May 21, 2026 MIR-26-19

Collapse of Emissions Control Barge *STAX 1* Capture and Control Articulated Arm

On June 2, 2024, about 1649 local time, the emissions control barge *STAX 1* was capturing emissions from the containership *Erving* at the Fenix Marine Services Container Terminal in the Port of Los Angeles, Los Angeles, California, when a ship-to-shore container crane struck the barge's capture and control articulated arm, causing it to collapse, and sections of it fell onto the barge, onto the *Erving*, and into the water (see figure 1 and figure 2).[1] The arm's hydraulic system released about 10 gallons of hydraulic oil onto the deck of the *Erving* and into the water. One person on board the *STAX 1* received minor injuries. Damages were estimated at $3.2 million.

Figure 1. *STAX 1* alongside *Erving* at Fenix Marine Service Container Terminal before the accident, with ship-to-shore cranes visible in the background. (Source: STAX Engineering)

[1] (a) In this report, all times are Pacific daylight time, and all miles are statute miles. (b) Visit ntsb.gov to find additional information in the public docket for this NTSB investigation (case no. DCA24FM043). Use the CAROL Query to search investigations.

Casualty Summary

NTSB casualty category	Ship/Equipment/Cargo Damage
Location	Port of Los Angeles, Los Angeles, California 33°43.91' N, 118°15.47' W
Date	June 2, 2024
Time	1649 Pacific daylight time (coordinated universal time –7 hrs)
Persons on board	1 (*STAX 1*), 25 (*Erving*)
Injuries	1 minor
Property damage	$3.2 million est.
Environmental damage	Visible sheen; about 10 gal hydraulic oil released
Weather	Visibility 10 miles, winds south-southeast 6 knots, seas calm, air temperature 82°F, water temperature 68°F
Waterway information	Channel; turning basin width 300 ft, depth 50 ft, deck height 15 ft

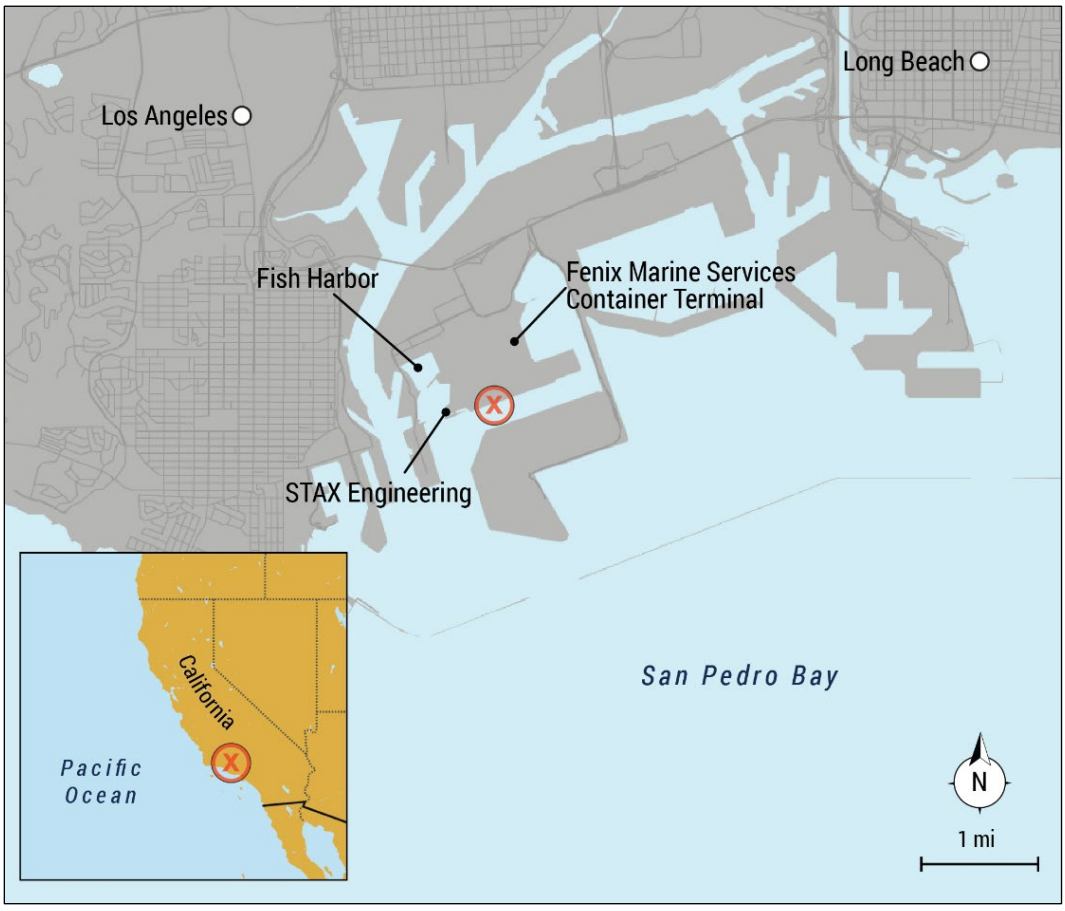

Figure 2. Area where emissions control barge *STAX 1* sustained equipment damage, as indicated by a circled *X*. (Background source: Google Maps)

