National Transportation Safety Board

Marine Accident Brief

Launch Capsizing of the Yacht *Baaden*

Accident no.	DCA14LM009
Vessel name	Recreational yacht *Baaden*
Accident type	New build capsizing at launch
Location	Fidalgo Marina ramp, Anacortes, Washington
Date, time	May 18, 2014 2050 Pacific daylight time (universal coordinated time – 7 hours), twilight
Injuries	3 minor injuries
Damage	Total constructive loss, estimated at $10 million
Environmental damage	None
Weather	Clear, visibility 10 miles, no wind, air temperature 60°F, water temperature 54°F
Waterway information	Fidalgo Marina Harbor, Fidalgo Bay, a sheltered recreational boat harbor; calm surface, minimal flood current, near high tide (about 2158)

The newly built yacht *Baaden* was being launched stern first down the Fidalgo Marina boat ramp in Anacortes, Washington, with eight shipyard personnel on board when it capsized after entering the water at 2050 on Sunday, May 18, 2014. The yacht was salvaged but was declared a total constructive loss, estimated at $10 million. Three shipyard personnel who were trapped below decks for up to half an hour were treated for minor cuts and injuries at local hospitals. No pollution was reported.

The yacht *Baaden* after the accident and salvaging.

The National Transportation Safety Board (NTSB) was the lead federal agency in this investigation. The parties to the investigation were New World Yacht Building LLC (doing business as Northern Marine), builder of the *Baaden*; Roddan Engineering; and the US Coast Guard.

Vessel and Builder

New World Yacht Builders began construction of the *Baaden* in December 2011, working from an existing 80-foot-hull mold built in 2002 by Northern Marine. Like other large Northern Marine yachts, the vessel was custom designed. The 80-foot mold was lengthened in the midsection and stem, the bow was given more flare, and a swim platform was added. The resulting 85-foot vessel was designated Northern Marine model 8501 and was the first of its kind. New World described the *Baaden* as having commercial fishing vessel roots in an 85-foot European-style, luxury, long-range, oceangoing expedition yacht. The builder, the buyer's representative, and an interior design firm collaborated on the vessel design and styling. Several sister vessels built to the 80-foot-hull design were completed and are in operation.

Northern Marine was an established builder of large resin-infused composite motor yachts from 57 to 152 feet long, building more than 25 hulls since its inception in 1995. Following the company's bankruptcy in 2010, New World Yacht Builders, founded the previous year, acquired Northern Marine's assets and kept the company name and construction techniques, taking over the model lines, boat styles, equipment, and maintenance of existing Northern Marine boats. The management and employees of New World included several former Northern Marine personnel. At the time of the accident, New World employed 52 people, primarily at its Anacortes yard. Following the accident, the builder entered receivership and ceased operations in August 2014.

