Testimony of

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Before the

Hawaii Public Utilities Commission

— *On* —

Container Damage and Loss aboard Deck Cargo Barge *Ho'omaka Hou*, Towed by *Hoku Loa*, June 22. 2020

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NTSB | National Transportation Safety Board
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Good morning, Chairman Griffin and Members of the Commission. My name is Michael Kucharski. I am honored to appear before you today on behalf of the National Transportation Safety Board (NTSB) to discuss our investigation of the container damage and loss aboard Deck Cargo Barge *Ho'omaka Hou*, towed by the *Hoku Loa* that occurred on June 22, 2020.

The NTSB is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant accidents in other modes of transportation—railroad, highway, marine, and pipeline. We determine the probable cause of the accidents we investigate and make safety recommendations aimed at preventing future accidents. The recommendations that arise from our investigations and safety studies are our most important tool for saving lives and preventing injury.

When a major marine casualty occurs, the NTSB works closely with the Coast Guard in conducting its investigation into the causes. Typically, the Coast Guard will take the lead in the factual portion of the investigation, with NTSB participation. However, each agency conducts its own separate analysis since they have different purposes for their investigations. The sole purpose of an NTSB investigation is to determine the probable cause and to make recommendations on how to prevent future accidents, or to mitigate damage and injury if an accident does occur.

NTSB's "probable cause" determination is intended to inform the general public about the cause(s) of the accident in clear and simple terms and to guide those who have a role in preventing future accidents. It has been generally agreed that no legal standard of proof must be met to conclude that something was a "probable cause" of an accident. The use of the word "probable" distinguishes NTSB's determination from the legal concept of "proximate" cause. It also allows for the possibility that there may be multiple causes to an accident or incident. NTSB's probable cause statements also often will identify contributing factors, which further explain or supplement the probable cause(s).

Accident Events

On June 22, 2020, about 0230 local time, the deck cargo barge *Ho'omaka Hou* was under tow by the towing vessel *Hoku Loa* off the northeast coast of the big island of Hawaii en route to Hilo, when fifty 40-foot containers stacked on the after deck of the barge toppled, causing 21 to fall into the ocean. There were no injuries or pollution reported. Eight containers were eventually recovered by salvors, and 13 remain missing. Cargo loss was estimated at $1.5 million, and damage to the barge and containers was estimated at $131,000.

The 108-foot-long, 477-gross-ton *Hoku Loa* was a twin conventional propeller towing vessel built in 1991, and owned and operated by Young Brothers, LLC. The tug towed barges between the Hawaiian Islands and frequently towed on routes between Honolulu, Oahu, and Hilo. Its crew of six was comprised of a captain, chief mate, second mate, engineer, and two able seamen.

The *Ho'omaka Hou* was a 340-foot-long-by-90-foot-wide flat deck unmanned, unpropelled freight barge built in 2007. The barge was certificated by the US Coast Guard to operate on an oceans route in accordance with its stability letter and loadline requirements of its classification society, the American Bureau of Shipping (ABS). The barge was also owned by Young Brothers and operated in interisland service.

After its last voyage, the *Ho'omaka Hou* had been empty, at the company pier, for a few days before loading commenced for the accident voyage. The company port engineer responsible for maintenance of the barge said he performed a thorough inspection of the barge prior to loading and found no deficiencies that would compromise cargo.

On June 20, the cargo was driven aboard by the machine operators and secured by lashers. The barge superintendent and the lead person (who directed the barge team) checked the lashings to confirm that all were secure and tight. About 1830 the final barge stow plan, hazardous cargo paperwork, and paperwork for bonded items were finalized and the barge superintendent advised the company dispatcher that the barge was ready for the tug. Although the weights of most of the containers were documented by the company shoreside, the final barge stow plan showed the container locations but not the container weights. The cargo consisted mostly of 20- and 40-foot-long dry cargo and refrigerated containers but also included ISO tank containers, wheeled vehicles, flatracks, and palletized cargo.[1] Containers and ISO tanks were stowed in both fore and aft and in athwartship orientations. Palletized cargo was generally secured on top of the uppermost containers.

Following a crew pre-departure job safety assessment, the *Hoku Loa* departed its berth at pier 21and transited 1.2 miles to where the *Ho'omaka Hou* was docked at pier 39. The tug arrived at the barge about 2004. The second mate and two crewmembers checked the barge's drafts, obtained the cargo papers from the barge superintendent, ensured the tug's towing wire was connected to the bridle, and checked to see if any of the lashings were out of place and were all tight. After reporting their findings and that all was in good order to the master, the master determined the tow was in compliance with the vessel's stability letter and applicable loadline regulations. The tug got underway at 2028. The *Hoku Loa* tow entered the open ocean about 2115, with an estimated time of arrival (ETA) at Hilo of 0400 on June 22 (a transit of about 32 hours).