1 Factual Information

1.1 Background

The *STAX 1* was a 160-foot-long, United States-flagged industrial vessel (emissions control barge). The platform was originally built as a Navy tank barge (YON) in 1975. In 2020, STAX Engineering Inc purchased the barge and extensively modified it, adding an exhaust capture system comprised of an articulated arm (also known as a boom). The vessel was built to reduce pollution from ocean-going vessels while docked at California's ports.[2] The boom had a maximum elevated height of 279 feet, and two flexible exhaust ducts attached to it captured maritime emissions from vessel exhaust stacks. The combination of the boom and the exhaust ducts was known as an emission capture boom.

The 623-foot-long, United Kingdom-flagged cargo vessel (containership) *Erving* was built by Hyundai Heavy Industries Co, Ltd in 2011. The vessel was owned by Moljim Shipping Ltd and operated by Zodiac Maritime Ltd. The *Erving* routinely transported cargo (containers) between southeast Asia terminals and the United States west coast terminals. The vessel had a maximum container capacity of 13,556 twenty-foot equivalent units.[3]

The Fenix Marine Services (FMS) Container Terminal was located on Terminal Island in the Port of Los Angeles, in Los Angeles, California. The terminal had four 1,000-foot berths with 16 Panamax ship-to-shore (STS) cantilever container gantry cranes, including eight Super Post-Panamax container cranes, along the berths (see figure 3).

[2] California regulations require that every vessel coming into a regulated California port either use shore power (for instance, plug into the local electrical grid) or a California Air Resources Board-approved capture and control technology to reduce harmful emissions. These emissions include diesel particulate matter, fine particulate matter, oxides of nitrogen, reactive organic gases, greenhouse gases, and oxides of sulfur.

[3] *Twenty-foot equivalent units* measure the carrying capacity of a containership based on the number of 20-foot-long containers the vessel is capable of loading (standard shipping container lengths are 20 and 40 feet).

Figure 3. FMS Container Terminal STS cranes with the crane booms in the lowered position. (Source: FMS)

1.2 Event Sequence

On June 2, 2024, at 0346, the containership *Erving* arrived at the FMS Container Terminal in Los Angeles, and moored starboard side to berth no. 302.

At 0408, the *STAX 1* emissions control barge arrived along the port side of the *Erving,* slightly aft of the containership's midships area, aligned so that the boom pedestal was directly abeam of the *Erving*'s exhaust funnel.[4] There were five crewmembers aboard the barge. *STAX 1* crewmembers boarded the *Erving*, and about 0415, with the *Erving* second engineer present, they inspected the *Erving*'s exhaust stacks and positioned the emission capture boom. A crewmember in the *STAX 1*'s control room started the system, and once it was confirmed to be operating properly, all *STAX 1* crew departed from the ship's funnel. The *STAX 1* emission control system captured and processed the *Erving*'s auxiliary diesel engines' exhaust without incident for the next 11 hours.

[4] The primary purpose of a ship's funnel is to lift the exhaust gases clear of the deck to avoid fouling the ship's structure or decks or impairing the crew's ability to carry out their duties.

At 0605, a team of contracted longshoremen from the Pacific Maritime Association (PMA) and the International Longshore and Warehouse Union (ILWU) boarded the vessel to facilitate the discharge and loading of containers in accordance with the *Erving*'s cargo plan.[5] Seven STS cranes (nos. 11, 12, 13, 14, 15, 16, and 17) were used during the first shift under the instruction and direction of FMS Container Terminal tower personnel and contracted longshoremen.

FMS Container Terminal waterfront operations ran from 0600–1700 (first shift) and 1800–0300 (second shift). Each shift consisted of a dock boss, a hatch boss, two crane operators, a dock signal person, four swingmen, and eight or nine yard-tractor operators assigned to each crane, along with a ship boss for each vessel alongside. All waterfront personnel reported up to their walking bosses and foremen, who ultimately reported to the assigned ship boss. The FMS tower personnel consisted of day-shift (0700–1645) and night-shift (1700–0300) personnel.[6]

STAX 1 crewmembers typically worked a 12-hour shift, consisting of a day and night shift. In preparation to relieve the day-shift crew, *STAX 1* night-shift personnel (a supervisor, two deckhands, and one deckhand trainee) boarded a work skiff at the STAX Engineering lay berth in Fish Harbor, northwest of the FMS Container Terminal. At 1545, the night-shift crew got underway, bound for the *Erving*. While approaching the *Erving*, the night-shift supervisor noticed the forward exhaust capture ducting was torn about 5 feet above the *Erving*'s forward auxiliary engine exhaust stack.

The night-shift crew arrived at 1556 and boarded the *STAX 1* shortly before the 1600 crew change. After completing the crew change turnover, the *STAX 1* night-shift supervisor, two deckhands, and the trainee boarded the *Erving* to repair the damaged exhaust capture ducting.

