National Transportation Safety Board

Marine Accident Brief

Grounding of Bulk Carrier *Nenita*

Accident no.	DCA17FM003
Vessel name	*Nenita*
Accident type	Grounding
Location	Columbia River at navigation marker “23,” Three Tree Point, in the Welch Island Reach near Skamokawa, Washington, 46° 16.0’ N, 123° 31.2’ W
Date	November 19, 2016
Time	0246 Pacific standard time (coordinated universal time – 8 hours)
Injuries	None
Property damage	$4 million est.
Environmental damage	None
Weather	Clear visibility, calm winds, air temperature 45°F
Waterway information	The Columbia River is the largest river in the US Pacific Northwest. Near the accident site, the main channel of the river follows the north (Washington State) shore and has a current velocity of about 1 knot.[1]

On November 19, 2016, the fully-laden bulk carrier *Nenita*, registered in the Marshall Islands, was outbound on the Columbia River when the vessel suffered an engine failure impacting its ability to maneuver. The vessel subsequently ran aground at Three Tree Point on the Washington State side of the river, damaging its bulbous bow and hull. After the grounding, the *Nenita* was towed to Longview, Washington, for temporary repairs. Two weeks later, the vessel resumed the voyage to its original destination. There were no injuries or reported pollution as a result of the accident.

***Nenita* undergoing temporary repairs at Longview, Washington, following the accident.**

[1] National Oceanic and Atmospheric Administration (NOAA), *United States Coast Pilot 5*, Washington, DC: US Department of Commerce, 2017.

The 738-foot-long, 106-foot-wide *Nenita* was built at the Sasebo Heavy Industries Co. Ltd shipyard in Sasebo, Japan, and delivered in May 2006. On November 10, 2016, the *Nenita* arrived at the entrance to the Columbia River and, from November 17 to 18, loaded soybeans at the Port of Kalama, Washington. After taking on a full load of soybeans, the vessel departed the dock about 1915 on November 18 and shifted to the Kalama deep anchorage to await a favorable flood tide for the transit down the Columbia River to sea. At 2222, a pilot boarded the *Nenita* for the outbound transit.

All pre-departure tests on the bridge and in the engine room were carried out satisfactorily along with a master-pilot exchange of information. In describing their relationship, both the master and the Columbia River pilot told investigators that they performed their respective jobs professionally, and all orders and instructions were carried out. In addition to the master and pilot, the bridge team consisted of a mate at the engine telegraph and a helmsman. The chief engineer, second engineer, third engineer, and an oiler were in the engineering control room, in accordance with the operating company's maneuvering manning requirements.

The anchor was heaved at 2235 and by 2300 the vessel was under way headed down river. The first few hours of the transit were uneventful. As the pilot navigated the vessel through the river during this time, the engine and rudder performed satisfactorily. The main engine remained in bridge control throughout the entire outbound transit.

Per the *Nenita*'s pilot information card, the vessel's maximum engine order was "Full Sea Speed." During the transit, the pilot used the term "Nav Full" to order Full Sea Speed; the *Nenita* crew was familiar with this terminology and there was no confusion with the pilot's orders (Nav Full will be used for the remainder of this report). The pilot used Nav Full while navigating the *Nenita* down the river to get more propeller wash past the rudder and impart a greater steering effect.

