Personnel Abandonment of Weather-Damaged US Liftboat *Trinity II*, with Loss of Life Bay of Campeche, Gulf of Mexico September 8, 2011

Accident Report

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Marine Accident Report

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National
Transportation
Safety Board

490 L'Enfant Plaza, SW
Washington, DC 20594

National Transportation Safety Board. 2013. ***Personnel Abandonment of Weather-Damaged US Liftboat*** **Trinity II,** ***with Loss of Life, Bay of Campeche, Gulf of Mexico, September 8, 2011*. Marine Accident Report NTSB/MAR-13/01, Washington, DC.**

Abstract: This report discusses the September 8, 2011, accident involving the US liftboat *Trinity II*. Ten persons were on board. Because of severe weather and boarding seas associated with Hurricane Nate, the elevated liftboat's stern jacking leg failed and the onboard personnel abandoned the vessel. Four of them died.

Safety issues identified in this accident include inadequate weather preparedness and improper use of available lifesaving equipment.

As a result of this accident investigation, the National Transportation Safety Board makes new safety recommendations to the US Coast Guard, the US Department of State, Trinity Liftboats, Geokinetics, and the Offshore Marine Service Association.

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Acronyms and Abbreviations

AB	able-bodied seaman
AIS	automatic identification system
CFR	*Code of Federal Regulations*
CPR	cardiopulmonary resuscitation
CRAE	Centro Regional de Atención a Emergencias (PEMEX emergency response operations center)
EPIRB	emergency position indicating radio beacon
GPS	global positioning system
INMARSAT	International Maritime Satellite (telephone)
NASA	National Aeronautics and Space Administration
NHC	National Hurricane Center
NTSB	National Transportation Safety Board
OMSA	Offshore Marine Service Association
OS	ordinary seaman
PEMEX	Petróleos Mexicanos
QC	quality control technician
SAR	search and rescue
SAROPS	Search and Rescue Optimal Planning System
SCT	Secretaría de Comunicaciones y Transportes (similar to the US Department of Transportation)
SEMAR	Secretaría de Marina (Mexican Navy)
SOLAS	International Convention for the Safety of Life at Sea
STCW	International Convention on Standards of Training, Certification and Watchkeeping
VHF	very high frequency
VTS	vessel traffic service

Executive Summary

On Thursday, September 8, 2011, about 1225 central daylight time, the 78.5-foot-long liftboat *Trinity II*, while elevated and at work about 15 miles offshore in the Bay of Campeche, Gulf of Mexico, sustained damage to its stern jacking leg from severe weather associated with Hurricane Nate. Four US crewmembers and six non-US contractors were on board the vessel. When the stern jacking leg failed, causing the vessel to list, the master placed a mayday call over the radio and ordered everyone on board to abandon ship. All 10 persons, wearing lifejackets, entered the water where they clung to one of the vessel's 12-person lifefloats. Three days passed until search and rescuers located nine of the personnel. Two of them were dead by that time, and a third would die later at the hospital. Four days after finding the nine personnel, responders recovered the body of the 10th person. The six survivors sustained serious injuries. The estimated damage to the *Trinity II* was $1.5 million.

The National Transportation Safety Board (NTSB) determines that the probable cause of the accident was the failure of Trinity Liftboats (the vessel owner/operator) and Geokinetics (the chartering organization) to adequately plan for the risks associated with a rapidly developing surface low pressure weather system, which ultimately subjected the elevated liftboat to hurricane-force conditions, causing the stern jacking leg to fail and the onboard personnel to abandon the vessel. Contributing to the injuries and fatalities was the failure of the *Trinity II* crewmembers to make effective use of the vessel's available lifesaving equipment, resulting in the personnel's prolonged exposure to the elements while awaiting rescue.

Safety issues identified in this accident include the following:

- **Inadequate weather preparedness:** Although both Trinity Liftboats and Geokinetics had company hurricane plans in place, neither plan addressed the risk posed by locally forming weather systems. Instead, the plans assumed that weather systems affecting the area of operation would arrive from the east and thus provide a few days' advance warning. Further, neither plan would be activated unless a named tropical weather system approached the area. However, in this accident, the conditions that eventually would produce Hurricane Nate developed locally from a strengthening surface low pressure system. As a result, the company hurricane plans were never activated, and the personnel on board the *Trinity II* had minimal advance warning to prepare.