About 1605, while waterfront personnel continued to unload containers, the FMS first-shift stevedore manager and the operations manager—located at the FMS tower—discussed remaining tasks for their shift. Their discussion included the presence of the *STAX 1* outboard of the *Erving* and the need to raise the boom of STS crane 16 so that it was clear of *STAX 1*'s emission capture boom. (STS crane 16 had a boom trolley length of 211 feet, and the height from the wharf to the STS crane boom, when lowered, was 164 feet.) The first-shift operations manager relayed this information via VHF radio to the first-shift ship boss (ship boss 1). Ship boss 1 then

[5] The ILWU is composed of several local unions.

[6] The FMS tower consisted of stevedore managers, operations managers, and planners, who monitored and directed container shipping operations, port logistics, vessel stowage, and box move counts to produce the booklet and head sheet. The operations managers and planners reported to the stevedore managers.

told the first-shift crane operator (crane operator 1), who was operating STS crane 16. (Each crane working alongside the vessel had its own separate, assigned radio channel.)

About 1615, before the start of the flex shift, the second-shift ship boss (ship boss 2) drove over to the *Erving* to visually inspect the general loading and unloading operations taking place and to see which cranes were in operation.[7] He told investigators he did not see the *STAX 1*. There were three crane operators scheduled for the flex shift: Two had planned work aloft, and one (crane operator 2) was designated to move cranes into position.

Between 1620 and 1630, ship boss 2 and crane operator 2 arrived at the foremen's trailer in preparation for their flex shifts. Ship boss 2 told crane operator 2 that when he arrived, the first-shift operators were still working. Crane operator 2 received a copy of the evening's preliminary "head sheet," an outline of intended container movements and other important information for each shift, from ship boss 2.[8] This document did not contain directions to move any cranes, nor did it indicate that *STAX 1* was present outboard of the *Erving*.

While in the foremen's trailer, crane operator 2 overheard the superintendent speaking to other personnel in the trailer about STS crane 16's boom remaining in the lowered position and "not working." A short while later, crane operator 2 told ship boss 2 that he was going to the dock and left the office. According to crane operator 2, he left the foremen's trailer before receiving any instructions from ship boss 2.

While crane operator 2 and ship boss 2 were in the foremen's trailer, crane operator 1 (the first-shift steady STS crane 16 operator) was still working. All other crane operations had concluded for the first shift. Crane operator 1 received instructions to raise the crane's boom at the conclusion of his shift from ship boss 1. At 1638, crane operator 1 finished unloading the last container. He told investigators that he returned the STS crane 16 main trolley cab to the parked position, but the trolley park position indicator light did not illuminate. He then attempted to boom up the crane from the trolley cab but was unsuccessful. He tried turning control power off and then on again to reset the system. He then pressed the button to boom up the crane but again could not raise it.

[7] Some oncoming personnel were scheduled to work a "flex shift," beginning work an extra hour earlier (at 1700) to prepare operations for the oncoming shift. Flex-shift preparations included moving the STS cranes along their rail systems to the vessel's next offload/loading bays, troubleshooting or repairs, and performing routine maintenance aloft.

[8] Head sheets were considered tentative and incomplete.

Crane operator 1 called ship boss 1 via VHF radio to inform him of the issue and request that he call for a crane mechanic to provide assistance. Ship boss 1 instructed crane operator 1 to come down from the crane and indicated that he would handle it. Ship boss 1 attempted to raise STS crane 16's boom using the crane's waterside dock-level control station but was unable to do so. He called for a mechanic over VHF radio, and he and crane operator 1 departed, leaving the crane's boom lowered. Meanwhile, about 1640, crane operator 2 had proceeded to the highline for his flex shift (see figure 4).[9]

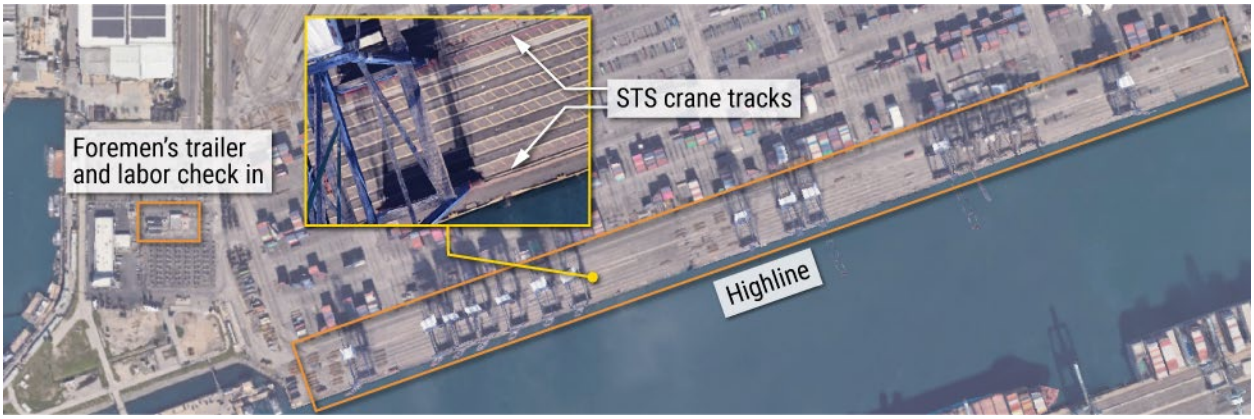

Figure 4. FMS Container Terminal highline and surrounding area. Inset shows the tracks the STS cranes traveled along within the highline. (Background source: Google Earth)