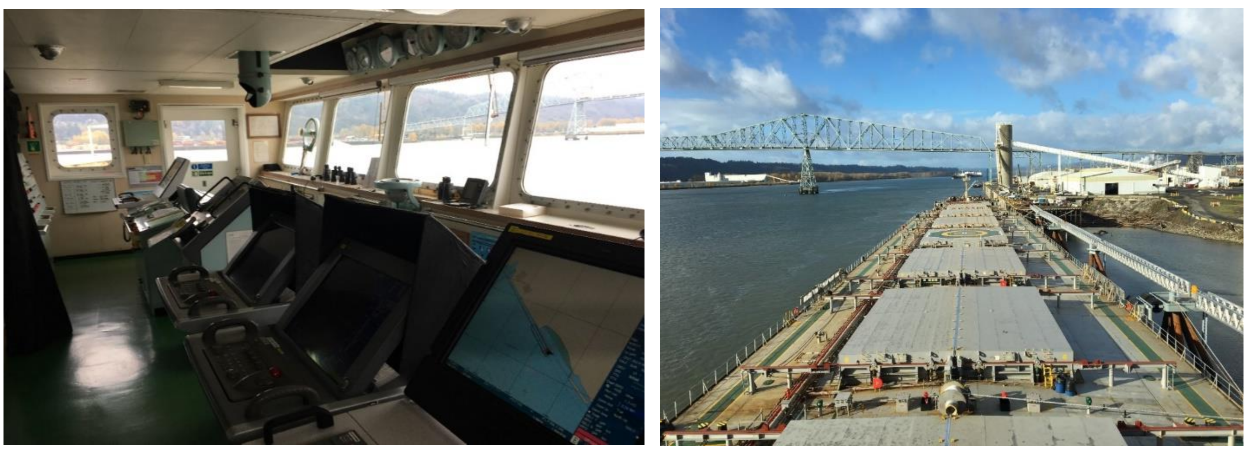
As indicated on the pilot information card, the engine speed for Nav Full was 102 rpm. However, the *Nenita*'s engine load program reduced this rpm to ensure that the engine did not exceed its maximum torque limitation. Factors such as a full load of cargo, shallow bottom depth in relation to the keel, or working against a heavy current could increase the load on the engine and consequently reduce maximum rpm. Based on voyage data recorder (VDR) information from the accident, the *Nenita*'s engine speed was about 90 rpm when Nav Full was ordered. According to crewmember statements and a review of the maneuvering load program, an increase in speed from full ahead 70 rpm to Nav Full 102 rpm could take approximately 30–45 minutes.

Accident Events

About 0230 on November 19, the main engine cooling fresh water low pressure audible alarm sounded and the visual alarm illuminated on the display panel in the engine control room. The chief engineer acknowledged the alarm as the second and third engineering officers left the control room to the identify the source of the alarm condition. The third engineer discovered a crack on the main propulsion engine no. 3 cylinder cooling jacket located near the base of the cylinder cover. Cooling water was reportedly leaking from the cracked cooling jacket at approximately 5–10 gallons per minute. The chief engineer told investigators that he immediately notified the bridge of the failure via the ship's phone. A minute later, the no. 3 cylinder cooling water outlet high temperature above 95 degrees C (203 degrees F) alarm activated, which automatically initiated an emergency slowdown of the main engine to below 30 rpm. This function was designed to protect the engine from damage due to the loss of cooling water until the abnormal condition was corrected. About a minute later, the main engine cooling water expansion tank low level alarm activated followed by the cooling water outlet high temperature alarms on the remaining six cylinders. The second engineer closed the cooling water inlet and outlet valves to the no. 3 cylinder while the third engineer started to refill the expansion tank with water.