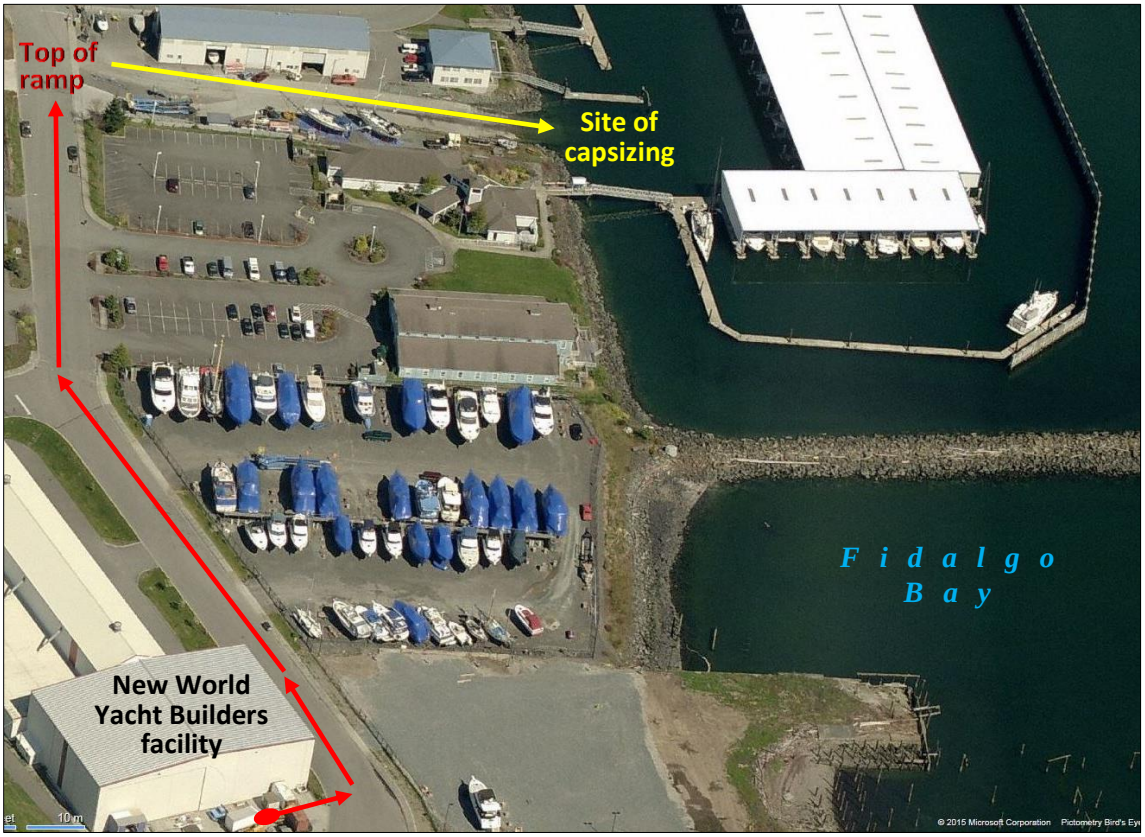
Accident location in Anacortes, Washington. (Background by Bing Maps)

Accident Events

New World's safety coordinator for the launch described it as a three-step process. First, the vessel was pulled bow first from the builder's facility to an area just above the ramp. Next, the boat was turned 90 degrees from the street and lined up on the centerline of the ramp. Then it was slowly rolled stern first down into the water on a dolly/cradle system custom designed for launching the vessel.

The *Baaden* was originally scheduled for launching on Saturday, May 17, and a safety briefing was given the day before for the 16-person launch team. A "lead person" was designated for the street move and the ramp launch.

The launch was timed to reach the water at or just before high tide because the rising tide would help to float the boat and facilitate the launch process. However, delays pushed back the estimated time that the yacht would reach the water, so the lead person and team postponed the launch until the next day.



Tow path of the *Baaden* on May 17 from the back pad of New World's facility to the top of the ramp (red arrows), where the vessel was rotated and remained for a day before being launched down the ramp on the evening of May 18 (yellow arrow). (Background by Bing Maps)

The team reconvened Sunday with a launch window from 2000 to 2200 to coincide with the predicted 2145 high tide of 8.5 feet. The stern-first launch began about 1900 and was paused about 2015 when the *Baaden* reached the water's edge while the buyer's representative, a subcontractor, and six New World employees boarded the vessel using a shoreside man lift. Three of the launch crew were on deck to operate the vessel, and five were stationed in the engine spaces below to operate equipment and check the hull.

Stern view of *Baaden* and aft dolly during the vessel's tow toward the launch ramp. (Photo by New World Yacht Builders)

The launch ramp, method, and equipment were consistent with several other similarly sized yacht launches Northern Marine had performed in the past. The primary equipment consisted of a large tow truck (wrecker) positioned at the top of the ramp, connected to and anchoring a crane below it. The crane was connected by steel cables to three multiwheeled house-moving dolly assemblies. The dollies supported custom-built steel cradles holding the vessel fore and aft. Two dollies were beneath the aft cradle and were held together with a tie bar. The aft cradle supported the *Baaden* with wood blocks port and starboard to prevent it from rolling. The third dolly was located immediately aft of the bow thruster and carried a small cradle in which the front of the vessel's keel rested. The forward cradle did not constrain the vessel from rolling.

Front dolly with connecting bar (left) and the two rear dollies and aft cradle assembly (right). (Photos by Coast Guard)

The launch team could hand steer each of the dollies until they reached the water. As the yacht rolled down the ramp, the crane operator controlled its speed by braking the payout of steel cables connected to the dollies.