At 1643, the second-shift operations manager (operations manager 2) left the foremen's trailer to conduct his routine round, checking the highline and decking (cargo/container staging) areas in his work truck before the start of the flex shift. He checked which cranes needed to be moved on the flex shift. While at the decking area, about 1646, he heard operations manager 1 call out on VHF radio that crane operator 1 could not get STS crane 16 boomed up.

While operations manager 2 was checking the highline and decking area, crane operator 2 proceeded to STS crane 15's waterside dock-level control station to move STS crane 15 to the next cargo bay. (STS crane 15's boom was in the lowered position.) Crane operator 2 told investigators that he was unaware that the *STAX 1* was operating next to the *Erving* (his line of sight was blocked by the containership). He stated, "If I would've seen that [emission capture boom], I would have stopped."

Crane operator 2 explained to investigators that the first-shift crane operators always raised the crane booms, and second shift "always moved [the cranes] from the

[9] The highline was the open portion of the marine terminal immediately next to the *Erving*'s berth, used in the direct transfer of cargo between the terminal and vessel. The cranes moved along the dock on a pair of rails within the highline.

bottom." To move an STS crane in the desired direction using the waterside dock-level control station, a crane operator had to turn the spring-return, three-position selector switch in the direction the crane should move on the track (clockwise for right, counterclockwise for left). The crane operator then had to hold the switch in place as the crane moved along the track. If the crane operator let go of the selector switch, the spring-return mechanism would return the switch to the center position, and the crane would stop moving.

Crane operator 2 wedged the selector-switch handle for STS crane 15 in place, which allowed the crane to continue moving leftward even if he was not physically present to control the movement of the crane. The selector switch remained wedged in place while he stepped away, about 35 feet back, to monitor the crane's alignment with the next bay. The operator told investigators that using an item such as "a sunflower seed, toothpick, a nail, stick, or a rock" to hold the selector switch in place was common practice when moving a crane to its assigned bays during the flex shift. He was not aware of rules prohibiting this practice.

About 1648, crane operator 2 began moving STS crane 16 in the same way he moved STS crane 15—via the waterside dock-level control station, with the selector switch wedged in the desired direction. While the crane was moving, he walked away about 35 feet to visually monitor the crane's progress and alignment with the next bay.

During this time, the *STAX 1* night-shift supervisor, two deckhands, and the trainee were still atop the *Erving*'s exhaust superstructure, making repairs to the exhaust ducting. The other *STAX 1* crewmember was aboard the barge in the control room. The night-shift supervisor and a deckhand noticed STS crane 16 boom begin to move toward them (see figure 5). The supervisor told his crew to move the exhaust ducting over the railing as he attempted to swing the emission capture boom aft, away from the path of the STS crane's boom.