- **Improper use of available lifesaving equipment:** The *Trinity II* carried two inflatable liferafts that had recently been installed on board the vessel. Although the four Trinity crewmembers had completed training in how to operate lifesaving equipment, they inflated the first of the two liferafts on deck as the personnel prepared to abandon the vessel. Inflating the liferaft on deck—instead of throwing the canister containing the liferaft into the water, which was the proper method and was clearly illustrated in the launching instructions posted where the liferafts were stowed—caused the liferaft to blow away from the deck in the hurricane-force winds and vanish in the rough seas. The second liferaft was also lost in the high winds after a large wave hit the canister, causing the liferaft to inflate while still on board the vessel. Ultimately, the personnel ended up having to cling to a lifefloat, which, unlike the liferafts, did not provide out-of-water flotation, shelter from the elements, and food and water. Further, although the *Trinity II* was equipped with an emergency position indicating radio beacon (EPIRB), the crewmembers did not take it with them when the personnel abandoned the vessel.

The EPIRB, had it been brought along and activated, would have enabled search and rescuers to narrow the search area and reduce the time the men had to spend in the water.

As a result of this investigation, the NTSB makes new safety recommendations to the US Coast Guard, the US Department of State, Trinity Liftboats, Geokinetics, and the Offshore Marine Service Association.

1. The Accident

1.1 Background

In February 2011, the 78.5-foot-long US liftboat *Trinity II* (figure 1) departed Louisiana for the Bay of Campeche in the southern Gulf of Mexico. The vessel, owned and operated by Trinity Liftboat Services, LLC ("Trinity Liftboats"), of New Iberia, Louisiana, had been chartered by Geokinetics, Inc. ("Geokinetics"), a geophysical services company headquartered in Houston, Texas.

Figure 1. *Trinity II* after the accident.

Geokinetics had chartered the *Trinity II*, along with several other vessels, to seismically explore petroleum reserves in the Bay of Campeche in the southern Gulf of Mexico (figure 2). Petróleos Mexicanos (PEMEX), Mexico's state-owned petroleum company, had contracted Geokinetics to conduct the seismic work. PEMEX authorized and oversaw all exploration and production of hydrocarbons in the Bay of Campeche.

Figure 2. Map of the Gulf of Mexico and surrounding regions, including the accident site in the Bay of Campeche. Background by Google.

When the *Trinity II* arrived in the Bay of Campeche, local PEMEX authorities stationed in Ciudad del Carmen inspected the vessel and approved it for work. During the charter, Geokinetics—which had operational control of the project—managed the operation from its field office in Frontera, Mexico, about 50 miles west of Ciudad del Carmen.[1]

To fulfill the PEMEX contract, Geokinetics chartered a total of 10 vessels to work in the Bay of Campeche. Trinity Liftboats owned and operated two of the vessels, *Trinity I* and *Trinity II*, both liftboats.[2] During seismic exploration, the other chartered vessels would lay cables on the seafloor from the *Trinity I* and the *Trinity II*. A shock wave was then generated from one of the other vessels. The wave would enter the water column and penetrate the seafloor,

[1] The charter agreement stated in part that the vessel would be operated as requested by Geokinetics, "subject always to the exclusive right of the [vessel] company or the master of the vessel to determine whether operation of the vessel may be safely undertaken." Effectively, however, Geokinetics exerted daily control and coordinated with local PEMEX authorities.

[2] The *Trinity I* worked in shallower waters than the *Trinity II* because the jacking legs on the *Trinity I* had thinner steel, which limited the water depth in which the vessel could operate. At the time of the accident, the *Trinity I* was located only about 2 miles offshore, some 13 miles closer to land than the *Trinity II*.

and the cables on the seafloor would detect the reflected energy.[3] Recording devices on the *Trinity I* and *Trinity II* would then collect the signals for data processing to identify earth formations favorable to petroleum deposits.