The second mate told investigators that changes to the tug's engine speeds were made along the route, as was normal practice, to adjust the vessel's speed to make the planned ETA at Hilo. At 0000 on June 22, the tug's course was 128 degrees at a speed of 4.6 knots, the engine rpm was at 620, and the vessel was 11.95 miles north-northwest of Pepeekeo Point. About that time, a nearby weather buoy off Hilo (about 18 miles southeast of the tug) recorded "steep" seas from the east with a significant wave height of about 6 feet (1.8 meters).[2]

By 0200, the officer of the watch (the second mate) completed a course change to 159 degrees and reduced the engine rpm to 600 to make speed for the 0400 ETA. According to several crewmembers, the vessel tended to roll more on this leg between Pepeekeo Point and Hilo because

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[1] ISO tank containers are built based on International Organization for Standardization standards and are designed to carry liquids.

[2] As applies to wave steepness data obtained from the National Oceanographic and Atmospheric Administration National Buoy Data Center, for a given wave height, a steep wave will have a shorter (smaller) dominant wave period than a wave of average steepness.

the sea and swell were closer to the beam, but this leg of the accident voyage was no different than others, with weather and sea conditions as predicted.

At 0300, the tug crew conducted the company-required pre-arrival job safety meeting. At about 0400, the assist tug *Tiger 10* approached the barge as it entered Hilo harbor for docking. During the approach, the captain of the *Hoku Loa* was informed that containers on the stern of the barge had toppled over. This was the first time any of the *Hoku Loa* crew realized the collapse had occurred.

Once moored, shoreside personnel carried out a damage assessment and found that the aftermost row of containers stowed in a fore and aft direction had collapsed and that 21 40-foot containers had fallen overboard. Later that afternoon, a salvage company was hired to search for and recover the lost containers. Eight containers were found adrift about 3 miles off Pepeekeo Point and were recovered by salvors. Thirteen containers were not found. The cost to repair the recovered containers and to replace those missing was $104,885; the cost to repair the barge was estimated at $25,000; and the cost of lost or damaged cargo was estimated to exceed $1.5 million.

Following the accident, a thorough inspection of the concrete deck and fixed securing points on the *Ho'omaka Hou* was completed. Damage to the concrete deck was deemed to be pre-existing, except for "small pockets of damage" that corresponded to where the ends of the containers rested on the deck.

The crew of *Hoku Loa* was tested for alcohol and drugs with negative results.

The crew stated that they performed a visual inspection of the cargo lashings while they were on the barge to connect the tow wire from the tug to the barge and undock the barge on the evening of June 20 (2 days prior to the estimated time of cargo loss). Although the company's safety management system stated that the master was "responsible at all times for the… integrity of the cargo," it did not include any of the crew's duties as to the proper loading or securing of cargo aboard the barge.

The Young Brothers barge team was the shore workers involved in the loading operation of the barge.[3] Young Brothers provided investigators with job descriptions for the barge team positions. The barge superintendent was in overall charge of cargo handling operations and was responsible for developing "initial barge load plans and modifing[y] as cargo availability changes." The company provided lashing guidance to the barge team members in a 17-page document labeled by the company as an Occupational Safety and Health Administration (OSHA) publication, called Container Lashing Tips.

About 0700 on June 19, the day before the *Hoku Loa* picked up the barge, the Young Brothers barge team members met to discuss the cargo to be loaded. Shortly after the meeting, machine operators began loading the barge with shipping containers and non-containerized cargo that was waiting in the yard. Containers continued to arrive in the yard during the loading process,

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[3] Most of the barge team had been with the company for many years, and those interviewed stated that the company provided them with general safety guidance and instructions on how to use the lashing gear (chains, binders, and locking cones) to secure cargo on the barge.

so the machine operators stacked the containers based on the total number of containers they expected to load on the barge. According to the terminal director for Young Brothers, cargo containers were weighed by the shippers and their gross weights (the total weight of the container plus its contents) in pounds, were chalked on their sides. He said that company maintenance personnel would visually inspect all containers for damage after they entered the company's container yard and that their employees had many years of experience inspecting and repairing containers. If questionable damage was found, the container would be removed, or "locked" from use, until it could be fully inspected and repairs could be made, if needed. One of the superintendents in overall charge of loading for the accident voyage told investigators that he did not feel there were any containers on the barge that were unfit to ship.