The *Baaden* on its front and rear dollies on the upper ramp prior to final launching. (Photo from YachtVid video)

Team members said the launch was not rushed as they were ahead of schedule. Video footage and team members' statements indicate the launch was proceeding according to plan until about 40 seconds after the *Baaden*'s front dolly completely submerged. About 2037, with the transom immersed and the swim steps forward of the swim platform beginning to get wet, launch team members said they heard a sudden loud clank and crunching sound from the stern area. Then the boat shifted bodily on the front cradle and lurched to port where it remained heeled to about 12 degrees, according to an NTSB video study.[1] Following this movement, the *Baaden* had slightly less trim by the stern.

The team suspended the launch to assess the condition of the vessel and launch mechanisms. No leaks were found inside the hull, and the launch mechanisms were normal. The team decided to continue the launch, in part because they could not pull the yacht back out of the water and they feared it would roll over when the tide went out. The safety coordinator said the team felt comfortable continuing and did so about 12 minutes later. The launch team believed the boat would right itself from the port list once it floated free from its cradles.

[1] The NTSB video study measured the heel angle over time through the first heeling event (initial roll) and final capsizing. This study is available in the docket for this investigation; visit http://www.ntsb.gov and search for accident ID DCA14LM009.

The *Baaden* after its initial roll to port and stable at about 12 degrees with its generators and propulsion engine running. (Photo provided by *Western Mariner*)

When they continued, the safety coordinator said that initially the boat "didn't want to go." When the crane operator released the brakes, the cables between the dollies and the crane went slack. The team had started the vessel's main engine immediately after the initial roll and now used reverse propulsion to assist in pulling the yacht down the ramp and then off the rear cradle. The vessel began to move into the water, and a team member functioning as lookout near the port bow told investigators the port stabilizer fin appeared to be dragging on the ramp as the vessel and dollies moved aft.

About 2050, when the depth at the end of the upper ramp was about 7.8 feet, the vessel moved to port again and slipped off the front cradle while increasing its list to port. The New World owner, who was acting as launch captain, said he increased reverse throttle to get the vessel off the cradles quickly, and the *Baaden* began accelerating aft and continued to slowly roll. The buyer's representative heard unsecured items moving inside the boat (lazarette ballast, appliances, and equipment), and a few seconds later the roll rate increased and the boat quickly capsized, drifted into the marina, and began filling with water through its engine air intakes.

The *Baaden* at 25 degrees port heel (determined by NTSB video study) and in the process of rolling completely over to port while backing down. (Screenshot from YachtVid video)

The launch safety coordinator said he called 911 for emergency assistance immediately following the rollover.

The launch captain was in the stern control station (cockpit) and expected to move to the flying bridge once the boat entered the water, but as the yacht rolled over, he and the deck crew were forced to stand on the starboard side windows until the boat stopped moving. He then secured the engines and moved down a deck to the wheelhouse to call for help for the crew below decks. He could not reach the engine room because the only stairwell was submerged.

Launch crew in the engine room said tools and equipment moved to port as the vessel rolled over. They initially considered exiting through the lazarette to the stern swim platform, but when they saw water leaking into the engine room through the lazarette door, they determined the lazarette was likely flooded. They recalled that a portlight (a watertight window that does not open) in a starboard-side head directly forward of the engine room was cracked and might provide an escape, so they made their way there.

The *Baaden* floating freely about 1 minute after rolling over to about 80 degrees. (Photo from YachtVid video)

Shoreside team members were in communication with the trapped crew using handheld radios and were told of their planned escape route. Standing on the starboard side of the hull above the waterline, the launch team used a rock to break the glass portlight for the head and began clearing it. Water had been slowly rising inside the head, but when the portlight was broken, water rushed in. Four crewmembers were removed, but a fifth person could not fit through the portlight. Local emergency responders used a fire ax to further clear the portlight, enabling the last launch crewmember to be pulled free.

The captain cut his hand while clearing the portlight glass, and paramedics on scene directed him to a hospital. Two other trapped persons were treated at local hospitals for minor cuts and injuries received while being extricated through the portlight hole.

Following the rescue, New World contacted a salvage company which arrived later that night, and the boat was boomed to mitigate potential oil pollution. The vessel sank to the bottom of the marina basin at about a 65 degree port list but did not completely submerge in the shallow water.