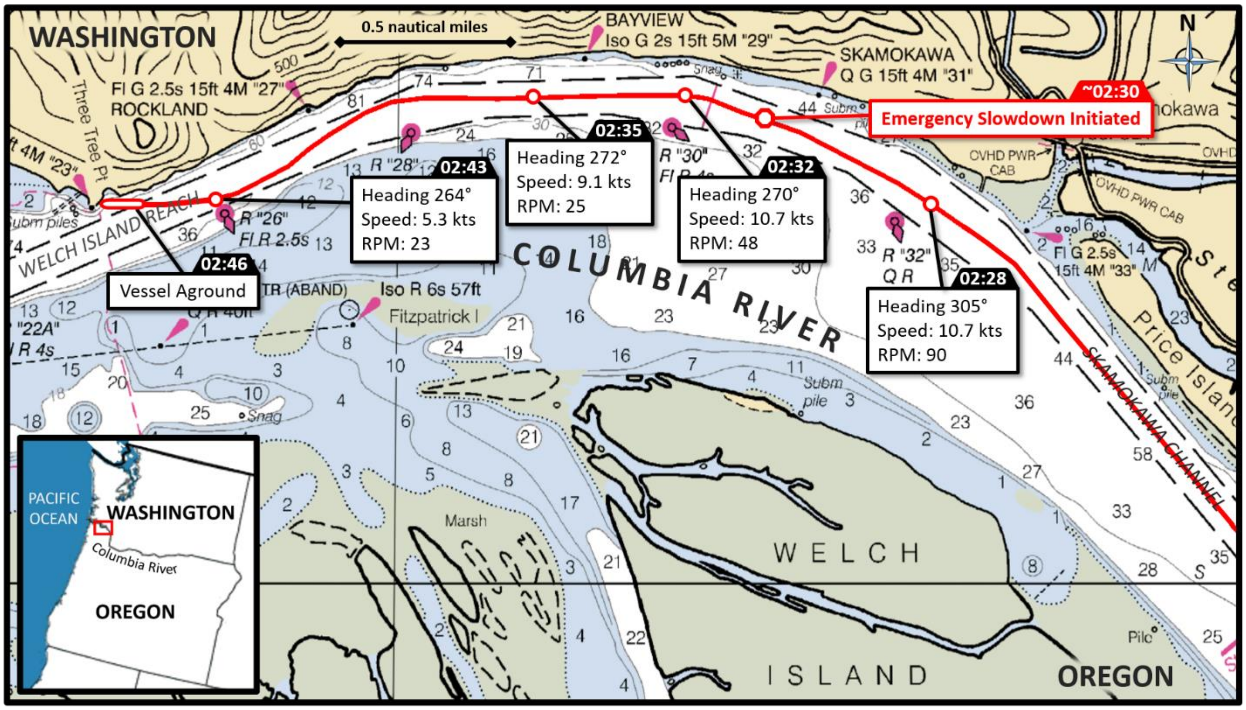
Meanwhile on the bridge, at 0231, after passing navigation buoy R "30" to port (near Bayview, Washington) and heading for the Welch Island Reach, the pilot ordered port 20 degrees rudder and then instructed the helmsman to steer a course of 270. About 0232, after feeling a reduction in vibration, the pilot asked, "Hey, what happened to our engine?" The VDR showed a drop in speed from about 90 rpm to 48 rpm while the engine order telegraph was still in the Nav Full ahead position. At the time of the rpm reduction, the vessel was making about 11 knots.

Soon after, the VDR captured audio of the master talking on the ship's phone to the chief engineer and watch engineer inquiring about the loss of rpm on the main propulsion engine. The conversation between the master and the engineering personnel was not conducted in English, and thus the pilot could not understand the discussion. A minute and a half into the phone call with the chief engineer, the master told the pilot about a "leaking pipe on the main engine . . .. They are fixing it." During the next 10 minutes, the phone conversation between the master and engineering personnel continued in their native language. The pilot asked several times, "What's going on with the engine?" and stated, "I need some rpms."



Left is photo of the *Nenita* navigation bridge. Right is photo looking forward on the *Nenita* from the navigation bridge.

After the pilot questioned the engine performance, he ordered the rudder to midship and instructed the helmsman, who was trying to maintain the ordered course of 270, that he might have to use a lot of rudder due to the loss of rpm. The master then shifted the engine order telegraph down to dead slow ahead one position at a time to match and go below the actual engine rpm, which had now decreased to about 35 rpm.



Chartlet shows portion of Columbia River where *Nenita* was transiting when the engine casualty occurred and the vessel eventually grounded. (NOAA chart 18523)

At 0235, the *Nenita*'s engine rpm decreased further to 25. The master asked if the ship should anchor, and the pilot responded that in the vessel's present location there was not a place to safely anchor without going aground, primarily due to the anticipated change in current from flood to ebb.

A few minutes later, the pilot radioed ashore inquiring about the availability of two tractor tugs to assist the *Nenita*. From this point until the last moments before the grounding, the pilot asked the master with increasing urgency and exasperation the status of the engine, the availability of more engine rpm, and the ability of the engine to go astern. He made clear to the master that the lack of engine response was putting the vessel at risk of running aground. The master was likely relaying the pilot's questions and concerns to the engine room while on the phone, but the conversation was only in his native language, and he never responded back to the pilot in English.

The *Nenita* continued to decrease in speed, now making about 6 knots at about 25 rpm ahead as it passed navigation marker "27" on the north bank of the river. The pilot ordered increasingly large helm orders to port and starboard to maintain the center of the channel; however, steerageway eventually was lost, and the vessel began to drift to starboard. The pilot, having received no verbal acknowledgement from the master about the engine status, ordered both anchors dropped and then ordered the engine to emergency full astern.

At the same time that the anchors were being ordered let go, the engine momentarily increased speed to about 65 rpm ahead. The engine speed then began to decrease and reversed to about 75 rpm astern, likely in response to the pilot's last command, emergency full astern. At 0246, the *Nenita* ran aground at Three Tree Point in Washington State. Consequently, the pilot ordered the engine stopped and commenced making initial calls to the appropriate authorities. The master ordered all tanks sounded. There was no oil or pollution observed around the vessel.