Similar to other liftboats, the *Trinity II* had jacking legs designed to rest on the seafloor and raise the hull above the sea surface to create a stable platform (figures 3 and 4). The level of elevation above the surface of the water would depend on sea state and the type of work being done. The three 145-foot-long legs on the *Trinity II* were arranged in a triangular pattern with two legs positioned at the forward outboard sides of the hull and a single leg positioned at the stern on the centerline of the hull. The length of the legs was fixed; that is, the legs did not have sections that slid or passed within one another to extend or contract the legs. When under way, the vessel typically transited with the legs fully raised above the main deck.

Figure 3. File photo, provided by Trinity Liftboats, showing the *Trinity II* jacked up during operations.

The bottom of each jacking leg was fitted with a rectangular steel pad (about 26 feet long, 11 feet wide, and 2 feet tall) to prevent excessive penetration (more than a few feet) of the legs into the seafloor when the vessel was jacked up. Each leg was supported by a tower-like structure, about 13 feet tall, through which the legs passed (figure 4). The support towers were rigidly mounted to the liftboat's hull and the legs were connected to the towers through a rack and pinion gear system that enabled the legs to be raised and lowered.

[3] *Water column* is a hypothetical column of water that extends vertically through the water between the surface and the bottom.

As part of the vessel's general certification process, the US Coast Guard had approved a maximum water depth of 100 feet in which the *Trinity II* could operate. The *Trinity II* master told investigators that, depending on the amount of leg penetration into the seafloor, the crew would restrict the operating depth to 80–85 feet. (For other operating restrictions, see section "1.12 Vessel Information.")