Most of the machine operators interviewed agreed that the general rule was to stack light (lower weight) containers on top of heavy containers, and to stow refrigerated containers on the bottom two tiers because the refrigerated container electrical cords needed to reach generators located on the deck of the barge. However, numerous barge team members stated that heavy containers could be loaded over light containers if some "heavies" came into the yard after the lighter containers had already been loaded. All barge team members that assisted in loading the barge told investigators that they loaded and secured cargo aboard the barge for the accident voyage as they had in the past. One of the machine operators said that they had typically stacked containers five high; a barge superintendent stated that, since the onset of the COVID-19 pandemic, stacking overall tended to be higher (but did not exceed tiers five containers high).

The containers in the toppled row were loaded in a fore and aft orientation and stacked on top of each other in five-high tiers except for the outboard stack on the starboard side, which was stacked four high. All the containers were 40 feet long, and there was a total of 10 stacks across the barge, port to starboard.

Cargo was secured to the *Ho'omaka Hou* with a combination of steel devices that were not a permanent part of the vessel (loose fittings) and steel devices that were a permanent part of the vessel (fixed fittings). The *Ho'omaka Hou* did not have a cargo securing manual, nor was it required to by regulations.

All 50 containers in the collapsed row had some type of steel cone placed at the corners between containers. Of the 40 cones used, 8 were locking type cones and 32 were stacking cones. Additionally, steel chain with hooks were used to secure 6 of the 50 containers to the deck.

In addition to chain lashing arrangements, barge team members used steel stacking cones in the four bottom corner castings of each container that was to be stacked on top of another container. Barge team members used locking cones at the bottom corner castings of the second-tier containers to the outboard port and starboard stacks of containers. Once the second-tier outboard port and starboard containers were in place, a barge team member flipped the locking handle to lock the two containers together.

Lashing gear was usually checked for proper operation and lubrication by barge team laborers after taking the gear off secured cargo during the unloading of the barge and again prior to use before securing cargo during the loading of the barge. Defective lashing gear was removed from service and repaired by the company repair shop if determined to be repairable.

There were no specific regulatory requirements for loading and securing cargo on unmanned barges such as the *Ho'omaka Hou*.[4] Both the ABS and a private company that designs and analyzes cargo securing optimization stated that stacking cones allow containers to slide or lean against each other when a vessel rolls and offer little to no protection against tipping. They also noted that, although stacking heavy containers over light containers can be done, advanced/complex calculations would be needed to calculate the sufficiency of the securing arrangement. According to the cargo optimization company, normal stratification—the heaviest container on the bottom, with the next containers progressively lighter, and the top container as lightest in the stack—is considered the best practice. Similarly, the ABS noted that, according to its principles of securing devices for container carrying ships, the permissible weight of individual containers successively decrease as the tier height increases.

The owner of a similar interisland Hawaiian barge stated that they used locking cones on all stacked containers on their barges, and they did not stack containers more than four high on their barges. The owner also told investigators that they were working with a software company to develop a loading program for their barges. Another interisland owner/operator told investigators that when they had loaded barges in the past, they used lashing rods and turnbuckles to secure rows and sorted and arranged containers based on weight so that heavier containers were placed on the bottom and lighter ones were at the top of the stack.

Industry sources providing guidance for loading and securing containers aboard ships stated that the design (maximum) compressive force on the corner post of a 40-foot container is 85.1 long tons, and that reverse stratification stacking—that is, stacking so that the lightest container was on the bottom, then then next lightest was on top of it, and so on so that the heaviest container was on top—should not be used unless discussed in the vessel's cargo securing manual, with calculations provided. It also noted that the forces on a securing arrangement increased when a stack of containers were reverse stratified.[5]

The NTSB conducted a study to determine the locations of the centers of gravity for each stack in the collapsed row of containers on the *Ho'omaka Hou,* based on the weights of each container, as provided by the company. The study also calculated the centers of gravity for each stack as if they had been stacked according to normal stratification and as if they had been stacked according to reverse stratification. The as-stacked vertical centers of gravity in Stacks 1, 2, 6, 7, 8, 9 and 10 were close to the calculated highest possible center of gravity for each stack. Except for Stack 2, each of these stacks lost containers.