Damage to ***Nenita's*** **bulbous bow starboard side. (Photo by Spring Marine Bulk, S.A.)**

During the grounding, the *Nenita*'s forepeak flooded when the vessel's bulbous bow was breached. Web frames were damaged in the bow and shell plating was torn, folded, or fractured. The forward end of the bilge keel exhibited no signs of damage.

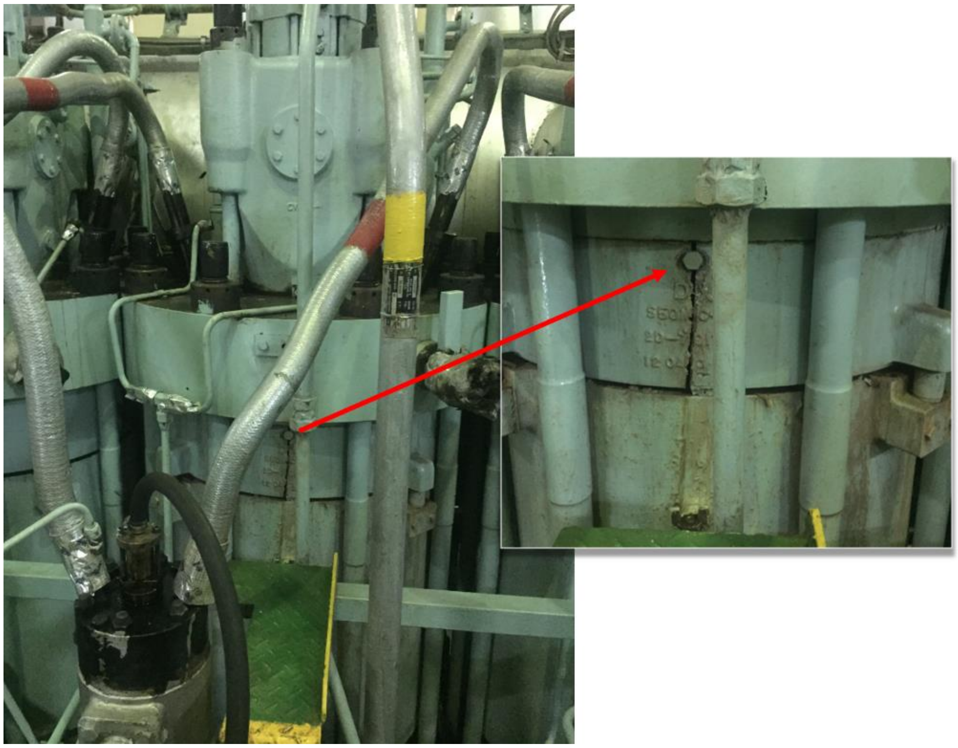
Investigators documented the fractured no. 3 cylinder cover cooling jacket and the condition of the other six cylinders cooling jackets. No. 1 and no. 2 cylinders also showed signs of cooling water weeping from the cooling jacket o-rings and connections, and investigators observed potential hairline cracks in the area of the bolts securing the cooling jackets in place.

The vessel was towed to Longview, Washington, for temporary repairs, where seventy cubic yards of cement were added to the bulbous bow void space. As a precautionary measure, the *Nenita*'s technical manager, in agreement with the US Coast Guard and the vessel's classification society, Lloyd's Register, replaced the cooling water jacket covers on Nos. 1, 2, and 3 cylinders with spare covers and replaced the jacket cover securing bolts. The vessel remained in Longview until the temporary repairs were approved by the Coast Guard and the classification society on December 6. Provisional transit was authorized to allow the *Nenita* to offload the cargo of soybeans at its original destination in Qinzhou, China. Following the offload, the vessel proceeded to Guangzhou Shipyard in southern China for permanent repairs.

Analysis

The *Nenita*'s loss of speed in the Columbia River channel occurred because of the fracture and failure of the no. 3 cylinder cooling jacket cover on the two-stroke crosshead-design Mitsui-MAN B&W 7S50MC-C main propulsion engine. Cooling water escaped from the fractured cooling jacket, which caused the no. 3 cylinder water outlet temperature to rise above 95 degrees C (203 degrees F), initiating an automated slowdown of the engine to protect it from further damage. The reduced speed resulted in reduced maneuverability. Steering was greatly affected, and despite the pilot's use of heavy rudder orders to maintain course, he was unable to keep the ship in the channel and it eventually grounded.