The *Baaden* resting on the bottom at about 65 degrees on the day after accident. (Photo from Bowditch Marine)

Salvage

The day after the accident, the salvage team placed two righting straps around the vessel, rolled it to an upright position, dewatered it, and removed the 120 gallons of fuel on board in preparation for a stability assessment by naval architects. On May 21, a test of the yacht's ability to float without straps and a stability assessment determined that the vessel could not be towed without support straps as it was unstable and would roll to port. This assessment of the vessel's stability was not an accurate comparison to its stability during its launch, however, as 2 long tons (LT) of unsecured ballast and other unsecured items had shifted to port and water remained trapped in pockets and in absorbent materials on the port side of the vessel.

On May 23, the *Baaden* was towed while secured with supporting straps and was lifted and placed ashore on cradles at a nearby dock in Anacortes. In July, the yacht was transported back to New World's shed.

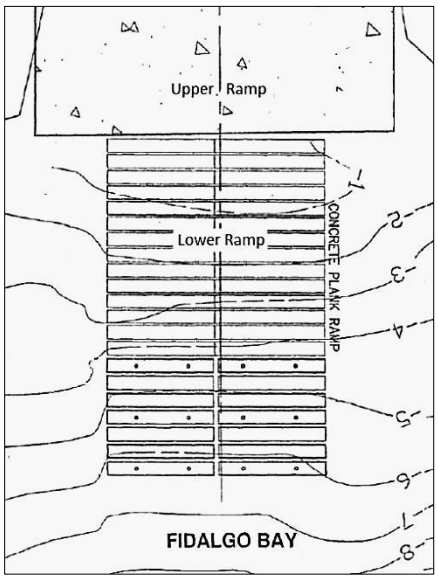
Damage

Due to water damage to interior woodwork, machinery, and electrical systems and expenses associated with repairing the vessel, at the time of this report the *Baaden* was considered a total constructive loss with an estimated value of $10 million.

Launch team members inspected the launch cradles, dollies, and equipment after the incident and noted that one of the tires on the forward dolly was flat, and witnesses said they saw bubbles coming from the forward dolly at the time of the launch. The tire likely was damaged during the initial port roll at 2037.

Ramp Layout and Launch Complications

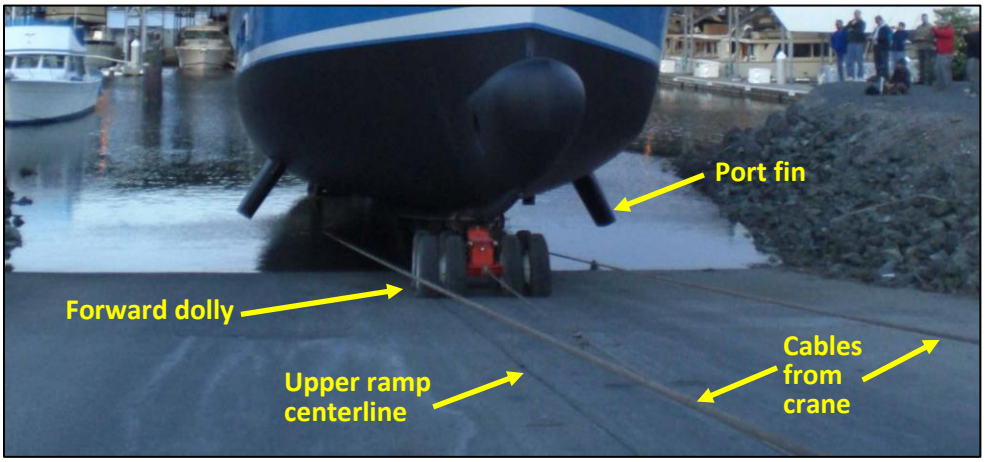
The Fidalgo Marina ramp consisted of a 40-foot-wide concrete upper ramp with about a 6.5 degree downslope and a more recently installed narrower lower ramp of 24-foot-wide concrete planks that extended about 37 feet beyond the end of the upper ramp. The lower ramp was offset about 4 inches below the end of the upper ramp.



Fidalgo Marina ramp in plan view. (NTSB annotated excerpt from drawing provided by Fidalgo Marina)

During previous Northern Marine/New World launches, the Fidalgo ramp did not have the lower ramp extension and the dollies rolled off the upper ramp into the mud. The last two launches, however, required directing the vessel down the center of the lower ramp while the dollies were completely underwater and obscured from view.