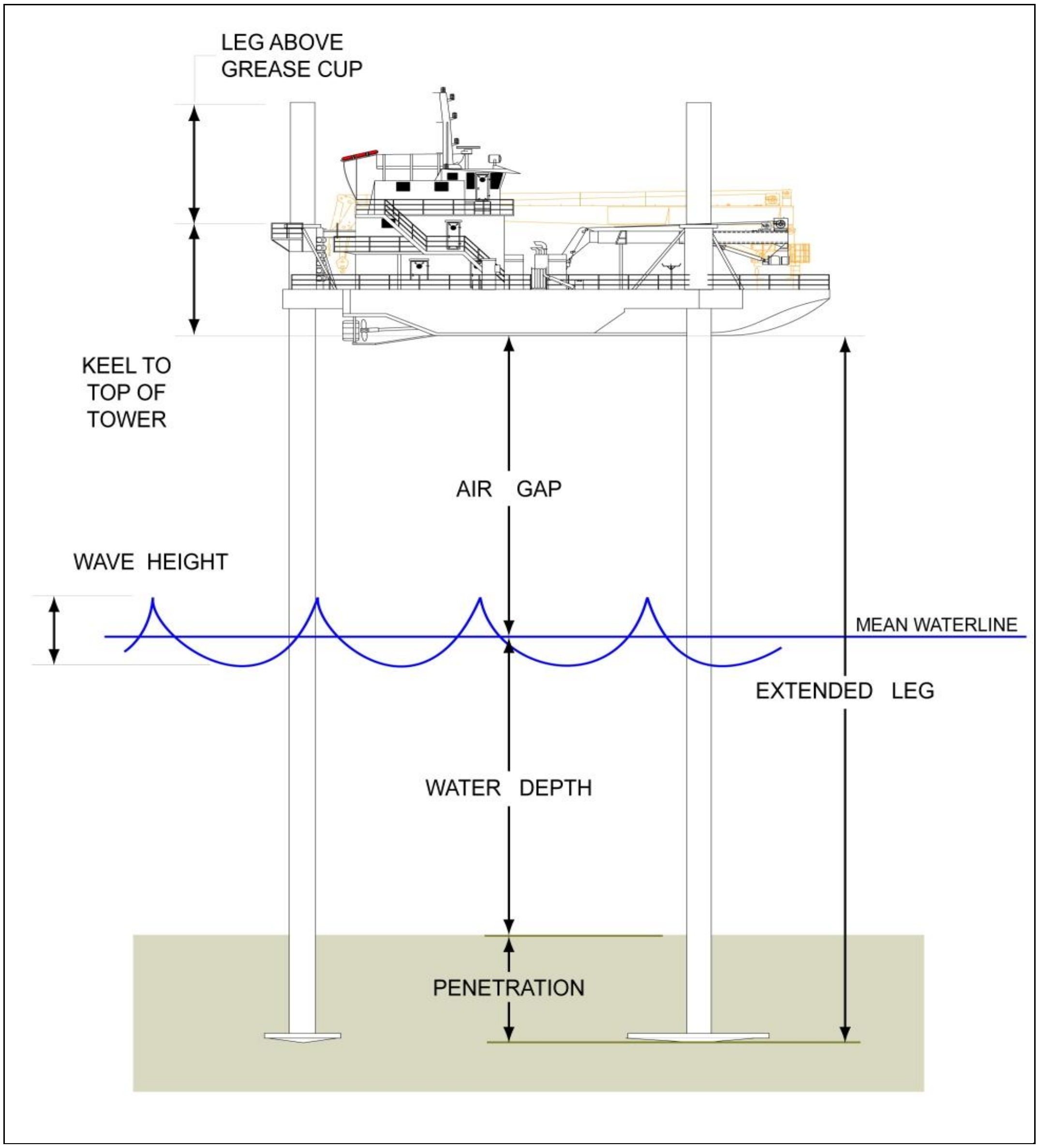

Figure 4. Diagram, recreated from the *Trinity II*'s operating manual, showing various components of the liftboat's design and function.

The crew would raise and lower the legs individually using hydraulic drive motors controlled from the wheelhouse. A tilt sensor and alarm was fitted in the wheelhouse to alert the operator should the vessel be inclined 1.5 degrees or more in either the longitudinal or athwartship (side to side) axis.

The legs on the *Trinity II* were constructed of 42-inch-diameter high-strength steel pipe with a 0.75-inch wall thickness. Welded to one side of each leg was a 4-inch by 3-inch gear rack. The interior of each leg was fitted with a welded steel reinforcing structure for strength (figure 5). (Also see section “1.12 Vessel Information.”)

Figure 5. Photo of a liftboat leg’s interior, similar to the three jacking legs on the *Trinity II*. The leg’s interior steel reinforcing structure is visible.

The *Trinity II*’s onboard personnel included Trinity Liftboats crewmembers and Geokinetics contractors.[4] In late August 2011, the personnel moved the *Trinity II* to the accident location (about 15 miles offshore, north of Frontera, in about 84 feet of water) and commenced work. Leading up to and at the time of the accident, 10 people were on board the *Trinity II*. Four of them were Trinity Liftboats crewmembers, all US citizens, including a master, a mate, an able-bodied seaman (AB), and an ordinary seaman (OS).[5] The remaining six persons (four Mexican citizens, one Australian citizen, and one Bangladeshi citizen) were Geokinetics contractors. (For additional detail, see section “1.11 Personnel Information.”)

[4] This report uses the term “personnel” when referring to both Trinity crew and Geokinetics contractors.

[5] An AB is employed in a vessel’s deck department, is qualified usually by 3 years’ sea service on deck, and is capable of performing all duties required to maintain, manage, and operate the vessel. These include (among other things) steering by compass, keeping lookout, operating deck machinery, and rigging cargo gear. An OS is a deckhand who, usually, has less experience than an AB (typically 1 year’s experience or less).

1.2 Formation of Hurricane Nate

Each day about 0700 and 1900 central daylight time, the *Trinity II* received weather forecasts provided via e-mail by FleetWeather Ocean Services, a marine weather forecasting company serving the shipping industry.[6] On Sunday evening, September 4, the personnel received a report in which FleetWeather forecasted the possibility of a surface low pressure system forming nearby.[7] In his postaccident interview with National Transportation Safety Board (NTSB) investigators, the *Trinity II* master stated that he discussed the weather forecast with one of the two onboard Geokinetics navigators who directed the vessel during positioning (one navigator worked the day shift; the other worked nights). Together, the master and the navigator assessed whether they should move the *Trinity II* closer to shore.[8] Jacking down and moving a liftboat can be a complex and time-consuming process. It requires testing the condition of the seafloor in the new location by performing an initial vessel elevation (preload) to ensure even and minimal seafloor penetration. The entire moving process commonly takes about 3–6 hours. Moreover, in the *Trinity II*'s present location, the three jacking legs were penetrating about 10 feet into the seafloor. This amount of penetration was substantial and would make the moving process more time-consuming. Further, the personnel and the vessel had operated during low pressure systems before, and the wave heights predicted for the next day were moderate, about 1–4 feet. Therefore, considering all the factors known to them at the time, the personnel determined that the *Trinity II* would stay in its present location.