No metallurigical testing or analysis was conducted on the fractured cooling jacket cover to determine if abnormal conditions such as pre-existing cracks, unusual metal composition, corrosion, or manufacturing defects were present. Vibration and propeller shaft torque could not be evaluated. The vessel was not equipped, nor required to have, a torque meter or vibration sensor on the propeller shaft.



Cracked cooling jacket on main engine no. 3 cylinder, postaccident. Arrow shows one of four hex head securing bolts for the jacket cover. (Photo by Coast Guard)

Investigators reviewed maintenance records, standing orders, and engine room log books and found no. 3 cylinder cover was overhauled on June 11, 2016 (5 months prior to the accident), by the current operating company, which had taken over the vessel's operations one month prior, in May 2016. The cylinder had approximately 2,089 running hours since the overhaul. In the inspection reports completed during and after the overhaul of the cylinder, the remarks section of the maintenance report stated, "Check all parts found in good condition." There were no engine room log book entries or outstanding work orders for no. 3 cylinder listed in their corrective or preventative maintenance system. There was also no history of high jacket water temperature alarms prior to the engine casualty. The crew indicated that the jacket cooling water thermostatic valve operated as designed and no rapid temperatures changes were recorded.

In recent years, several incidents have been reported worldwide of cooling jacket failures on the two-stroke crosshead-design MAN Diesel & Turbo 50 and 60 MC-C engines built in the mid-2000s, like the engine on the *Nenita*. This is the second accident that the NTSB has investigated in the last 10 years involving the fracture and failure of cooling jackets on engines of these types manufactured from gray cast iron. The 2012 collision of the oil tanker *FR8 Pride* with the mobile offshore drilling unit *Rowan EXL I* was caused by the failure of the cylinder no. 5 cooling jacket on the *FR8 Pride*'s MAN B&W 5S60 MC-C engine. On two separate occasions prior to the *FR8 Pride*'s collision, cooling jackets had cracked and failed. After the accident, the crew called on the assistance of the engine manufacturer's service engineers, who identified several possible causes for the cracked cooling jackets. The NTSB's investigation, however, concluded that the cause of the cracked cooling jacket remained undetermined.

In March 2015, Coast Guard Marine Safety Unit Portland (MSU Portland), Oregon, investigated a simular cooling jacket fracture and failure on a MAN 50 MC-C engine aboard the bulk carrier *Miyama* in the vicinity of the *Nenita*'s grounding. The Coast Guard determined that the cooling jacket casting had a latent defect. Deteriorated securing bolts allowed the cooling jacket to vibrate loose, precipitating the crack.

In January, 2014, MAN Diesel & Turbo issued a service letter indicating that most cases of cracked cooling jackets on the cylinder covers were related to insufficient cooling water maintenance. In such cases, heavy deposits of dirt and metallic particles (i.e. rust and chips, etc.) tended to find their way into the clearances between the cylinder cover and the cooling jacket, making heat expansion of the cylinder cover impossible without also exposing the cooling jacket to significant stress as the heat expansion was reducing the clearances. This stress had the potential to crack the cooling jacket.

MAN Diesel & Turbo's low-speed engine division, headquartered in Copenhagen, Denmark, developed and distributed the service letter via mail. MAN Diesel & Turbo indicated that the owner and operator of the *Nenita* did not acknowledge receipt of the service letter. The vessel's chief engineer and technical manager were unaware of the service letter at the time of the accident and could not produce a copy on board the *Nenita*.

Investigators were not present during the removal of the cylinder no. 3 cracked cooling jacket to document the condition of the jacket and rubber o-rings, or the presence of fouling in the cooling chamber from deposits, scale, and metallic particles. Photographs taken by the operator's third-party service technician were provided to the Coast Guard. However, investigators were unable to determine the level of deposits and scale present in the system from the limited and poor quality photographs.

