National Transportation Safety Board

Marine Accident Brief

Overpressurization and Rupture of Cargo Tank on Cargo Vessel *Fairchem Filly*

Accident type	Hull/Machinery/Equipment Damage	**No.** DCA19FM037
Vessel name	*Fairchem Filly*	
Location	Vopak Terminal, Ship dock 5, Houston Ship Channel, Deer Park, Texas 29°44.95' N, 95°05.76' W	
Date	May 30, 2019	
Time	0750 central daylight time (coordinated universal time – 5 hours)	
Injuries	None	
Property damage	Est. $750,000 to vessel and $100,000 in cargo	
Environmental damage	None	
Weather	Temperature 83°F, winds from the north at about 5 miles per hour, clear visibility	
Waterway information	Houston Ship Channel at the Vopak Tank Terminal facility. The terminal has four deep-draft tanker berths and eight barge docks located on the south side of the channel.	

On May 30, 2019, about 0750 local time, the Marshall Islands-flagged chemical tanker *Fairchem Filly*, with a crew of 22, experienced an overpressurization of the number 3 port and starboard cargo tanks while discharging liquid hexene at Vopak Terminal in Deer Park, Texas. The overpressurization resulted in damage to the number 3 port cargo tank and the tank top (deck). All cargo was contained on board the double-hulled vessel, with no pollution or injuries reported. Damage to the *Fairchem Filly* was estimated at $750,000, and the contaminated cargo was an estimated $100,000 loss.

Chemical tanker *Fairchem Filly* after the accident in Galveston, Texas.

Area of accident where one of the *Fairchem Filly*'s cargo tanks ruptured during discharge operations. (Background source: Google Maps)

Background

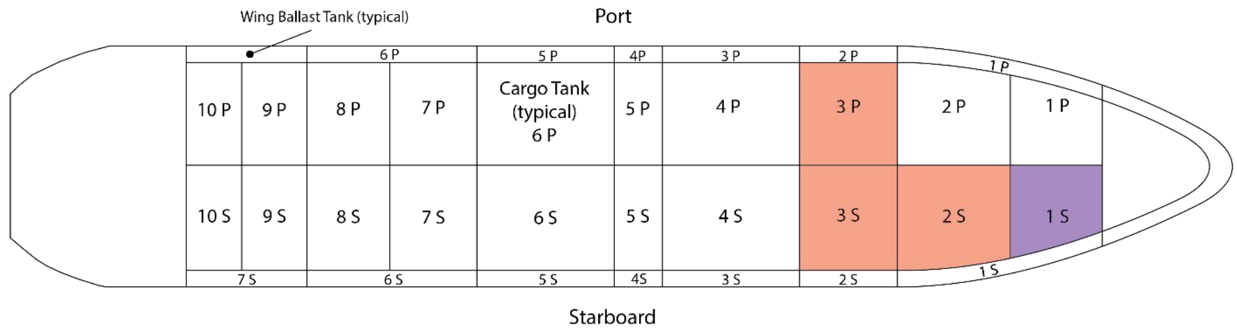
The 479-foot chemical tanker *Fairchem Filly* was built in 2007 at Usuki Shipyard in Usuki, Japan, and flagged in the Marshall Islands. The ship was owned by HSL Filly Shipping LTD and operated by Fleet Management Ltd, who provided the crew and technical management. The vessel was double-hulled, meaning it had an inner watertight hull in addition to its outer hull. Double-hull construction is intended to minimize the chances of cargo loss to the environment by providing protection from side or bottom damage. The cargo tanks of the *Fairchem Filly* consisted of 20 separate, stainless steel cargo tanks, ranging in capacity from 169,519 to 485,442 gallons, which allowed the vessel to carry a variety of small-batch, highly specific chemicals at the same time.