Although several launch team members stated that the *Baaden* appeared centered on the ramp during the launch, postaccident analysis of photographs shows the forward dolly roughly 2 feet to the right of the upper ramp centerline (looking down the ramp) before entering the water. The aft dolly assembly was 16 feet wide and the lower ramp was 24 feet wide; therefore, if the yacht's stern was more than 4 feet off the ramp's centerline, the aft dolly tires would begin leaving the ramp.

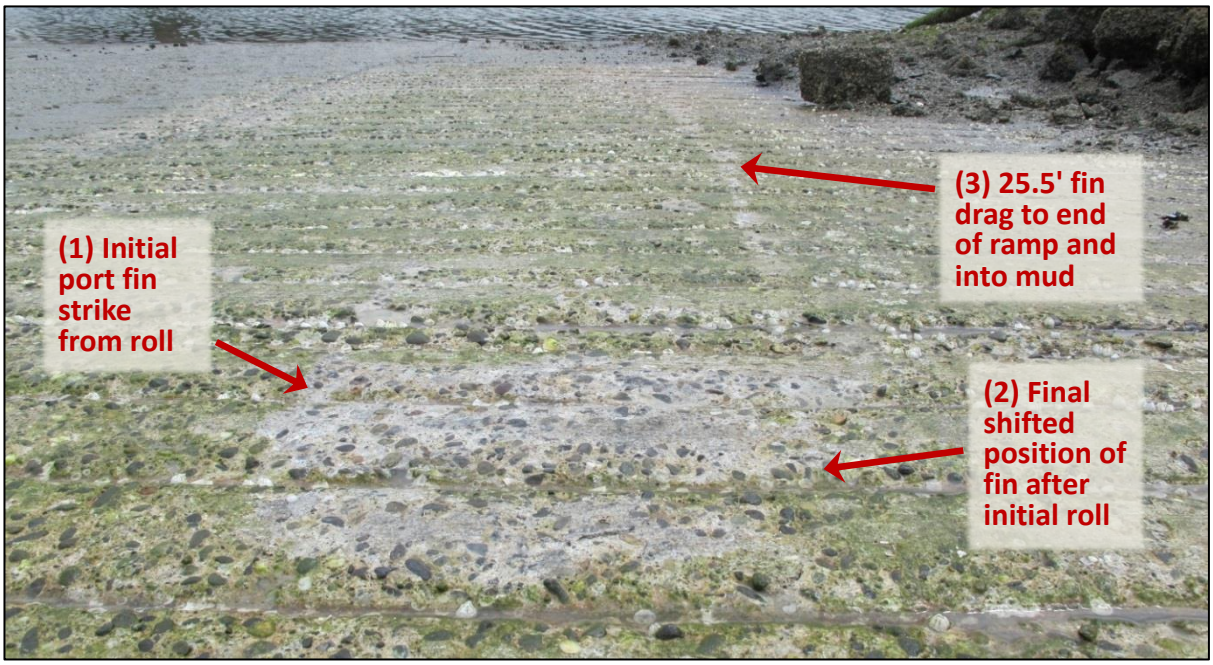


The *Baaden* on the upper ramp before its initial roll onto the port fin. The forward dolly is to the right of the upper ramp centerline. (Photo provided by New World)

Damage to the underside of the *Baaden*'s port stabilizer fin showed evidence of compression failure as well as transverse and longitudinal gouging. Investigators matched the damage to the fin with scrape marks found on the upper ramp following the accident. A 25.5-foot-long scrape down to the bottom edge of the upper ramp matches the distance from the stabilizer fin to the axle of the forward wheel set of the aft dollies. Additionally, New World

photographed markings on a roughly 10-foot section of the right edge of the lower ramp's concrete planks that indicated the axle between tire sets contacted it. This evidence suggests that the aft dolly tires rolled off the right side of the upper ramp into the mud; this dropped the stern cradle to port and jostled the partially buoyant vessel, causing the *Baaden*'s initial roll to port.

The width of the topmost portion of the fin scrape also indicates that the *Baaden* bodily shifted nearly 2 feet to the right side of the ramp during this roll before settling at a 12 degree port heel. With the vessel still supported primarily by the aft cradle, the roll was likely stopped only by the yacht's port fin contacting the ramp.



