged equipment. Engineers will confirm that it is safe to continue testing with the damaged equipment, if applicable.	Yes	No damage observed. A lot of dust was observed.
2.3	Verify whether power analyzer functions normally by checking if the waveforms of the voltage are displayed on display screen.	Yes	In the electric workshop on the vessel, parties confirmed that the power analyzer functions normally.
2.4.	Connect power analyzer, which is a sensor that measures quantities of the rate of power flow in electrical system, at the following points: Point 1) On the secondary side of TR 1 step-down transformer (6600V/440V) Point 2) On the output of UVT (Undervoltage Trip) controller inside in No.1 incoming panel. Power analyzer will be connected for several days to collect data if another blackout/trip happens to occur.	Yes	One power analyzer was connected to Point 1 and Point 2 (Brand: Fluke), and the other power analyzer (Brand: Sonel) was connected to Point 1 only. These are to be connected for the following 48 hours. NTSB also installed 2 cameras, one where the power analyzer was connected and the other camera on MVSB on TR1 side.
2.5.	During the multi-day observation period, the vessel crew should immediately notify NTSB, HHI, and interested parties if anomalies are detected, such as blackouts, alarms from TR1 or TR2, and/or trips in the AMS. *Note: crew is permitted to respond to any developing issues during the observation period, as necessary, to ensure the safety of the vessel and its personnel.*	Pending	If no event is detected in the power analyzers by 4/26/24, the parties will start running at least two seawater pumps on 4/26/24 to see if it would trigger an event. If no event is triggered on 4/26/24, Synergy is to try different ways to trigger an event that would lead to a blackout of the 440V SWBD and record in detail what it did to trigger the event until 4/29/24. If no event is detected by 4/29/24, then the parties will stop monitoring and the power analyzers will be removed.

2.6.	HHI engineers to perform export of the power analyzer data.	Pending	The data recorded in the power analyzers will be extracted and uploaded on Kiteworks.
2.7.	Provide testing data and discuss results with NTSB and interested parties.	Pending	This will take place if any event is observed on or before 4/29/24.
2.8.	Provide NTSB and interested parties HHI analysis upon completion.	Pending	This will take place if any event is observed.
3.	**Collect AMS & HiMAP-BCG from April 1 to present, and HiMAP-T and HiMAP-FI from April 10 to present**		
3.1.	*Note: this will allow collection of information including pressure readings from inline fuel oil filters, operational data from compressed air system, event logs related to the April 12, 2024 blackout, and event logs from the Power Management System (PMS).*	Yes	HHI will upload HiMAP-T and HiMAP-FI on Kiteworks.
4.	**F.O. Service System**		
4.1.	Locate the Bunker Delivery Note in the vessel.	Yes	
4.1.1.	NTSB is to collect the Bunker Delivery Note and distribute hard copies to interested parties.	Yes	NTSB is to upload it on Kiteworks.
4.2.	Identify and record the current valve status on FO service line from FO tanks (LFO service tank, ULSFO service tank, MGO service tank) in the purifier room. - 101V, 102V, 103V, 104V, 110V, 65V,105V, 108V, 107V, 106V, 141V.	Yes	Valves closed: 101V, 102V, 103V, 104V, 106V, 141V Valves open: 105V, 107V, 108V, 65V (valve from HFO service tank to main engine and No. 1 and No. 2 GE) Valves not in use: 110V *Note: M/E MGO Cooler was not in use, and the valves 135V and 136V were closed, and 134V was open.*