[4] Cargo securing regulations apply to self-propelled vessels of over 500 gross tons on international voyages, which must comply with The International Convention for the Safety of Life at Sea sections VI/5.6 and VII/7.
[5] *ABS Guide for Certification of Container Securing Systems* (ABS Guide) – 2014; *A Master's Guide To: Container Securing, 2nd edition*, 2012 by The Standard P&I Club and The Lloyd's Register Group; *Gard Guidance on Freight Containers*, 2016.

Analysis

The shipping containers' corner casings were designed to withstand up to 85.1 long tons compressive force. Because the total weight of each collapsed container stack did not surpass the container corner casing strength, it is unlikely that the structural failure of the containers' corner casings was the cause of the toppling.

A postaccident inspection of the barge revealed no deformation of fixed securing points on the barge, indicating that the fixed fittings did not fail. Although there were parted chain lashings and other deformities/failures to the loose fittings observed, investigators could not determine if the damaged loose fittings contributed to or caused the accident or if they were a result of the collapse of the row. Because the damage to the barge's concrete deck did not include significant scraping, scratching, or other indication of the containers sliding, it is unlikely that a failure to the fixed or loose lashing gear caused the collapse of container stacks.

Although the master was ultimately responsible for the seaworthiness of the tow and the integrity of the cargo, his crew were not required to witness the loadout of the barge and only performed a brief visual inspection of the cargo lashings prior to departure. Rather, he relied upon the barge superintendent's report to the company dispatcher that the barge's cargo was properly loaded and secured. Further, the company did not provide the master with the weights of the cargo to afford him a means to determine if the lashings were sufficient for the way the containers were stacked.

Because loading and securing cargo on the barge was spelled out in the duties of the barge team members, investigators looked to the barge team members for their processes and procedures. The barge superintendent told investigators that there was no initial barge load plan for the *Ho'omaka Hou* with weights of the containers because load planning was done "as the day goes on" during loading. Therefore, barge team members were never given a copy of a stow plan to assist in them in stacking the containers.

The NTSB study of the centers of gravity of the containers in the toppled stacks on the accident voyage showed that most were loaded in a manner that produced reverse stratification—meaning that heavier containers were loaded above lighter containers. Reverse stratification results in stacks having a higher center of gravity than stacks created by placing the heaviest containers on the deck, with progressively lighter containers above, referred to as normal stratification. Normal stratification is preferred because it creates a stack having the lowest possible center of gravity.

Because of the reverse-stratification, the toppled stack's securing arrangements (lashings and locking cones) would have been subject to greater forces, as compared to stacks with normal stratification, while moving in a seaway. The containers were secured primarily with stacking cones, which provided little protection against the containers leaning or tipping.

It is likely that when the barge turned about 30 degrees to a new south-southeasterly course about 0200, the dynamic rolling from the seas on the vessel's beam resulted in increased forces on the container stacks with the greatest reverse stratification so that, unchecked by the lashings used solely on outboard stacks of containers and the stacking cones used as the primary securing point between containers, the containers tipped over and caused the row to collapse.

An initial barge load plan showing stratified container weights would have been a useful tool to assist the barge team machine operators in stacking containers on the barge to reduce or eliminate reverse stratification. Even though machine operators stated they tried to stack containers with heavy containers on the bottom and light ones on top, neither the barge team member job descriptions nor the company-provided Container Lashing Tips included instructions pertaining to the order in which to stack containers. Instead, on the accident voyage, heavy containers in the collapsed row were consistently loaded over lighter containers, and stacks 1, 7, 8, and 10—which accounted for 20 of the 21 lost containers—were loaded almost exactly in reverse stratification. In addition, the company did not provide the barge team procedures or calculations to determine if the lashing arrangements were sufficient for the reverse-stratified container stacks.

The National Transportation Safety Board determined that the probable cause of the collapse of container stacks onboard the barge *Ho'omaka Hou* towed by the *Hoku Loa* was the company not providing the barge team with an initial barge load plan, as well as inadequate procedures for monitoring stack weights, which led to undetected reverse stratification of container stacks that subjected the stacks' securing arrangements to increased forces while in transit at sea.

Lessons Learned

It is important for cargo planners to have tools, such as stow plans and calculations, to assist with determining proper stowage and the sufficiency of securing arrangements for containers stacked on barges. These tools should address the potential that container stacks may be stacked in a reverse stratified manner.

Thank you for providing me this opportunity to discuss NTSB's investigation of this unfortunate incident. I would be pleased to answer any questions you might have.

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