Looking down the concrete upper ramp, scrape marks match the size and position of the *Baaden*'s port stabilizer fin at (1) initial strike, (2) final shifted position, and (3) final drag to end of ramp.

Underside of port stabilizer fin showing compressive damage and both transverse and longitudinal scraping.

The fin gouges and narrow 25.5-foot upper ramp scrape correspond with the resumption of the launch when the *Baaden*'s astern propulsion was needed to help pull the yacht further into the water. The narrow scrape ends at the upper ramp's waterside edge, about 2.5 feet to the right of the lower ramp planks. This indicates that the fin dragged down the ramp as it supported the yacht and then dropped off the ramp edge and into the mud. This sudden loss of support likely initiated the final roll of the vessel.

The evidence was insufficient to determine the exact position of the *Baaden* relative to the cradle or the exact trim angle preceding the final roll. The launch method of resting the bow on the forward cradle did not constrain the vessel from rolling once the stern began to become buoyant and reduced the weight on the aft cradle wood blocks. This method of launching limited the margin for error or complications during the launch sequence.

Vessel Weight, Ballasting, and Stability

To determine the displacement (weight) and overall center of gravity of a vessel in the design and building stage, designers total the estimated weight and center of gravity of individual hull components and equipment. This was done during construction of the *Baaden*. Additionally, at two points during construction, the yacht was actually weighed to verify the accuracy of the ongoing estimates by placing several load cells (weight scales) under the vessel and summing the individual cell readings. Five cells were used—three beneath the bow on the centerline and two beneath the aft cradle, one on each side. Each load cell was photographed, and these recorded weights were supplied to an offsite naval architect, Roddan Engineering, contracted by New World to determine stability. This stability naval architect had previous experience working with New World and Northern Marine but was not the vessel's hull or overall designer. He stated that he reviewed only vessel speed, powering, weight, and stability.

The first load cell weight test in July 2013 showed the vessel's actual weight to be 76.9 LT, which was 5 percent less than the weight estimate. Using the results, the stability naval architect estimated that the vessel's final weight would be 130 LT at a 6'5" draft, and with 25.93 LT of installed ballast, it would meet Coast Guard stability criteria.

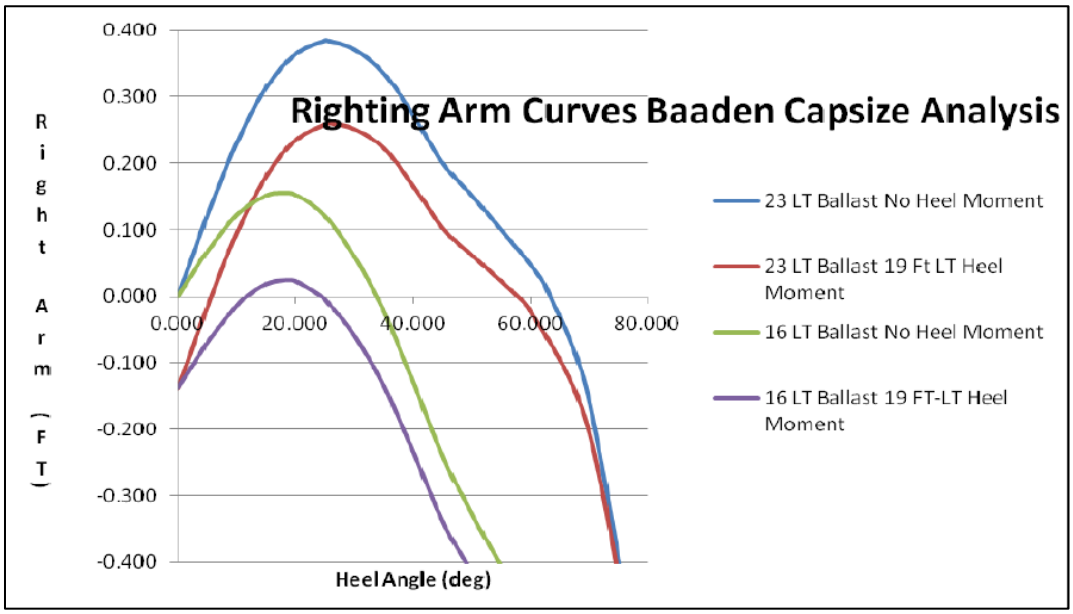
As the vessel neared completion, a second load cell weigh in March 2014 showed a vessel weight of 124.1 LT, which was over the estimate for the corresponding level of vessel completion. This weight was supplied to the stability naval architect, who revised his projected final weight up to 154.1 LT at a corresponding draft of 7'2". The naval architect said he understood from New World that 23 LT of ballast was already on board during this load cell weighing, and with suggested ballast the yacht was again projected to meet Coast Guard stability criteria.