The winds and seas increased on Monday, September 5. On Tuesday morning, September 6, the National Hurricane Center (NHC) reported a 20 percent probability that the surface low pressure system, which was stationary and centered north-northeast of the *Trinity II*, would strengthen further in connection with a cold front approaching from the northwest. The master told investigators that he asked the Geokinetics day navigator if the weather would pose a problem to operations and that the day navigator said no. However, using the vessel's onboard anemometer for measuring wind speed, the personnel noted that the winds increased further and appeared even worse than the forecast. By noon that day, the weather had become severe enough that the vessel could no longer be safely moved. Because of their barge-like shallow hull and the fact that the vessels typically travel with the jacking legs fully raised above the main deck, liftboats have sea state restrictions when the vessel is afloat and/or under way (not jacked up). In the *Trinity II*'s case, the sea state restriction was 5 feet. By the time FleetWeather's forecast arrived that evening, predicting 3–6-foot seas by Wednesday morning, the actual wave height at *Trinity II*'s location was already at or above 5 feet. The remaining options at that point were to jack the vessel higher and/or to evacuate the personnel. On Tuesday evening, the weather deteriorated further and the crew jacked up the *Trinity II* three times to stay clear of the waves. It is not known to what specific elevations the crew raised the vessel that evening. (Also see sections "1.7 Weather Information" and "1.12 Vessel Information.")

[6] Unless otherwise noted, all times in this report are central daylight time (coordinated universal time –5 hours), based on the 24-hour clock.

[7] In the northern hemisphere, a surface low pressure system is characterized by counter-clockwise rotation close to the ground or sea level. From a meteorological standpoint, a surface low pressure system in tropical or subtropical regions has the potential to further develop and strengthen under the right atmospheric conditions.

[8] The *Trinity II* was not equipped with a voyage data recorder, nor was it required to be. Investigators therefore relied on survivor statements describing the accident events.

The next day, Wednesday, September 7, the vice president of Trinity Liftboats ("Trinity vice president") in New Iberia called the master to discuss the updated NHC forecast, which now indicated a 70 percent chance of further system development and 8–10-foot seas. This meant that the crew would not be able to jack down and move the vessel for another couple of days. The master also spoke on the phone with the president of Trinity Liftboats ("Trinity president") as well as the Geokinetics project manager in Frontera. Geokinetics had no contingency plan for a sudden, locally forming weather occurrence such as this. According to the Geokinetics project manager in Frontera, no policy existed for "when [a storm] forms directly on top of you."[9] The project manager told the master that PEMEX could launch a helicopter from Ciudad del Carmen to evacuate the *Trinity II* personnel in case it was needed, and the two men discussed possible helicopter evacuation scenarios. The master also discussed the situation with the onboard personnel.

Also on Wednesday, Geokinetics stopped operations because of the weather, and the smaller vessels returned to Frontera. However, a Geokinetics manager in Houston informed the Trinity president that the 230-foot-long *Mermaid Vigilance*, which was one of the 10 vessels involved in the seismic operation, would remain in the area as a standby vessel to assist if needed. This information was conveyed to the *Trinity II* master as well. At this stage, the personnel's intent was still to ride out the storm on board the liftboat.

On Wednesday afternoon, the *Trinity II* personnel noted that the sustained wind speed increased from about 40 mph to more than 50 mph. The weather system was now a tropical storm, which the NHC named "Nate." The rough seas were hitting the *Trinity II*'s jacking legs. The stern leg, which along with the two forward legs had been penetrating about 10 feet into the seafloor before the onset of the storm, began to sink deeper. The reason for the stern leg's additional penetration was not clear, but the Trinity president later told investigators that the prevailing wind direction and pounding waves may have forced that leg deeper. The master told investigators that the vessel's tilt alarm was sounding intermittently.