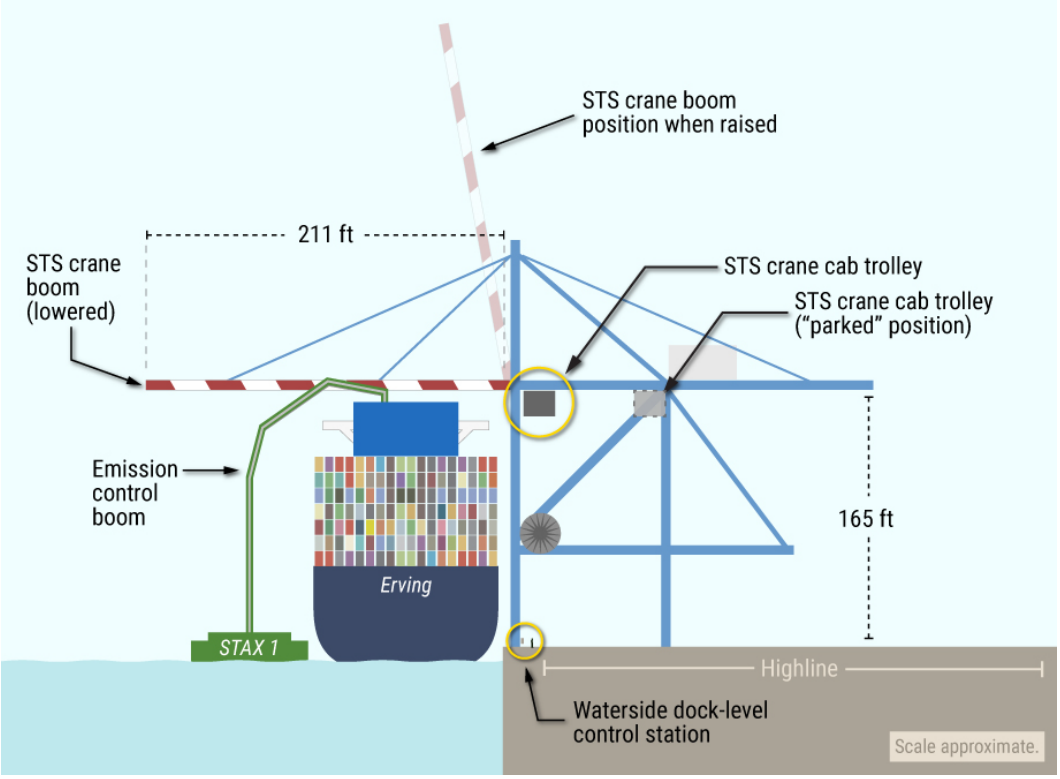

Figure 5. Diagram (looking toward the *Erving*'s bow) showing the position of the STS crane boom if it were raised versus its position at the time of the accident. (Scale approximate.)

One of the *STAX 1* deckhands repairing the exhaust duct on the *Erving* ran toward the starboard-side handrails of the funnel. He yelled and waved his arms in the direction of the crane operator trolley cab, which was about 200 feet away, to indicate that the operator should stop moving the crane. No one was in the cab, but he was unable to see into the trolley cab due to the angle of the trolley cabin front windshield.

At 1649, while STS crane 16 was moving toward the stern of the vessel, the crane contacted the *STAX 1* emission capture boom (see figure 6). Sections of boom fell onto *STAX 1*, onto the *Erving*, and into the water. A portion of the emission capture boom landed on the *STAX 1* control room, injuring the crewmember inside. From the ground, crane operator 2 saw the *STAX 1* deckhand atop the *Erving*, recognized that the deckhand was signaling to stop, ran over to the waterside dock-level control station, and pressed the emergency stop button, which immediately stopped the crane.

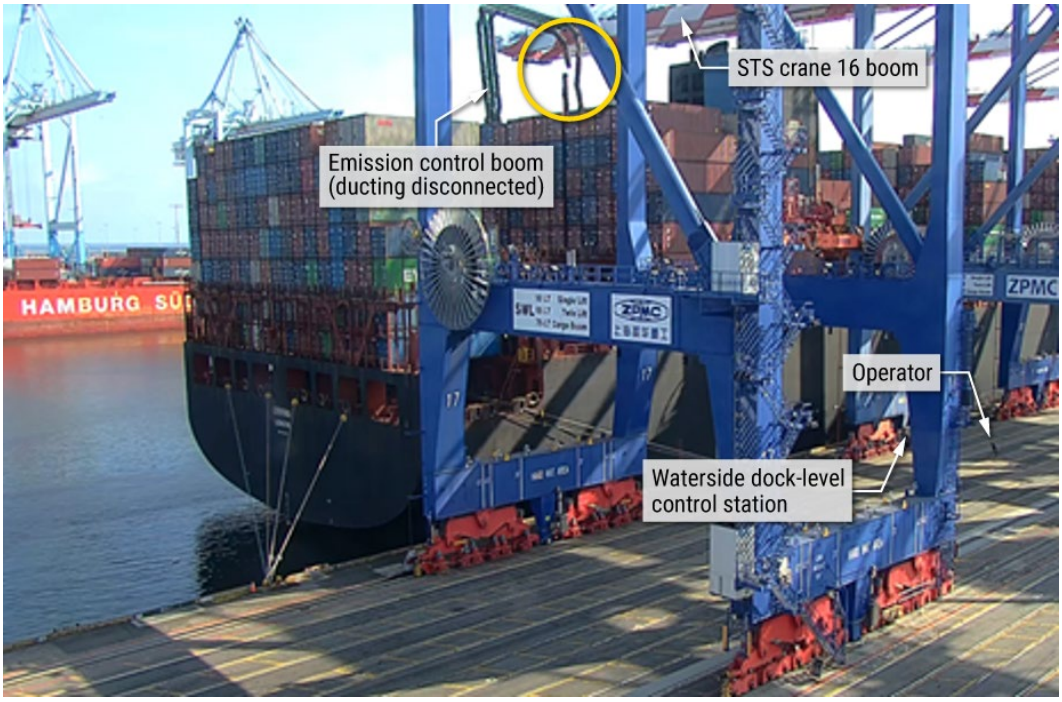

Figure 6. STS crane 16 boom contacting the *STAX 1* emissions capture boom (*circled*) and crane operator 2 running toward the waterside dock-level control station. (Background source: FMS)

Moments later, crane operator 2 called operations manager 2 using his personal cell phone (the only VHF radio the crane operator had access to was installed in the crane trolley cab). He told the operations manager that the crane may have hit something. At the same time, another FMS employee told ship boss 2 over VHF radio that the *STAX 1* emission capture boom had been struck and collapsed.