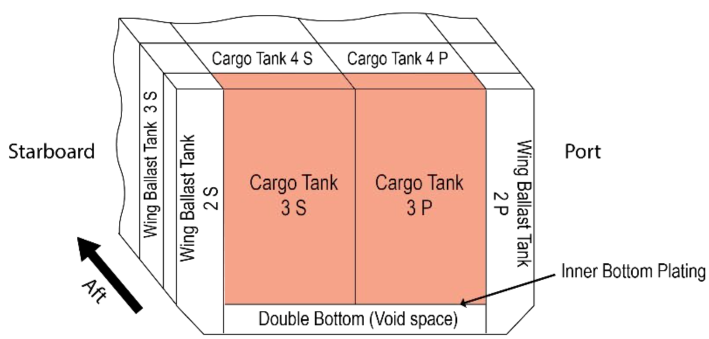
Vopak Terminal Deer Park Inc. was a tank farm facility specializing in the import, export, and distribution of various biofuels, chemicals, and petroleum products and had the ability to transfer product via a network of piping to and from deep-draft vessels, barges, rail cars, distributing piping, and trucks. Vopak's waterfront facility consisted of 12 vessel berths—8 barge and 4 deep-draft—and was located along the Houston Ship Channel near the entrance of Buffalo Bayou.

Accident Events

At 0406 on May 30, the *Fairchem Filly* arrived alongside Vopak Terminal's ship dock 5, one of the terminal's four deep-draft docks, and all mooring lines were secured. Shortly after, cargo discharge operations began. On the morning of the accident, the chief officer, third officer, and pumpman on the *Fairchem Filly* took part in the cargo operation. The terminal crew consisted of three people: a shift supervisor, a dock supervisor, and a dockman.

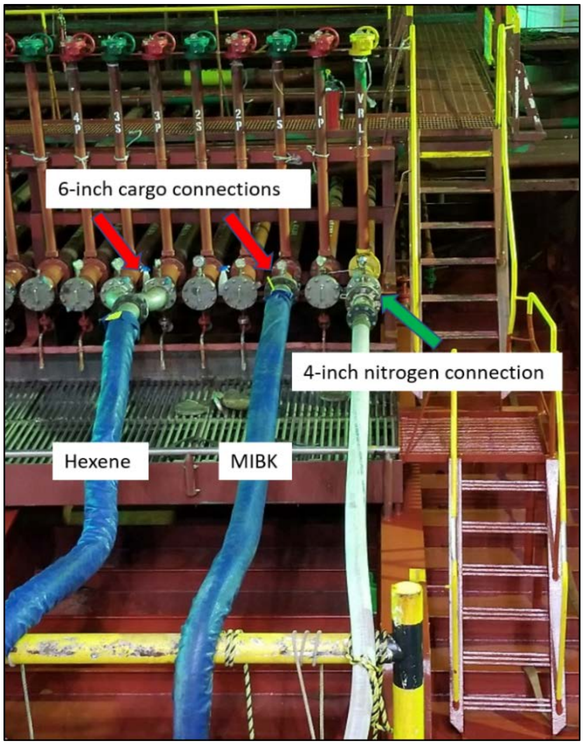
The tanker's number 1 starboard (1S), number 2 starboard (2S), and number 3 port and starboard (3P and 3S, respectively) cargo tanks contained product and were all scheduled to be discharged to the terminal. Tank 1S was approximately 38% full and contained 65,171 gallons of methyl isobutyl ketone (MIBK) in a liquid state. Tanks 2S, 3P, and 3S were each 93% full and, combined, contained about 914,563 gallons of liquid hexene. All other cargo tanks aboard the *Fairchem Filly* were empty.





Simplified diagram of the cargo tanks and wing ballast tanks on board the *Fairchem Filly*. The cargo tanks carrying hexene are marked in orange, and the cargo tank carrying MIBK is marked in purple.