On Wednesday evening, the wind and seas increased further, and the radio controller at Geokinetics in Frontera asked the watchstanders of the three remaining vessels that had not returned to port (including the *Trinity I*) to check in every 15–20 minutes. The master told investigators that, at about this point, he concluded that it was necessary to consider evacuating the *Trinity II* personnel, and he related this need to Geokinetics in Frontera. The master of the *Mermaid Vigilance*, which was the intended standby vessel and a few miles away at that point, replied that he would try to turn his vessel around to head to the *Trinity II*, but that the rough waves made it difficult to do so.

Later that night, the master of the *Mermaid Vigilance* reported that he would not be able to assist the *Trinity II*. He said that the sea state made it nearly impossible to turn his vessel around, that the vessel had sustained storm-related damage, and that he had an injured crewmember on board. He returned the *Mermaid Vigilance* to port.

[9] Unlike this storm, many of the tropical weather systems that affect the Gulf of Mexico arrive from the east (developing while crossing the Atlantic Ocean), with several days' advance warning. However, tropical weather systems forming locally from surface low pressure systems are not rare. About one-third of all tropical weather systems in the Gulf of Mexico and North Atlantic Ocean develop from surface low pressure systems, low-level frontal boundaries, or upper-level disturbances that approach from the west or form locally.

During the night into Thursday, September 8, the *Trinity II* master gathered together the crew and the contractors to review emergency procedures. He discussed the possibility of abandoning ship if the situation worsened, the use of lifejackets, and the importance of staying together in the water if abandonment became necessary.[10]

The *Trinity II* carried a variety of lifesaving equipment, including two 25-person inflatable liferafts, which were located in cradles on the main deck on the port and starboard sides. No US regulations required that these liferafts be on board. However, in connection with Trinity Liftboats' obtaining Coast Guard approval to operate the *Trinity I* and the *Trinity II* in foreign waters, the Coast Guard determined that the liftboats should each be equipped with two liferafts as an additional safety precaution before the vessels made the journey to Mexico.[11] Trinity Liftboats indicated that PEMEX would likely also require the liferafts once the vessels arrived in Mexico. The liferafts, which in addition to providing out-of--water flotation also contained drinking water, nonperishable food, thermal protection sheets, and antiseasickness tablets, among other supplies, had recently been installed on board the *Trinity I* and the *Trinity II*.

The *Trinity II* also carried the following lifesaving equipment, which was required by Coast Guard regulations:

- Three 12-person lifefloats with a floating strobe light attached;
- One rescue boat;
- Twenty-eight adult lifejackets equipped with a chemical light and whistle;
- Three ring buoys, two with lights and two with lines;
- Twelve emergency rocket flares; and
- One 406-megahertz emergency position indicating radio beacon (EPIRB).[12]

Throughout the night into Thursday, the master was in frequent contact with the Trinity president via the vessel's satellite telephone, updating him on weather conditions and on how the vessel was responding. The two men talked about possibly disengaging the top hydraulic unit of the stern leg's jacking mechanism; doing so might provide an additional 3 feet of elevation on the stern leg, if necessary. That operation had risks and was considered a last resort.

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[10] Emergency egress from a jacked up liftboat would be either onto an adjacent platform or rig, or by crane and personnel transfer basket to the water and a waiting vessel. The last person off (the person operating the crane) would use either a rope ladder or a knotted rope to descend. In the *Trinity II*'s case, the vessel was fitted with a knotted rope on the aft starboard side.

[11] In November 2010, Trinity Liftboats requested Coast Guard approval to operate the *Trinity I* and the *Trinity II* in foreign waters during the Geokinetics charter. A Coast Guard inspector from Lafayette, Louisiana, coordinated the approval process with his Coast Guard parent command in Morgan City, Louisiana, and with the Coast Guard sector office in New Orleans. In December 2010, the Coast Guard granted Trinity Liftboats the approval.

[12] The type of EPIRB that the *Trinity II* carried would, on activation, transmit a 406-megahertz signal, which would be received and stored by at least three satellites, enabling them to triangulate the EPIRB's location for greater accuracy. The EPIRB would also transmit the vessel's name, type, size, and who authorities should contact. According to the EPIRB manufacturer, authorities would receive notification within 1 hour, with a resulting search radius of about 2.6 miles.