Crane operator 2 was removed from duty. An FMS manager performed a reasonable suspicion assessment, and no signs or symptoms of impairment were found. Crane operator 2 left the facility about 1705.

1.3 Additional Information

1.3.1 Damage

STS crane 16's contact with the *STAX 1*'s emission capture boom sheared the boom at the pedestal base (see figure 7). The boom crane, both exhaust scrubber systems, one generator along with other miscellaneous equipment as well as the vessel's emission system control-monitoring station room, and the crew restroom required significant repairs and replacement of components. Damage to the *STAX 1* was estimated at $3.1 million.

Figure 7. *Top*: View from the starboard bow of the *STAX 1* showing the emission capture boom lying on top of the control room and across the deck. *Bottom, from left*: Top-down views of the *STAX 1* damage from stern to bow, as seen from the starboard side of the *Erving*. (Source: Coast Guard)

The *Erving* sustained damage to several handrails, ladders, crosswalks, platforms, and elevated walkways in container bays 75–83 (see figure 8). These components had to be replaced. Damage to the *Erving* totaled $175,000.

Figure 8. Areas of *Erving* container bay 83 where sections of the *STAX 1* emission capture boom fell (*outlined*), causing damage.

STS crane 16 sustained minor, superficial scraping on its boom carriage. The crane did not require any repairs.

1.3.2 Crane Operations

1.3.2.1 Pre-Shift Planning

Before each shift, the FMS managers (stevedores and operations personnel) discussed the work for the shift, including vessels involved, priorities, yard locations, equipment, and personnel, with the ship bosses, dock bosses, and vessel planners. Once a plan was determined, FMS managers provided head sheets, along with starting paperwork, noting the bays to work and loading/unloading sequence to the ship boss and dock boss. During a pre-shift planning meeting, the ship boss and dock boss would then communicate events happening during the shift, such as bunkering operations or vessel maintenance, to other bosses, including hatch bosses; lashing bosses, if lashers were ordered; and personnel, including swingmen, a dock signal person, and yard tractor operators.

According to the second-shift ship boss (ship boss 2), he typically received a preliminary head sheet about 1615. The preliminary head sheet was produced by the FMS Terminal Operations personnel and contained tentative instructions and tasks for the upcoming shift. The preliminary head sheet was meant to provide a shift foreman with a general overview of the shift, and the information provided was subject to change.

Operations manager 2 stated that he would usually provide ship boss 2 with the finalized head sheet about 1700. Ship boss 2 would then give copies of the finalized head sheet to the second-shift crane operators on the flex shift, the hatch boss, and the dock boss during the shift-planning meeting. On the day of the casualty, the second-shift ILWU flex personnel conducted their pre-shift meeting before beginning operations, shortly after 1705.

1.3.2.2 Procedures and Training

According to crane operator 2, moving a crane was a "two-person job," involving the crane operator and a signalman, who would observe the crane's movement from the ground while the crane operator moved the crane from the trolley cab. Flex signalmen were typically assigned specifically for this purpose. Crane operator 2 stated that a signalman was usually only provided during the flex shift when a vessel's hatch cover had to be replaced before the start of the next shift.

Ship boss 2 told investigators that on the day of the casualty, the crane should not have been moved because the crane operator did not have a signalman or a radio to communicate with the ship boss if issues arose. The ship boss also explained to investigators that, although he did not tell the crane operators how to move the cranes, "most of the time, [crane operators] should be moving [the crane] in the cab" rather than using the waterside dock-level control station. He also stated that cranes should not be moved before the start of a flex shift.

Crane operators were members of the ILWU and were required to comply with the PMA's *Pacific Coast Marine Safety Code*. According to section 8, rule 818 of the Code, "Crane operators shall not operate cranes when visibility cannot be maintained to assure a safe operation."

Crane operator 2 had 30 years' experience working as a longshoreman. He had worked as a crane operator for FMS since 2014. Training records for the PMA show the last time he received container gantry crane operations training was January 1998. PMA's "Container Gantry Crane Student Manual," dated January 2000, provided the follow guidance and warning to operators:

> Whenever you gantry [move a crane along its ground-mounted track fore or aft relative to a docked ship] from one hatch to another, check very carefully for any obstruction such as ship's gear, antennae, rigging, etc. before you move. If obstacles are in the way, make sure the boom is in the full upright position before traveling.
>
> DO NOT gantry at any time with the boom part way up. The crane was not designed for this kind of stress.

Crane operator 2 told investigators that no formal, on-the-job training had ever been provided for operating STS crane 16 or similar cranes. He stated that he had learned to operate the newer STS cranes "on his own" by observing or asking fellow workers.

1.3.2.3 Crane Trolley Cab Parking Procedures and Postcasualty Testing

The STS crane operator's manual provided guidance on the trolley cab parking position (see figure 9). The guidance instructed crane operators to:

- Drive the main trolley towards the parking position. Then push the button to have the trolley stop at the parking position.
- Releasing the joystick before the trolley reaches the parking position aborts the parking order. Then drive the trolley and push the button again.
- The button indicator flashes while the stop at parking position function is active. The indicator comes on when the trolley has stopped in the parking position.