Investigators reviewed photographs of the load cells from the second weight test. The photograph of the aft starboard load cell showed a value of 60,550 pounds. Additionally, the investigation determined the load cell values were written in grease pencil on the cradle above the cell from which they were taken. An aft starboard pencil value of 60,350, nearly similar to the value shown in the cell photograph, was found written on the cradle. However, the investigation determined that New World supplied the stability naval architect a value of 68,500 pounds for this cell—indicating a transcription error at New World—and the naval architect used this incorrect weight in his spreadsheet to determine total vessel weight and estimate launch stability. As the aft port load cell reading was 68,700 pounds, an actual aft starboard side reading of 60,550 was more than 8,000 pounds less than the aft port side. The stability naval architect said this 8,000-pound difference indicated a transverse weight differential and would produce a heeling moment to the heavier port side. This meant the vessel's center of gravity was further to port than had been estimated.

Left, aft starboard load cell reading of 60,550 pounds taken in March 2015. (Photo by New World) Right, aft starboard cradle grease pencil marks indicating 60,350 pounds 2 days after the accident. (Photo by Coast Guard)

In addition, the vessel's installed ballast weight had been overstated. New World had indicated that 23 LT of ballast was installed, and the stability naval architect used this figure in analyzing launch stability. After the accident, however, New World supplied a ballast diagram showing only 16.61 LT of ballast was in the vessel at launching, so the architect's analysis overestimated vessel stability.

The *Baaden*'s stability naval architect performed a postaccident stability analysis of four different launch conditions—for both the 16.61 and 23 LT ballast scenarios, with and without the port heeling moment created by the 8,000-pound transverse weight differential—all with zero trim (even keel) in calm water. The report calculated the port heeling moment to be 19 LT and concluded that when this moment is applied to the 16 LT ballast condition (as seen during the actual launching and indicated by the purple curve below), "there is very little righting available" to return the vessel to an upright position over a range of heel angles and "if the righting arm is negative, the vessel is unstable."



Postaccident analysis of the *Baaden*'s launch stability under differing ballast conditions. The 16 LT ballast curve shown in purple indicates the estimated stability of the yacht during the launch. (Graphic by Roddan Engineering Ltd.)

Investigators requested a postaccident weigh of the vessel to verify its launch weight for stability and center of gravity analysis, but with New World in receivership, the yacht was unavailable for weighing.

The investigation could not determine if the *Baaden* was completely clear from its cradles before its final roll began. However, once free and already heeled to 12 degrees from its initial roll, the momentum created from the yacht's second roll (initiated when its fin came off the upper ramp) combined with the movement of unsecured equipment and loose ballast in the lazarette would likely have overwhelmed the vessel's limited ability to right itself and pushed the vessel into negative stability past 25 degrees. The loose ballast consisted of 2 LT of unsecured containers of lead pellets that upon completion of the vessel would be placed as needed to adjust the final heel and trim.

The stability naval architect told investigators that he likely would have let the launch proceed with the lower 16.61 LT of installed ballast provided there was no transverse weight differential and associated heeling moment, but he would have recommended "corrective action" prior to launching for the lower ballast combined with the heeling moment created by the heavier port side. The architect stated that he recommended a minimum positive stability range of 30 degrees for a ramp launch.

Stern-first launching on an angled ramp or incline presents a stability issue that large vessels face only when first entering the water. The large trim angle causes the vessel's stern to become buoyant while the bow is supported on a cradle. This can cause a momentary negative righting arm and, without additional supports at the bow constraining the vessel from rolling, necessitates getting the hull into the water quickly to obtain full stability. The *Baaden* launch method did not use bow constraints, and no specific incline launching calculations were performed for the launch to evaluate stability at different trims and positions while entering the water.