4.3. Verify the current viscosity setting of the viscorator on M/E & G/E fuel oil service system in the purifier room.	Yes	The reading of the current viscosity on the viscorator for M/E, No. 1 and No. 2 was 8.5cst., 47 degrees in Celsius, and the setting at 15cst. *Note: There was a sticker "For ME, GE1, GE2" placed above the label of the original equipment entitled "M/E Viscosity Controller."*
4.4. Locate GE FO heater.	No	NSTB and Synergy informed HHI that the GE FO heater is non-operational and not in use.
4.4.1. Open the drain valve and check the status of the the drainage.	No	NSTB and Synergy informed HHI that the GE FO heater is non-operational.
4.5. Locate flow meter of the GE FO service system.	No	NSTB and Synergy informed HHI that the GE FO service system is non-operational.
4.5.1. Check and record the numbers on the display screen of the GE FO service system.	No	NSTB and Synergy informed HHI that the GE FO service system is non-operational.
4.6. Locate auto back flushing filter on GE FO service system.	Yes	HHI located the auto back flushing filter on the GE FO service system. However, it was non-operational.
4.6.1. Open the cap in the auto back flushing filter on the GE FO service system.	No	HHI located the auto back flushing filter on the GE FO service system. However, it was non-operational.
4.6.2. Check and record the status of the filter element in the auto back flushing filter on GE FO service system.	No	HHI located the auto back flushing filter on the GE FO service system. However, it was non-operational.
4.7. Locate GE MGO cooler.	No	NSTB and Synergy informed HHI that GE MGO cooler is non-operational.
4.7.1. Check and describe condition of the GE MGO cooler.	No	NSTB and Synergy informed HHI that GE MGO cooler is non-operational.

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Figure 4. *Left to right:* An HHI engineer inspects wire connections within the HV switchboard. Also shown, terminal block arrangement with individual wire connections.

Note: The following tables have been formatted for legibility. However, the content of the text and any graphics remain unaltered from HHI representatives' records and may contain typographical errors. In addition, HHI representatives added information to comment sections in some cases after their initial examination period. Record of testing results were finalized and circulated shortly after the examination sessions were completed. Most of the listed document requests, and other "pending" actions that are documented, have since been completed.

Table 4. April 26, 2024

Procedures	Completed?	Comments
1. Operational Status of Machinery in the Engine Room, as Reported by Synergy		
1.1 At the start of the examination, Synergy reported that the following Engine Machinery was in operation:		
1.1.1. No.1 DG		
1.1.2. No.1 Boiler Feed Water Pump		
1.1.3. No.1 Engine Room Ventilation Fan		
1.1.4. No.4 Engine Room Ventilation Fan		Synergy informed HHI engineers that, for this examination, it had recreated the operating conditions that were in effect at the time of the blackout observed on April 12, 2024.
1.1.5. No.3 Main Cooling Sea Water Pump		
1.1.6. No.2 Main Engine Fuel Oil Supply Pump	Yes	In addition to providing confirmation of the engine machinery operation status at the time of the examination, Synergy uploaded this same information to the NTSB Kiteworks. As noted above, Synergy reports that this accurately represents the vessel's operating status at the time of the blackout that was observed on April 12, 2024.
1.1.7. No.2 Boiler Water Circulation Pump		
1.1.8. No.2 Forward Seal Lubrication Oil Pump		
1.1.9. No.2 Main Engine Fuel Oil Circulating Pump		
1.1.10. Stern Tube Lubrication Oil Pump		
1.1.11. No.2 Main Engine Jacket Cooling Fresh Water Pump		

1.1.12. No.3 Central Cooling Fresh Water Pump	
1.1.13. Electric MGO Flushing Pump	
1.1.14. No.2 Air Conditioning Plant Booster Pump	
1.1.15. No.1 Main Lubrication Oil Pump	
1.1.16. No.1 Hydrophore Pump	
1.1.17. No.2 Main Air Compressor	
1.1.18. No.1 Refrigerator Compressor	
1.1.19. Hot Water Circulation Pump	

2. Operational Status of Engine Machinery in Cargo Holds, as Reported by Synergy			
2.1.	At the start of the examination, Synergy reported that the following Cargo Hold Machinery was in operation:	Yes	In addition to providing confirmation of the cargo hold machinery status at the time of the examination, Synergy uploaded this same information to the NTSB Kiteworks. As noted above, Synergy reports that this accurately represents the vessel's operating status at the time of the blackout that was observed on April 12, 2024.
2.2.	No.2F Hold Explosion Proof Exhaust Fan - 1 (E35)		
2.3.	No.3A Hold Explosion Proof Exhaust Fans - 2 (E35, E36)		
2.4.	No.4A Hold Supply Fans - 3 (S48, S50, S52)		
2.5.	No.4F Hold Supply Fan - 1 (S44)		
2.6.	No.5F Hold Supply Fans (S54, S55, S58, S60)		
2.7.	No.5A Hold Supply Fans - 4 (S62, S64, S66, S68)		
2.8.	No.6F Hold Supply Fans - 7 (S69, S70, S71, S72, S73, S74, S75)		
2.9.	No.7M hold Supply Fans - 2 (S77, S78)		
3. Check Operational Status of DGs			
3.1.	At the beginning of the examination, the vessel was only powered by DG1. Per Synergy's request, DG3 was placed in Standby (i.e., DG3 was idle and did not power the vessel, because the VCB was open).	Yes	(*Note: DG2 and DG4 were off.*)