Hexene, unlike MBIK, tends to absorb oxygen, which negatively affects its purity, and thus needs to be stored and transferred under a "blanket" or "pad" of inert gas. The *Fairchem Filly* utilized nitrogen to maintain a blanket of 2 pounds per square inch (psi) (13.8 kilopascal [kPA]) over the product while stored on board the vessel and during the transfer of the hexene to the terminal. During typical transfer operations, the remaining tank volume above the cargo increases as the liquid hexene is pumped off the vessel, requiring additional nitrogen to fill the space. Vopak supplied the *Fairchem Filly* with nitrogen for the transfer. Vopak received its nitrogen from a shoreside distribution piping network, utilizing a pressure-reducing station to reduce the incoming nitrogen from 170 psi to 90 psi (11.7–6.2 bar), which would then be distributed to the docks and used by vessels for purging and blanketing tanks. The connection between a ship and the terminal was normally accomplished via either a 2- or 4-inch shore-supplied hose.



Cargo manifold configuration on board the *Fairchem Filly* at the time of the accident. (Source: Vopak)

At 0430, the dock supervisor, who was acting as Vopak's Person in Charge (PIC) for the transfer, boarded the *Fairchem Filly* and met with the chief officer in the cargo control room.[1] The chief officer and Vopak PIC discussed the planned discharge operation and completed the vessel's "Ship/Shore Safety Checklist" and the terminal's "Declaration of Inspection" (the paperwork indicated that nitrogen blanketing would be utilized for the hexene discharge). For communications, the Vopak PIC provided the chief officer with a UHF radio that belonged to the terminal, set to channel 4, which they established would be the primary means of communication between the chief officer and the Vopak PIC throughout the discharge operation. They agreed that the secondary means of communication would be verbal communication at the cargo manifold. The ship's crew used a separate ship's radio (and channel) when communicating on board. Once the discussion and paperwork were completed, the Vopak PIC disembarked the vessel.

Utilizing the shoreside crane, Vopak's dockman and the *Fairchem Filly*'s pumpman began making hose connections. The 6-inch hexene and MIBK cargo discharge hoses were connected directly to flanges on board the vessel. A 4-inch nitrogen hose was connected via a reducer to the vessel's 6-inch vapor recovery line. To control the flow of the nitrogen, the shore used a 4-inch gate valve, and the vessel used a 6-inch butterfly valve. The ship's pumpman was assigned to operate the cargo manifold valves on the ship, including the nitrogen supply valve, and the Vopak PIC was responsible for the shore valves. All hoses were connected by 0540, and shortly afterward, the terminal completed a personnel shift change. The relieving dockman assumed the role of Vopak PIC from the dock supervisor and completed a handover with his counterpart. There was no requirement to inform the vessel of the shift change at that time, and no attempt was made. Over the next hour, terminal employees on the dock made physical checks of the cargo hoses and communicated with the terminal control room to verify that the terminal's piping system was lined up correctly.

At 0705, after communicating with the terminal, the *Fairchem Filly's* chief officer started the 3P and 3S cargo pumps from the cargo control room to begin discharging hexene to the terminal. The hexene in the cargo tanks was already inerted with an approximately 2-psi (13.8 kPa)

[1] A Person in Charge (PIC), as defined in 33 *Code of Federal Regulations* Parts 154 (terminal) and 155 (vessel), is an individual who has had additional training and experience in cargo operations and is designated to be the point of contact and in charge of their respective cargo operation. For the accident transfer, the dock supervisor acted as the Vopak PIC until the shift change at 0600, at which point the dockman took over as the Vopak PIC. The *Fairchem Filly*'s chief officer acted as the vessel's PIC for the duration of the transfer.

blanket of nitrogen, and the tanks therefore did not require any additional nitrogen supply from the terminal at the start of the operation. At this time, the vessel's 6-inch nitrogen supply line valve was closed; the dockman stated that he opened the shore valve "maybe a quarter of the way."