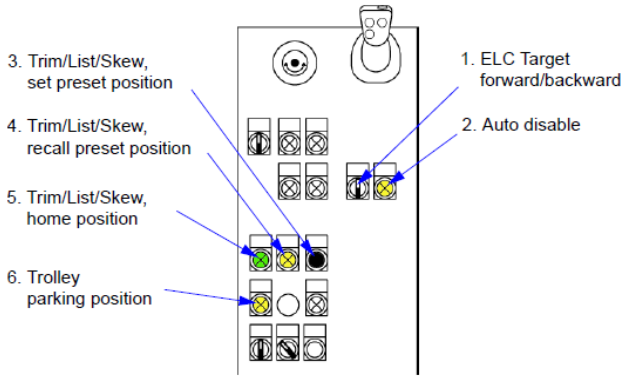

Figure 9. Crane trolley cab controls. (Source: FMS)

On June 2, after the casualty, an FMS crane technician tested STS crane 16 to troubleshoot crane operator 1's inability to boom up the crane. The technician took control of the crane from the trolley cab, moved the cab about halfway out on the boom to verify operations, and returned the cab to the parked position. No issues were found. The technician determined the crane did not boom up because the trolley cab was not fully returned to the parked position to register contact with the proximity switch. According to the technician, as the trolley cab was being moved toward the parked position, the "control off button was pressed prior to getting a parking acknowledge light." Therefore, the start interlocks were not meeting, thus preventing the boom from rising.

1.3.3 Postcasualty Actions

According to the FMS senior manager of health, safety, security, and environment, as of June 13, 2024, the company implemented the following actions as a result of the casualty. FMS—

- Installed locks on all STS cranes' waterside dock-level control stations to limit crane gantrying from the ground. A mechanic and appropriate additional personnel were required to be present to access a control station to ensure safe movement of the STS cranes from the ground.
- Changed the cranes' control system program to inhibit gantry function from the ground station with the boom in the lowered position.
- Revised all shift head sheets provided to each STS crane operator so that they state, "DO NOT GANTRY CRANES FROM GROUND" (see figure 10).

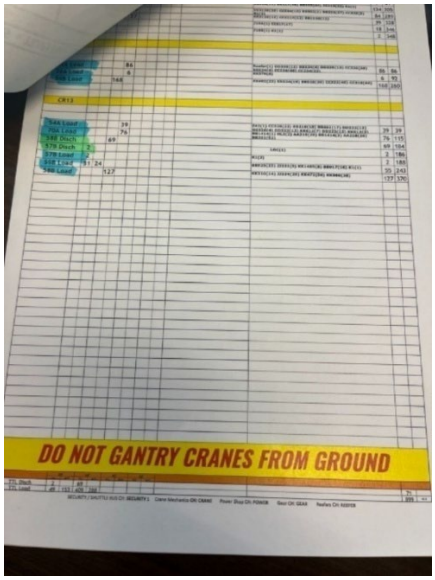

Figure 10. Example of revised FMS shift head sheet, showing the informational note added. (Source: FMS)

As a result of this casualty, STAX Engineering—

- Instituted a policy requiring that a sign that can be seen from the dock be installed on the inboard side of the vessel. The sign indicates that an emissions barge is along the outboard side of the vessel.
- Began hardening its barges by placing an external frame around the double-walled fuel tank of the five existing barges and moving the fuel tanks on three new barges below deck to prevent spills.
- Began hardening the control rooms on all the barges by adding an external frame on top of the barge control rooms.

2 Analysis

On June 2, while the *STAX 1* emission capture boom was attached to the containership *Erving* at the FMS Container Terminal, capturing emissions from the *Erving*'s exhaust stack, the lowered boom of ship-to-shore container crane STS crane 16 struck the *STAX 1* boom. As a result, the emission capture boom's arm collapsed and sheared at its pedestal base.

About 10 minutes before the casualty, FMS Container Terminal's shoreside container crane operator 1 attempted to raise STS crane 16's boom in preparation for the end of his shift. However, the boom would not rise. After the casualty, a technician determined the boom would not rise because the crane's trolley cab was not returned to the "parked" position. According to the technician, as the trolley cab was being moved toward the parked position, the "control off button was pressed prior to getting a parking acknowledge light." Therefore, the start interlocks were not meeting, thus preventing the boom from rising. In addition, based on the guidance in the crane operating manual, it is likely crane operator 1 released the joystick before the trolley cab reached the parking position, which would have aborted the parking order and resulted in the operator being unable to raise the boom. Therefore, when crane operator 1's shift ended, the boom remained in the lowered position.

Crane operator 2, who began performing tasks before the start of the flex shift, knew the boom was lowered and began moving the cranes along the track (gantrying relative to the docked *Erving*) using the waterside dock-level control station. Because STS crane 16's boom remained in the lowered position, it was unable to clear *STAX 1*'s emission capture boom, resulting in the crane striking the boom.