4. Inspect Scrubber System			
4.1.	Activate Scrubber by starting the sea water supply pumps.	Yes	HHI requested that Synergy crew activate the Scrubber according to its standard procedure. At that time, the Synergy crew activated and increased the RPMs of No.1 & 3 Scrubber sea water supply pumps as follows: 1. No.1 Scrubber Sea Water Pump: 45% Load 2. No.3 Scrubber Sea Water Pump: 55% Load Once the water supply pump load figures were consistently maintained as noted above, the Scrubber System displayed the following: 1. Total Scrubber Consumption: 161 kW 2. Fuel Sulphur Content: 3.2% The Scrubber System was then operated for 45 minutes at the load levels indicated above.
5. Check Low Voltage System during Scrubber Operation			
5.1.	Check Power Analyzers	Yes	The Power Analyzers were operational and collecting power measurements as installed during HHI's April 26, 2024 visit.
5.2.	Check Low Voltage (440V) Switchboard Status	Yes	There were no notable changes on the Low Voltage (440V) Switchboard after the Scrubber System was activated.
5.3.	Check UVT Control Voltage Status	Yes	There were no notable changes on the Under Voltage Trip ("UVT") Control Voltage (24VDC) after the Scrubber System was activated.
5.4.	Check Harmonics on Low Voltage (440V) Switchboard	Yes	There were no notable changes (minimal / acceptable levels of distortion observed) on the Low Voltage (440V) Switchboard after the Scrubber System was activated.

Table 5. April 29, 2024

Procedures	Completed?	Comments
1. Operational Status of Machinery in Engine Room, as Reported by Synergy		
1.1. At the start of the examination, Synergy reported that the following Engine Machinery was in operation:	Yes	Synergy informed HHI engineers that, for this examination, it had recreated the operating conditions that were in effect at the time of the blackout observed on April 12, 2024, with the exception that the No.1 Air Conditioning Plant was operating during the April 29 examination and had been operating since at least Sunday, April 28, 2024. At the start of the examination, TR1 was powering the Low Voltage (440V) Switchboard and in automatic changeover mode. TR2 was also in automatic changeover mode.
1.1.1. No.1 DG Running		
1.1.2. No.1 Boiler Feed Water Pump		
1.1.3. No.1 Engine Room Ventilation Fan		
1.1.4. No.4 Engine Room Ventilation Fan		
1.1.5. No.3 Main Cooling Sea Water Pump		
1.1.6. No.2 Main Engine Fuel Oil Supply Pump		
1.1.7. No.2 Boiler Water Circulation Pump		
1.1.8. No.2 Forward Seal Lubrication Oil Pump		
1.1.9. No.2 Main Engine Fuel Oil Circulating Pump		
1.1.10. No.2 Stern Tube Lubrication Oil Pump		

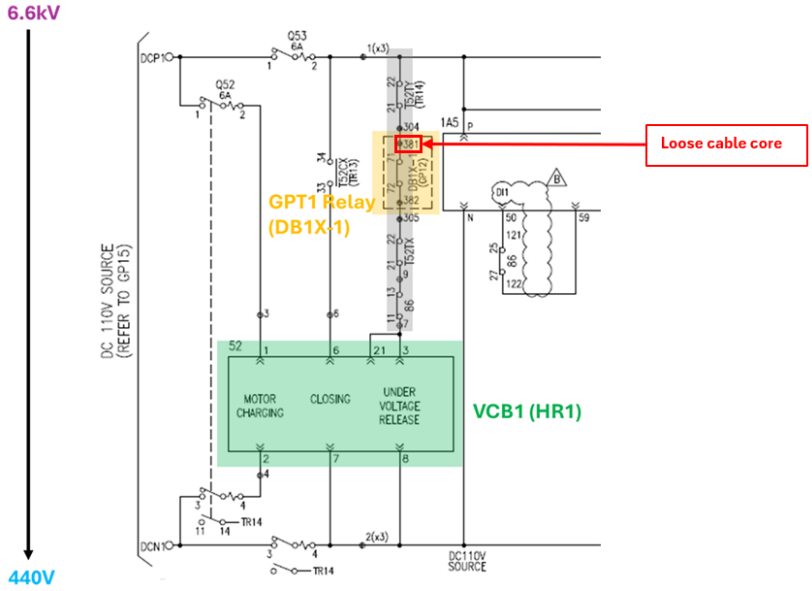
1.1.11. No.2 Main Engine Jacket Cooling Fresh Water Pump	
1.1.12. No.3 Central Cooling Fresh Water Pump	
1.1.13. Electric MGO Flushing Pump	
1.1.14. No.2 Air Conditioning Plant Booster Pump	
1.1.15. No.1 Main Lubrication Oil Pump	
1.1.16. No.1 Hydrophore Pump	
1.1.17. No.2 Main Air Compressor	
1.1.18. No.1 Refrigerator Compressor	
1.1.19. Hot Water Circulation Pump	
1.1.20. No.1 Air Conditioning Plant	