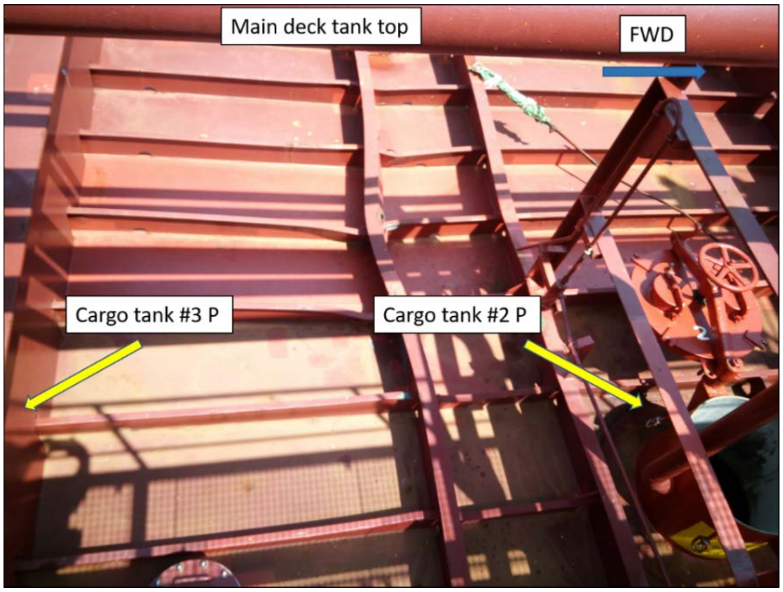
At 0738, the vessel's crew started the cargo pump for 1S, and the discharge of MIBK commenced. About the same time, the low inert gas pressure alarms for both the 3P and 3S cargo tanks sounded in the cargo control room, where the chief officer was stationed. These alarms indicated that the tanks' pressure fell below the low setting of 0.73 psi (5 kPa) and the nitrogen blanket was being depleted.

Over the next several minutes, the chief officer made numerous unsuccessful attempts to contact the Vopak PIC via radio from the vessel's cargo control room to request the status of the shore-supplied nitrogen. No attempts were made to verbally communicate from the ship's manifold (by the pumpman) with the Vopak PIC (dockman). Using the ship's radio, the chief officer radioed the ship's pumpman, who was stationed by the vessel's nitrogen control valve. In an effort to increase nitrogen flow and pressure, the chief officer instructed the pumpman to open the ship's nitrogen valve, which had been closed. Since the chief officer did not see a change in tank pressure, he instructed the pumpman to fully open the ship's nitrogen valve, thus making the ship entirely dependent on the terminal's valve to regulate the flow of nitrogen. At this time, the chief officer did not know whether the terminal's nitrogen valve was open, and if open, what percentage. About the same time, the terminal's CCTV footage showed the dockman exiting the dock break shack, which was located at the same end of the ship dock as the shore nitrogen supply valve, moving off camera to an unknown location, and then returning to the shack 3 minutes later.

At 0748, just 10 minutes after the 3P and 3S low-pressure alarms sounded, the same tanks registered an "ERROR" alarm, indicating a pressure of over 3.2 psi (22 kPa). About the same time, both the 3P and 3S cargo tanks pressure relief valves, which were set to open at 2.9 psi (20 kPa), opened. One crewmember stated that there was "so much noise" coming from the area where the valves were located. Crew also stated that the entire vessel "surged." Ballast water began flowing through the number 3 port wing ballast tank vent and down onto the deck. At 0749, the ship's crew turned off the cargo pumps for both the hexene and MIBK and responded to prevent the accumulating ballast water from spilling over the side of the vessel.

After several minutes, communication was re-established between the ship's chief officer and the Vopak PIC (dockman) via radio. The chief officer informed the Vopak PIC that the vessel had experienced an overpressurization of its 3P and 3S cargo tanks and that the 3P cargo tank had ruptured, releasing hexene into the adjacent ballast tank. Both the terminal and the vessel closed their respective valves, and cargo transfer operations ceased.