The first-shift FMS terminal stevedore manager and operations manager were aware of the *STAX 1*'s planned operations, which placed the *STAX 1*'s emission capture boom above the *Erving*'s container stacks and onto its exhaust stack during loading/offloading operations. However, the flex-shift waterfront personnel, which included the second-shift crane operator 2 and shift boss 2, were not aware of the *STAX 1* operations. Shoreside waterfront operations personnel typically held a pre-shift planning meeting to discuss crane movements planned for the flex shift as well as other critical information, such as the location of the *STAX 1* and its emission capture boom relative to the cranes. They also used head sheets to outline planned movements. Crane operator 2 began moving cranes without participating in a pre-shift planning meeting or receiving a final head sheet. The pre-shift planning meeting had not yet occurred because the flex shift had not yet started, and the preliminary head sheet did not include any information about the location of the barge or its emission capture boom. Had the crane operator waited for the pre-shift planning meeting and been aware of the *STAX 1*'s location, he may have opted not to move the crane.

Regardless of the crane operator's awareness of the *STAX 1*, the only way to ensure the lowered boom could clear the *Erving*'s exhaust stack before gantrying the crane would have been to have positive confirmation of line of sight from the crane's trolley cabin. According to the ILWU and the PMA's *Pacific Coast Marine Safety Code*, crane operators "shall not operate cranes when visibility cannot be maintained to assure a safe operation." An FMS ship boss told investigators he believed that, typically, crane operations should be performed in the trolley cab rather than using the waterside dock-level control station. According to crane operator 2 and ship boss 2, moving a crane typically also involved a second person: a dock signal person positioned on the dock where they could observe the crane's movement along its tracks and notify the crane operator, who would be in the trolley cab, if there were issues. However, crane operator 2 moved STS cranes 15 and 16 from the waterside dock-level control station instead of waiting for a dock signal person and moving the crane from the trolley cab. Without a means to identify obstructions in the path of STS crane 16's boom, crane operator 2 could not verify that the lowered boom would clear any obstructions, such as the *STAX 1*'s emission capture boom or the *Erving*'s exhaust stack.

FMS did not have formal guidance or training to guide personnel in crane operations when emission capture and control barges were operating nearby. Crane operator 2 had worked for FMS since 2014, but he last completed formal training in gantry crane operations in 1998. Crane operator 2 stated that he had received only informal, on-the-job training while working for FMS. Without establishing adequate formal guidance to set expectations for crane operations, FMS could not ensure all crane operators followed the same procedures. After the casualty, FMS revised the head sheets used for planning crane operations, adding a warning to not gantry cranes from the waterside dock-level control station. FMS also changed the crane's control system program to inhibit gantry function from the waterside dock-level control station with the boom in the lowered position and added locks to the stations to prevent ad-hoc use by personnel.

3 Conclusions

3.1 Probable Cause

The National Transportation Safety Board determines that the probable cause of the collapse of the emissions control barge *STAX 1* capture and control articulated arm was a shoreside crane operator moving a ship-to-shore container crane without verifying the crane's lowered boom had ample clearance over any obstructions, and the container terminal's inadequate guidance for gantrying cranes.

3.2 Lessons Learned

Planning Shoreside Container Crane Movements

During shoreside container crane operations, nearby structures, such as ground obstructions, vessel exhaust stacks or superstructures, or vessel emission capture systems, can potentially block crane movement. To mitigate the risk of a casualty occurring, it is critical that crane operators be aware of such structures and maintain line of sight of obstructions visible from a crane cab. Additionally, the use of a dock signal person can help to identify ground obstructions during crane movement. Including such obstructions in safety briefings or outlines of planned crane movements can improve awareness among crane operations personnel. Establishing and enforcing procedures regarding maintaining line of sight and using a dock signal person during crane operations can further mitigate the risk of a crane striking a nearby object or structure.

Vessel Particulars

Vessel	*STAX 1*	*Erving*
NTSB vessel group	Specialty/Other (Industrial vessel)	Cargo, General (Containership)
Owner/operator	STAX Engineering Inc (Commercial)	Moljim Shipping Ltd/Zodiac Maritime Ltd (Commercial)
Flag	United States	United Kingdom
Port of registry	Long Beach, California	London, United Kingdom
Year built	2005	2011
Official number	1252924 (US)	N/A
IMO number	N/A	9463023
Classification society	N/A	Lloyd's Register of Shipping
Length (overall)	158.4 ft (48.3 m)	1,200.8 ft (366.0 m)
Breadth (max.)	66.3 ft (20.2 m)	105.9 ft (32.3 m)
Draft (casualty)	20.2 ft (6.2 m) fwd, 21.8 ft (6.7 m) aft	39.0 (11.9 m)
Tonnage	514 GT ITC	32,987 GT ITC
Engine power; manufacturer	N/A	1 × 91,983 hp (68,592 kW); MAN B&W 2-stroke 12-cylinder diesel engine

NTSB investigators worked closely with our counterparts from **Coast Guard Sector Los Angeles/Long Beach** throughout this investigation.