2. Operational Status of Machinery in Cargo Holds, as Reported by Synergy			
2.1.	At the start of the examination, Synergy reported that the following Cargo Hold Machinery was in operation:	Yes	Synergy informed HHI engineers that, for this examination, it had recreated the operating conditions that were in effect at the time of the blackout observed on April 12, 2024, with the exception that the No.1 Air Conditioning Plant was operating during the April 29 examination and had been operating since at least Sunday, April 28, 2024.
2.2.	No.2F Hold Explosion Proof Exhaust – 1 Fan (E35)		
2.3.	No.3A Hold Explosion Proof Exhaust – 2 Fans (E35, E36)		
2.4.	No.4A Hold Supply – 3 Fans (S48, S50, S52)		
2.5.	No.4F Hold Supply – 1 Fan (S44)		
2.6.	No.5F Hold Supply – 4 Fans (S54, S55, S58, S60)		
2.7.	No.5A Hold Supply – 4 Fans (S62, S64, S66, S68)		
2.8.	No.6F Hold Supply – 7 Fans (S69, S70, S71, S72, S73, S74, S75)		
2.9.	No.7M hold Supply – 2 Fans (S77, S78)		

3. Download Power Analyzers' Data		*Note: per the procedures for April 24, 2024, power analyzers were connected at the following points:* *(1) On the secondary side of TR 1 step-down transformer (6600V/440V)* *(2) On the output of UVT (Undervoltage Trip) controller inside in No.1 incoming panel.*
3.1. Download Data from Power Analyzers (FLUKE (NORMA-6004) and SONEL (PQM-707)).	Yes	Download was completed.
3.2. Analyze download data.	Yes	A preliminary review of the data was performed during the examination. At the time of the blackout (i.e., 6:12 AM (EST) on April 29, 2024) voltage recorded at the Low Voltage (440V) Switchboard and UVT Control Voltage (24VDC) instantaneously dropped to zero.
4. Check Relay Condition on LR1 UVT Controller		
4.1. Confirm interlock circuit for LR1 UVT controller	Yes	Analyzed Low Voltage (440V) Switchboard drawing to identify the two (2) relay contacts to LR1 UVT Controller: - 52XS2 (for shore MCCB Closed) - 152TY (LR2 ACB Interlock)
4.2. Check condition of 52XS2 (for shore MCCB Closed)	Yes	No anomalies observed.
4.3. Check condition of 152TY (LR2 ACB Interlock)	Yes	No anomalies observed.
5. Check LR1 ACB		
5.1. ACB cover open	Yes	No anomalies observed.
5.2. Check and measure resistance value on UVT coil	Yes	- Default Value on UVT coil resistance: 138 ohm (this is the manufacturer's designed resistance). - Measured Value on UVT coil resistance: 140 ohm UVT coil resistance is within the specification.
5.3. Check condition of LR1 ACB	Yes	HHI Engineers simulated energizing LR1 UVT and checked the contacts for LR1 ACB Open/Closed. No anomalies observed.