The master told investigators that, during the night into Thursday, the stern leg penetrated an additional 6 feet into the seafloor in a matter of minutes, causing the vessel to become further trimmed down by the stern. The stern leg's jacking mechanism had also jammed at this point, which prevented the crew from further elevating the vessel, even though the two forward legs still had 12 feet of jack-up capability remaining. The master attempted to unjam the stern leg by lowering the bow to level the platform, but the attempt was unsuccessful. The master told investigators that the stern leg hydraulic system reached its maximum of 6,000 pounds per square inch and "just groaned. She was stuck." The air gap between the underside of the hull and the mean water level was about 20 feet, but the legs and the underside of the hull were still being pounded by high seas and the hull was being buffeted by strong winds. The master spoke once again with the Trinity president and told him that he believed the stern leg was going to break. The president replied that if the leg broke, the stern section of the *Trinity II* would likely fall slowly because the other two legs would keep the vessel aloft, but that it was important to be prepared nonetheless. According to the master, the president told him to inflate one of the vessel's liferafts on deck as part of the preparation. During postaccident interviews, the Trinity president told investigators that he did not give this instruction.[13]

Shortly after 0600 on Thursday, September 8, after Geokinetics in Frontera received another request from the *Trinity II* that the personnel be removed from the vessel, Geokinetics contacted the PEMEX entity Control Marino (structured similarly to the Coast Guard's vessel traffic service [VTS][14]), which provided 24-hour vessel monitoring and directed all vessel movement in the Bay of Campeche. On hearing from Geokinetics, Control Marino dispatched two Mexico-flagged vessels, the *Isla del Toro* and the *Bourbon Artabaze,* to head toward the *Trinity II*, with estimated arrival times of 1400 and 1500, respectively. (Investigators were unable to speak to anyone from the *Isla del Toro* or the *Bourbon Artabaze,* nor did Control Marino disclose when or from where the vessels departed.)[15]

1.3 Personnel Abandonment of the *Trinity II*

On Thursday morning, the personnel on board the *Trinity II* prepared for the possibility of abandoning the vessel into the water, in case assistance did not arrive. They gathered food and bottles of water into plastic garbage bags and readied the box containing the emergency flares. All 10 personnel, wearing lifejackets, mustered between the wheelhouse and the mess deck. The master told investigators that, later on Thursday morning, he sent the AB and others down to inflate the starboard-side liferaft. The four crewmembers had received prior training in how to use lifesaving equipment such as liferafts. Also, instructions for how to launch the liferaft were posted below the cradle in which the liferaft canister was stored, and illustrated how the canister

[13] Inflating a liferaft on deck has the potential to puncture the liferaft on vessel structures and equipment, especially when deck space is limited. Also, liferafts out of the water are very vulnerable in windy conditions. The only time a liferaft should be inflated out of the water is if the liferaft is launched by a davit, which is an armlike structure extending over the side of the vessel and used for lowering the liferaft. When davit-launched, the liferaft is held over the water, inflated in midair, and, importantly, secured parallel to the vessel with lines to prevent the liferaft from blowing around in the wind.

[14] VTS provides active monitoring and navigational advice for vessels in confined and busy waterways.

[15] According to PEMEX logs, both the *Isla del Toro* and the *Bourbon Artabaze* arrived on scene that afternoon. However, because the *Trinity II* personnel had by that time abandoned their vessel and were adrift in hurricane-force conditions, the vessel crews could not locate them.

should be thrown into the water before inflating the liferaft (figure 6). These instructions were also posted below the portside liferaft.

Figure 6. The illustrations, posted below the liferaft cradles, showing how to launch the liferafts.

The AB told investigators that before the personnel inflated the starboard-side liferaft, someone tied the liferaft's painter to the vessel's handrail.[16] They placed the liferaft canister onto the deck and inflated the liferaft. When the liferaft inflated on deck, the high winds caught it, parted (broke) the painter, and "just took [the liferaft] out to sea."