Investigators reviewed the 6 months of cooling water treatment service reports completed by the ship's crew and Wilhelmsen Ships Service prior to and postaccident to determine if the cooling water was treated in accordance with the original equipment manufacturer's (OEM's) specifications, rules, and recommendations.[2] Investigators discovered several reports with elevated chloride levels and low corrosion inhibitor. On June 30, 2016, a Wilhelmsen chemical engineer conducted onboard testing of the cooling water system while the vessel was in Singapore. The report results indicated elevated chloride at 40 parts per million (ppm) (50 ppm is the maximum allowed), a pH value of 8.3 (the specified range should be between 8.3 and 9.5), and a low amount of corrosion inhibitor, sodium nitrite, at 900 ppm (the specified range should be between 1,000 ppm and 2,400 ppm). The report stated, "Nitrite slightly below recommended limit. Need to dose more ROCOR NB liquid, to boost Nitrite reserver to 1,000–2,400 ppm."

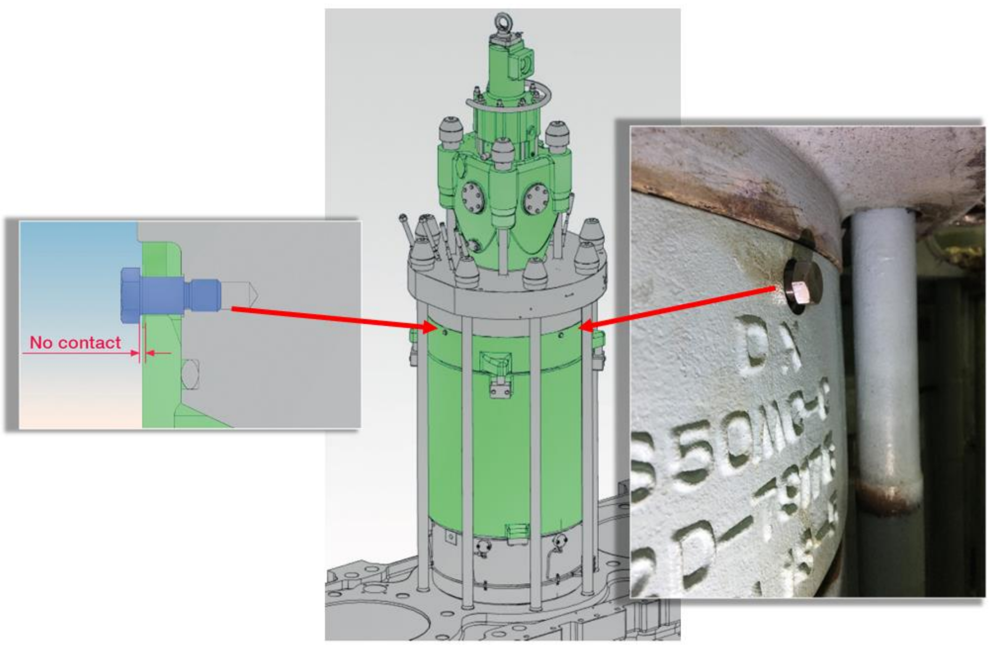
Cooling water chemical testing conducted on board by the third assistant engineer in July, August, and September indicated simular low levels of sodium nitrite. Sodium nitrite is an effective corrosion inhibitor for the common ferrous and nonferrous metals found in engine cooling water systems. When the cooling water system is treated to the specified range, a stable oxide film is formed on the metal surfaces and prevents corrosion caused by electrolytic action between dissimilar metals. A low level of sodium nitrite (less than 1,000 ppm) combined with low pH increases the risk of corrosion.

The chloride value of the cooling water should be kept as low as possible; any increase in value, whether sudden or gradual, is an indication of sea water contamination. If the chloride level

[2] Wilhelmsen Ships Service is a worldwide maritime support company providing services such as ships agency, logistics, and engineering testing.

exceeds 50 ppm, the possibility of corrosion in the system increases because chlorides have a negative effect on the passivation film created by nitrites, according to the manufacturer. Therefore, the manufacturer recommended that until corrective action was successful in bringing the chloride level back down below 50 ppm, the nitrite level should be kept close to the upper limit (2,400 ppm). An April 2017 Wilhelmsen Ships Service report emphasized, “Cooling water nitrites best to maintain between 1,440 ppm and 2,400 ppm for better protection.” In summary, elevated levels of chloride and low levels of nitrite over extended periods of time could lead to increased thermal stresses on the cooling jackets.