In addition to individual cargo tank pressure indicators in the cargo control room, the *Fairchem Filly* was equipped with an independent cargo vapor pressure-monitoring alarm and recording system, which automatically recorded and stored tank pressure data. After the accident, the system data showed a highest recorded pressure of 15.8 psi (109 kPa) in the 3P and 3S cargo tanks.



Main deck tank top deformation on the port side of *Fairchem Filly*.

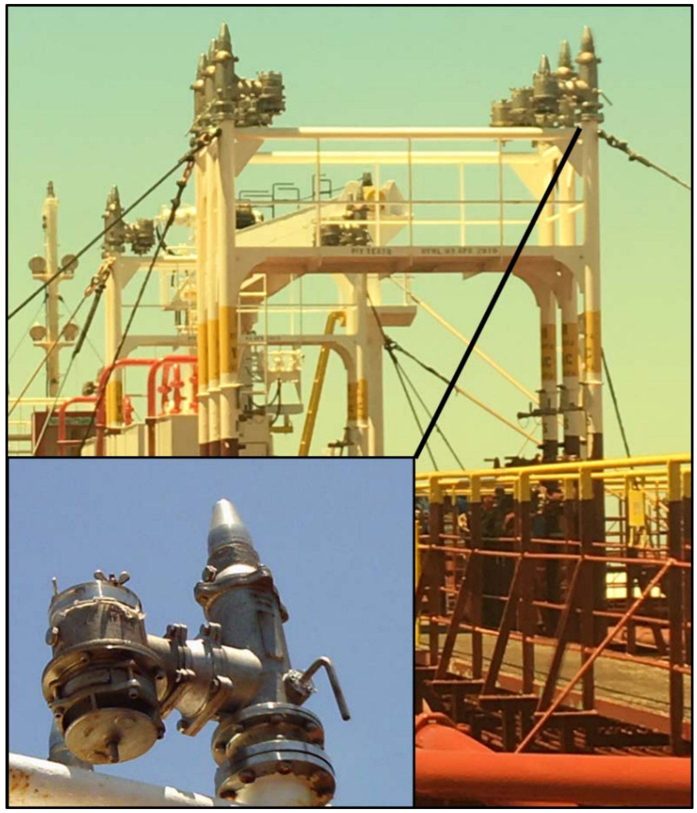
Additional Information

Vessel. After the accident, the *Fairchem Filly* proceeded to shipyard for repairs. The overpressurization of the 3P cargo tank caused the transverse bulkhead between 2P and 3P to buckle and ruptured the tank's inner bottom plating. In addition, the tank rupture damaged the bulkhead between the 3P cargo tank and the numbers 2 and 3 port wing ballast tanks. The main deck plating, deck transverse section, and deck longitudinals adjacent to the ruptured cargo tank and damaged ballast tanks were also damaged. Repairs required that all affected steel be cropped out and repaired with new material.

The *Fairchem Filly*'s crew typically worked 12 hours in each 24-hour period, but depending on a crewmember's position on board, these hours would vary. Critical operations on board, such as maneuvering or cargo operations, occasionally required essential crew members to alter their normal work hours to accommodate these operations. Vopak operated with 4 shifts per day, with each shift rotating through a 12-hour work schedule of 4 days on and 4 days off, followed by 4 nights on and 4 nights off.

Each cargo tank on the *Fairchem Filly* was protected from low and high pressure by a single bullet-style pressure/vacuum valve (PV valve). The PV valves were set to open at a high pressure of 2.9 psi (20 kPa) or at a low pressure of -0.51 psi (-3.5 kPa). The pipe diameter where the PV valve connected to the tank had an inside diameter of 4 inches. The seat diameter for the pressure relief port was 3.35 inches, and the seat diameter for the vacuum relief port was 5.9 inches. All PV valves on board were successfully overhauled and pressure-tested in early April 2019. In addition, in accordance with the vessel's pre-arrival checks, all the ship's PV valves were manually operated and visually inspected 10 days prior to the accident, when they arrived in Galveston anchorage, with no deficiencies noted.