Launch Condition Stability versus Delivered Stability

As a recreational vessel, the *Baaden* was not required to be inspected by the Coast Guard or meet commercial Coast Guard standards. However, according to the naval architect and builder, the vessel was designed to meet Coast Guard stability standards. The construction specifications for the *Baaden* included a requirement for a dockside incline test to be "performed by the Builder to measure vessel stability" and called for a trim and stability booklet to be produced. While the architect and builder estimated weight, center of gravity, and stability before launching, this incline test would have accurately determined the light weight of the vessel as well as its center of gravity and revealed if the vessel required design alterations, ballast addition, subtraction, and/or movement to meet the defined Coast Guard stability criteria. Although the *Baaden* had a low margin of stability during the launch, as determined by this investigation, the planned postlaunch stability test would have provided an opportunity to identify and rectify issues so the vessel would meet established stability criteria and be considered safe for sea.

Project Personnel and Oversight

Interviews indicated that New World used three project managers during the *Baaden* construction. Not all of the project managers had an engineering background, as their job was to communicate and implement the yacht buyer's requests as well as interface with the production manager and maintain project finances and scheduling. The overall design engineering and naval architecture was primarily overseen by New World's owner/general manager. Initially, a New World engineer and a designer, each with several years of experience, worked directly with New

World's owner. The engineer departed early in the project, and thereafter the designer served as the primary contact for the offsite stability naval architect.

The buyer's onsite "build captain" participated actively in styling and interior layouts of the *Baaden* design and requested the first weight estimate of the vessel during construction. In late 2013, the build captain's position was terminated, and his role was performed by a less active yacht management group. In January 2014, following the sudden illness of New World's owner, a consulting naval architect became acting general manager of New World in the owner's absence. Although the acting general manager had worked several years for Northern Marine in the past and was working on site for New World in various capacities, he had not previously been specifically involved with the *Baaden*.

In April 2014, the designer who worked on the weight estimates and directly provided information to the stability naval architect left New World. New World's owner returned to the *Baaden* project in May, just prior to the launch. New World personnel interviews indicated that the responsibility for overall vessel engineering was unclear in the final months of the project. The company's acting general manager stated that the *Baaden* project had more discontinuity in technical personnel and a greater amount of subcontracted work compared to past builds.

Engineers, managers, and other personnel involved with the design and construction of the *Baaden* were experienced and had successfully built and launched similar vessels in the same manner in the past. However, New World's transcription error from the reading on a load cell and incorrectly reported ballast weight resulted in the contracted offsite naval architect inaccurately assessing launch stability. These errors indicate a breakdown in the technical oversight of the design and build process.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the capsizing of the yacht *Baaden* during its initial launch was the vessel's low margin of stability due to the combined effects of a recording error during the final vessel weigh, which resulted in an incorrect assessment of the vessel's center of gravity, and an overestimation of the weight of installed ballast.

Vessel Particulars

Vessel	*Baaden*
Owner/operator	New World Yacht Building LLC (doing business as Northern Marine)
Port of registry	Bikini, Marshall Islands
Flag	United States
Type	Yacht, recreational
Year built	2014
USCG VIN number	1247236
Hull number (US)	NWL08501E313
Construction	Composite (resin infusion), fiberglass-reinforced plastic
Length, overall	85 ft (25.9 m)
Beam/width	20.75 ft (6.3 m)
Draft	7.17 ft (2.9 m)
Displacement	345,280 pounds at 7.17 ft draft (154.1 long tons, 156,616 kg)
Gross tonnage, international	199 tons
Net tonnage, international	59 tons
Engine power, manufacturer	Single 600 hp (447 kW) Caterpillar Model C18 ACERT
Fuel on board	120 gallons of diesel
Propulsion	Single, fixed-pitch propeller
Persons on board (at launch)	8

NTSB investigators worked closely with our counterparts from US Coast Guard Sector Puget Sound throughout this investigation.

For more details about this accident, visit www.ntsb.gov and search for NTSB accident ID DCA14LM009.

Adopted: July 23, 2015

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 49 *United States Code* 1131. This report is based on factual information either gathered by NTSB investigators or provided by the Coast Guard.

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." 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. 49 *United States Code*, Section 1154(b).