The MAN Diesel & Turbo service letter also discussed the securing of the cooling jacket to the cylinder cover by four specially machined bolts. Several different designs of fasteners were used on the *Nenita*’s engine model, and the one used aboard the vessel was a specially designed hex head bolt with metric machined threads and an unthreaded shoulder that was larger in diameter than the threads. The unthreaded shoulder acted as a spacer to provide expansion of the cooling jacket independent of the cylinder cover. The four bolts maintained the cooling jacket axial alignment without contact between the hex head and the cooling jacket (see illustration below).

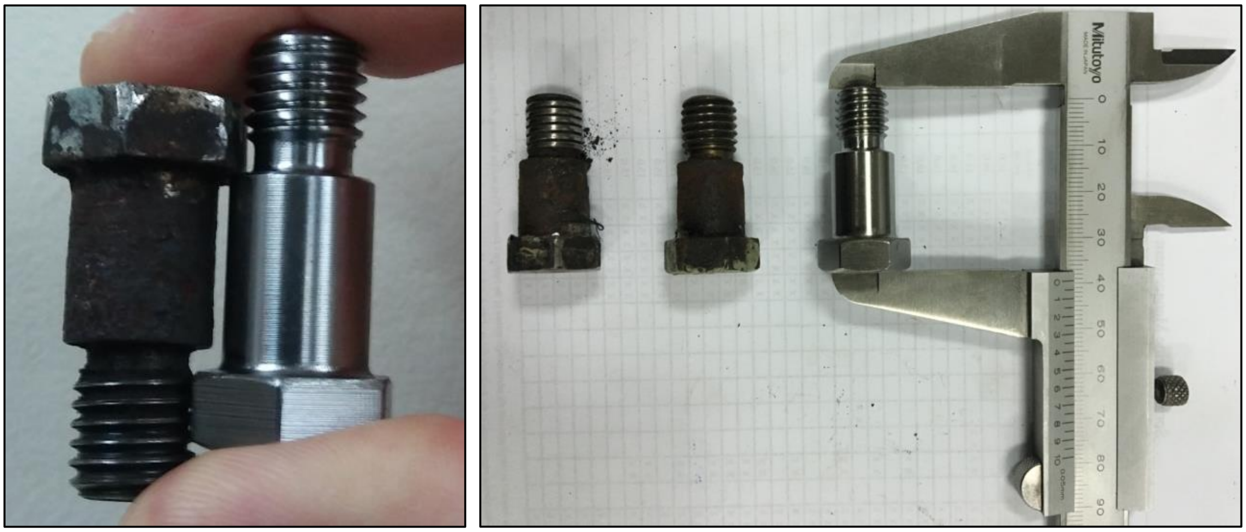


Simplified drawings of the hex head bolt and cooling jacket space. At right is the replacement hex head bolt and new cooling jacket installed on *Nenita*’s no. 1 cylinder. (Diagrams by MAN Diesel & Turbo SE)

Because investigators were not present during the removal of the cracked cooling jacket for cylinder no. 3, they were not able to document the condition of the four securing bolts. A data logging torque transducer or strain-gage torque wrench was not used during the removal to record the breaking torque. During interviews, the vessel’s technical manager told investigators that the bolts were not tightened to required torque specifications, but rather hand tightened by vessel engineering personnel with standard wrenches.

The technical manager provided investigators with the four bolts replaced on cylinder no. 3 cooling jacket after the accident. Investigators verified that the four bolts were produced by the OEM. One of the four bolts had damaged threads, an indication of a cross threaded condition (see photographs below). Also, investigators noted that the bolts used to replace the four removed bolts were a slightly different design; they were the same diameter and thread length, but the unthreaded shoulder length was 2 millimeters longer. The difference in length is a potential design modification to provide additional radial expansion of the cooling jacket.

The correct tension or pre-load applied to a bolt is critical to the reliability of the bolted joint assembly, but the condition of three of the four bolts removed from the cylinder no. 3 cooling jacket indicated improper or excessive torque. The unthreaded shoulders near the threads expanded outward, an indication of compressive stress resulting in the deformation of the base of the shoulder.



Comparison of bolts removed from no. 3 cylinder cooling jacket and replacement bolts shows same diameter and thread length, but unthreaded shoulder length of the replacement bolt was 2 millimeters longer. Also note damaged threads on leftmost bolt in right photo.