Terminal records indicated that the *Fairchem Filly* had been to Vopak Terminal three times in the past two years. During one of these visits, the vessel offloaded hexene under a nitrogen blanket, although none of the accident crew were on board for that transfer. The chief officer told investigators that prior to the accident, he had never discharged product under a nitrogen blanket while aboard the *Fairchem Filly* but had undertaken similar operations while employed on other chemical tankers.



Pressure/Vacuum valves on board the main deck of the *Fairchem Filly*.

The vessel's Quality Health Safety and Environment Management (QHSE) manual specified guidelines for nitrogen blanketing that laid out the dangers associated with blanketing, as well as methods to control the flow rate and prevent overpressurization. The QHSE manual required crew to install a 1-inch-diameter hose or orifice between the shore-supplied nitrogen and the ship's manifold to control shore-supplied nitrogen while blanketing; a 4-inch hose was used for the May 30 cargo operation (with no orifice installed). The QHSE guidelines also referred to a "Nitrogen Handling Checklist" that outlined the source and flow rate of nitrogen and other information associated with a nitrogen operation. The information contained in the checklist enabled the vessel's PIC to evaluate the use of different nitrogen supply hose sizes at various supply pressures to determine the volume of nitrogen gas that could be received over a one-minute interval. This company-required checklist was not completed for the May 30 cargo operation. Additionally, in the vessel's cargo control room, a placard was displayed, indicating that the maximum relieving pressure of the vessel's PV valves was 483 m^3 (17,057 ft^3) per hour.

Terminal. The terminal's policy for transfers outlined the special equipment needed and the operational steps for a transfer. The policy also stated that nitrogen could not be supplied to a vessel until a "Nitrogen Supply Acknowledgment" form was completed by the chief officer and the Vopak PIC. The form stated the difference between a nitrogen purge (the procedure for removing dangerous and explosive gases from the interior of tanks) and a nitrogen blanket (pad). In addition, the form stated that the ship would be in complete control of the flow of nitrogen and specified the flow rate of nitrogen supply (250,000 ft^3 per hour for a purge or 18,000 ft^3 per hour for a pad). This form was not completed for the May 30 cargo operation.

The terminal also had "work instructions" for each transfer that took place that provided details of the transfer operation and included directives for the quantity to be pumped and the destination of the transfer. There were two "work instructions" for the accident transfer: one for liquid cargo and one for nitrogen blanketing. The liquid cargo "work instruction" stated that a 2-

inch nitrogen hose must be used; the associated nitrogen blanket "work instruction" did not specify a hose size. On the morning of the accident, a 4-inch nitrogen hose was connected to the vessel.

Analysis

Relief valves are fitted to cargo tanks to protect the tanks from an overpressurization event. The ship's PV valves were overhauled and pressure-tested in April 2019 and had been inspected 10 days prior to the accident, with no deficiencies noted. Therefore, it is likely that the PV valves performed as designed. The terminal had no recent history of terminal equipment failure.

Relief valves have a maximum flow rate that cannot be exceeded, or the pressure will rise in the tank(s) that the valves protect. The terminal's Nitrogen Supply Acknowledgement form indicated that the terminal could move 250,000 ft^3 per hour through the hose for a purge, and their liquid cargo work instruction stated that a 2-inch hose must be used for blanketing. However, a 4-inch hose was used for the nitrogen blanket supply during the liquid hexene cargo transfer. Since the nitrogen pressure at the dock would not change whether completing a purge or a blanket operation, the use of a larger 4-inch hose on the morning of the accident would have likely allowed for a flow rate near the purge maximum. The ship's cargo tank relief valves had a capacity of 17,057 ft^3 per hour, as indicated on the cargo control room placard on board the vessel. Therefore, this arrangement allowed for a potential nitrogen flow rate well in excess of the maximum capacity of the cargo tank relief valves. Without accurate and ongoing throttling of the nitrogen control valves, the risk of overpressurization was constant.