6. Check GOPRO camera		
6.1. Check recorded video in the event of blackout	Yes	NTSB and Synergy downloaded GOPRO camera footage, which will be made available to the parties via Kiteworks.
7. Check HR1 in High Voltage (6.6kV) Switchboard		
7.1. Check cable cores connection status in HR1	Yes	HHI's engineers checked whether the cable cores connected to HR1 were properly secured. During this examination, it was observed that a cable connection for the "ACB non-closed alarm (125X)" contact (1LV6) was loose. HHI engineers advised that this cable would not cause a 6.6kV blackout because the relay is normally open – the purpose of the cable is to identify non-closure of LR ACB. HHI disconnected the 1LV6 cable and reconnected. No blackout was observed.
8. Check HR1 Manual Operation		
8.1. Confirm HR1 is open	Yes	Confirmed.
8.2. Close HR1	Yes	HHI engineers tried to inspect the LR1 operability. Because HR1 needs to be closed first to close LR1, HHI engineers attempted to close HR1 but were unable to close it. To investigate the cause, the HHI engineers opened the HR1 VCB cover and checked the cable connection of HR1 VCB using a multi-tester. The HHI engineers observed that the HR1 UVT Coil was not receiving 110VDC power as it should. HHI engineers reviewed the schematics related to HR1 UVT operation and inspected all relays in the HR1 path.
9. Check No.1 GPT		
9.1. Check Relay Condition of Relay (DB1X-1)	Yes	The Relay condition is normal.

9.2. Check Cable connection to the DB1X-1 Relay (nodes 381, 382)	Yes	HHI engineers found that one of the cable cores that connects the DB1X-1 relay of the GPT1 panel to the control line was loose. The DB1X-1 relay is for bus blackout detection. Two ends of the DB1X-1 relay are nodes 381 and 382. Node 381 is connected to node 304 of the control line and node 382 is connected to node 305 of the control line (see Figure below). HHI engineers found that the cable was loosely connected at node 381. That condition can create an open circuit and interrupt the 110VDC power to the HR1 UVT Coil, which would trigger an under voltage release trip of HR1. This would result in a 440V blackout without leaving any records in the HiMAP-T sensor.



9.3. Simulation	Yes	The UVT Controller protects the transformer and Low Voltage (440V) Switchboard from undervoltage by opening the breaker. For the HR1 to remain closed, a series of relays in the 110VDC UVT control line must be closed, thereby supplying the power needed to keep the HR1 closed. HHI engineers advised that if the cable is loosely connected, the UVT control voltage might not maintain a steady value of 110VDC. If this condition is not met, the HR1 will open, which would lead to a Low Voltage (440V) Switchboard blackout. If the transformers are set to an automatic switch mode, LR2/HR2 is automatically closed and TR2 is connected when HR1/LR1 is open. After explaining this to NTSB and the Parties, HHI offered to demonstrate what would happen if the loose cable core that connects nodes 381 and 304 was disconnected while HR1/TR1/LR1 was powering the 440V Switchboard. Before the simulation, HHI engineers informed the parties that an outage is expected once the cable core is disconnected, so Synergy and vessel crew should prepare for a blackout. One of the HHI engineers then disconnected the cable core at node 381. HR1 immediately opened, followed by LR1 opening. NTSB, HHI engineers, and the Parties observed that all equipment powered by the Low Voltage (440V) Switchboard, including operating lights throughout the vessel, immediately lost power. NTSB, HHI engineers, and the Parties observed that the Low Voltage (440V) Switchboard regained power after approximately 10 seconds, once automatic transfer from TR1 to TR2 re-energized the Low Voltage (440V) Switchboard.
9.4. Post-Simulation Observations	Yes	HHI Engineers, NTSB, and the Parties agreed that the results of the Simulation were consistent with those anticipated by HHI engineers, as described in 9.3 and discussed among the parties immediately before the simulation took place. During a debrief with the Engineering Group, the Parties agreed to extend monitoring with the Power Analyzers through the afternoon of Wednesday, May 1, 2024.

10. Download Data		
10.1. Download data from AMS and HiMAP-FI, HiMAP-T, and HiMAP-BCG.	Yes	Downloaded the following data: 1. AMS data 2. HiMAP data from - No.1 GPT (HiMAP-FI) - No.2 GPT (HiMAP-FI) - No.1 Main Transformer (HiMAP-T) - No.2 Main Transformer (HiMAP-T) - No. 1 Generator (HiMAP-BCG) HHI will share the data with NTSB and Parties.