The engine failure and subsequent reduction in speed eventually resulted in the loss of steerageway to the vessel while underway in a narrow winding river. The pilot, from the moment he realized the drop in engine revolutions, repeatedly asked the *Nenita*'s bridge team for either more rpm or the status of the engine as he tried to maintain the vessel's position in the channel. The master provided no definitive information to the pilot while he had an extended phone conversation with engine room personnel. If the pilot had received more detail about the engine casualty during the fifteen minutes between the engine failure and the grounding, he would have had more information to make a decision about his next course of action. If he knew the vessel was not going to quickly regain propulsion, he would have had more time to identify an anchoring location or attempt a softer-bottom grounding. Without this information, the pilot maintained his position in the channel in the hopes of regaining engine speed. Consequently, the ship lost steerageway and grounded.

Investigators attempted to determine how the increase in ahead rpm just prior to the grounding was initiated. Although it could not be determined conclusively, the increase was most likely due to the activation of an override or bypass of the engine control system's automatic slowdown function. Regardless, the pilot was not aware of the increase in rpm or the capability to bypass the automatic slowdown.

According to Coast Guard investigation officers based at MSU Portland, postaccident actions have been taken by the Columbia River Pilots as a result of this accident. Instructions have been added to the pilot card, which is presented to a vessel's master at the time of pilot boarding, including noting whether or not the vessel has an engine control system bypass or override button/switch that can be used in an emergency. Additionally, the pilot card states that the bridge team must communicate in English while the vessel is being navigated through pilotage waters.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the grounding of the bulk carrier *Nenita* was the failure of a main engine cylinder cooling jacket that initiated an automatic reduction in engine speed, resulting in the eventual loss of steerageway. Contributing to the accident was the lack of information relayed from shipboard personnel to the pilot about the status of the main engine, which prevented him from taking effective corrective action following the engine casualty.

Water Chemistry

Maintaining proper water chemistry in engine cooling water systems reduces corrosion, scale, and the formation of deposits, which ensures effective cooling (heat transfer) to satisfy the system's operating requirements. Mariners should conduct testing per the manufacturer's recommended schedule, ensure levels of treatment are correct, and maintain water quality within specified limits. Insufficient cooling water maintenance may result in increased corrosion, clogging of cooling water passages, or, ultimately, the failure of equipment.

Tightening of Fasteners

Over the last two years, the NTSB has investigated three separate accidents that may have been caused by a failure to tighten fasteners on marine engines to the manufacturer's recommended torque settings. Undertorqueing a fastener may cause excess vibration or allow the fastener to come loose, while overtorqueing may lead to failure of the fastener or the machinery component being secured. When installing fasteners, mariners should use a calibrated torque wrench and follow the manufacturer's recommended tightening guide and torque values.

Vessel Particulars

Vessel	*Nenita*
Owner/operator	Lester Marine Inc. / Spring Marine Bulk S.A.
Port of registry	Majuro, Marshall Islands
Flag	Marshall Islands
Type	Bulk carrier
Year built	2006
Official number	6917
IMO number	9304289
Classification society	Lloyd's Register
Construction	Steel
Length	738.1 ft (225 m)
Draft	42.8 ft (19.8 m)
Beam	105.5 ft (32.2 m)
Gross tonnage	40,042 gross tons
Engine power; manufacturer	Single 12,378 hp (9,230 kW) Mitsui-MAN B&W 7S50MC-C diesel engine
Persons on board	24 crew, 1 pilot

NTSB investigators worked closely with our counterparts from Coast Guard Marine Safety Unit Portland, Oregon, throughout this investigation.

For more details about this accident, visit www.ntsb.gov and search for NTSB accident ID DCA17FM003.

Issued: January 4, 2018

The NTSB has authority to investigate and establish the probable cause of any major marine casualty or any marine casualty involving both public and nonpublic vessels under Title 49 *United States Code*, Section 1131. This report is based on factual information either gathered by NTSB investigators or provided by the Coast Guard from its informal investigation of the accident.

The NTSB does not assign fault or blame for a marine casualty; rather, as specified by NTSB regulation, "[NTSB] investigations are fact-finding proceedings with no formal issues and no adverse parties . . . and are not conducted for the purpose of determining the rights or liabilities of any person." Title 49 *Code of Federal Regulations,* Section 831.4.

Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by conducting investigations and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report. Title 49 *United States Code*, Section 1154(b).