When a low-pressure alarm was activated on the vessel's hexene tanks, the chief mate repeatedly attempted to contact terminal personnel via a handheld radio to request nitrogen, but the Vopak PIC (dockman) did not answer. Since the chief officer could not contact the Vopak PIC, he ordered the ship's pumpman to open the ship's nitrogen supply valve all the way, after which the pressure in the tank should have risen, but it did not. At this point, instead of securing the vessel's nitrogen valve and stopping the operation until communications could be restored, the chief officer had the pumpman fully open the nitrogen valve, effectively removing all shipboard throttling control of the nitrogen coming on board. With the ship's throttling ability removed, the combined effect of the nitrogen pressure at the dock, the amount that the terminal valve was open, and the larger 4-inch hose (without a flow-reducing orifice installed before the ship's manifold) resulted in the rapid pressurization of the cargo tanks, exceeding the relief valve capacity and overpressurizing the tanks to 15.8 psi (109 kPa), as recorded on the cargo vapor pressure-monitoring system. Since the nitrogen hose connection was improperly configured (without a 1-inch hose or orifice), the flow rate of nitrogen had to be controlled by the ship or terminal personnel by manually adjusting the dock or ship valve. Therefore, communication between the ship and terminal personnel was critical. On the morning of the accident, the vessel's pumpman was directed to open the vessel's nitrogen control valve wide before communication with the terminal was established and the dock's valve position verified. Since the valves were opened too far, the nitrogen supply rate exceeded the tank relief capacity design limit.

Although both the terminal and operator of the vessel had procedures and control measures in place that clearly outlined a nitrogen blanketing operation, the procedures were not followed on the day of the accident. The terminal's crew had work instructions that required that a 2-inch nitrogen hose be used to transfer liquid cargo, and the ship's QHSE manual required its crew to use a 1-inch hose or orifice. However, on the day of the accident, a 4-inch nitrogen hose was connected to the vessel with no orifice, which removed engineered controls designed to limit the flow rate of nitrogen to the cargo tanks safely below their relief capacity. Additionally, the ship's QHSE guidelines included a "Nitrogen Handling Checklist," which outlined the flow rate and other information associated with a nitrogen operation, but the ship's crew did not complete this checklist on the day of the accident. Had the crew referenced this checklist, it is likely that they would have known that the potential flow rate of nitrogen would have exceeded the cargo tanks' PV valve relief capacity, and they may have reassessed and corrected the configuration by using the correct hose size or a reducing orifice.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the overpressurization and rupture of the 3P cargo tank aboard the *Fairchem Filly* during offloading was the vessel and terminal personnel involved not following policies and procedures related to cargo discharge and nitrogen-blanketing operations. Contributing to the casualty was the lack of effective communication between the vessel and terminal personnel and the decision of the vessel's PIC to continue discharge operations after being unable to communicate with the terminal.

Vessel Particulars

Vessel	***Fairchem Filly***
Owner/operator	HSL Filly Shipping LTD care of Fairfield Chemical Services / Fleet Management Limited
Port of registry	Majuro, Marshall Islands
Flag	Marshall Islands
Type	Chemical / Oil Product Tanker
Year built	2007
Official number (US)	N/A
IMO number	9323077
Construction	Steel
Classification Society	American Bureau of Shipping
Length	479 ft (146 m)
Draft	19 ft (5.8 m)
Beam/width	78.7 ft (24 m)
Tonnage	11,638 GT ITC
Engine power	8,360 hp (6,150 kW) direct drive diesel engine.
Persons on board	22

NTSB investigators worked closely with our counterparts from Coast Guard Sector Houston-Galveston throughout this investigation.

For more details about this accident, visit www.ntsb.gov and search for NTSB accident ID DCA19FM037.

Adopted: March 26, 2020

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*, 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*, 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*, 1154(b).