Shortly after noon, the personnel began seeing larger swells that hit the *Trinity II*'s bow and washed over the deck, shaking the vessel. The survivors reported that, about 1225, after several large waves hit the hull, the stern leg broke and the vessel's stern collapsed several feet downward into the water. The master told investigators that he then ordered abandon ship and placed a distress mayday call over the radio, and that the personnel grabbed their supplies and headed for the main deck. As they made their way to the second liferaft, which was located on the portside, a swell hit the mate and knocked him down onto the deck.

The master told investigators that he returned to retrieve the EPIRB, which was located on a port bulkhead immediately outside the wheelhouse (figure 7). The master said that he was unable to retrieve the EPIRB because the portside crane was "picking up and slamming side to side," and he thought that it would hit him if he got too close. The master returned to the main deck without the EPIRB. (After the *Trinity II* was salvaged and returned to port, investigators found the EPIRB still in its container. It was undamaged and had not been activated.)

[16] On an inflatable liferaft, the *painter* is the line that inflates the liferaft. One end of the painter is attached to the vessel; the other end is attached to the liferaft.

Figure 7. The *Trinity II*'s EPIRB during postaccident examination, and the EPIRB's location on the portside bulkhead just outside the wheelhouse.

The survivors told investigators that, after a wave crashed onto the port liferaft canister, the liferaft inexplicably inflated while still in the cradle. The liferaft then became stuck between the handrail and the garbage compactor, located immediately forward of the liferaft cradle. As the personnel pushed the liferaft over the handrail, it filled with water. The master said that the painter was looped around the handrail but that the painter parted when the wind caught the liferaft. The liferaft entered the water and floated away. With the two liferafts now gone, the personnel were uncertain what to do next. The vessel's cook and the "QC 2" (one of two quality control technicians, or "QCs," on board the vessel) then took the initiative to retrieve one of the lifefloats (figure 8) from the stowage location behind the wheelhouse and passed it down to the stern of the vessel on the port side.

Figure 8. One of the three lifefloats on board the *Trinity II*.

After several large swells hit the *Trinity II*, the master gave the order for everyone to enter the water, as he was worried the vessel would capsize. The personnel threw the lifefloat overboard, entered the water from the vessel's stern, and then held on to the lifefloat's grab lines. The lifefloat was equipped with an attached floating strobe light. The other onboard QC ("QC 1") said that the cook had wanted to retrieve a second lifefloat, but that everyone else began entering the water and he did not want to be left behind.

The personnel did not bring any of the food, water, and other provisions they had prepared earlier. They did bring one ring buoy and extra lifejackets. The master told investigators that he brought along a waterproof radio, but lost it as he entered the water.

On Thursday afternoon, the storm reached sustained winds of 75 mph and briefly became "Hurricane Nate" before losing strength and dropping back to tropical storm status after midnight on Friday, September 9.[17] The air temperature during the 3 days the men spent in the water ranged from about 75° to 86° F. Water temperature for the same period ranged from about 84° to 86° F.

1.4 Survival at Sea

Throughout Thursday night into Friday, all 10 personnel clung to the lifefloat as it drifted in heavy seas and high winds, and all of them activated the chemical lights on their lifejackets. The master told investigators that, early Friday morning, they drifted within about half a mile of a platform, but that the wind and the current then changed, pulling them away. Also, at some point during the day on Friday, the personnel saw a helicopter several miles away but were unable to get its crew's attention. The master told investigators that, by Friday afternoon, some of the men began to get discouraged and that he tried to keep them positive.

The weather remained rough throughout Friday. The personnel took turns resting by lying across the lifefloat two at a time. The master indicated that he told everyone to remain tied to the lifefloat but that, for unknown reasons, the night navigator kept untying himself from the grab line and drifting away. About 2330 on Friday evening, the night navigator drifted away and became permanently separated from the group. The other men tried to direct the lifefloat toward his voice as he called out but were unable to reach him, and eventually the night navigator disappeared in the darkness and high seas.

On Saturday, the weather improved but the condition of the personnel began to deteriorate. According to the survivors, the day navigator was not making any sense when he spoke. Later in the day Saturday, they began hearing helicopters but again were not spotted by the searchers. On Saturday evening, the OS inexplicably removed his lifejacket a number of times and tried to jump out of the lifefloat. The other men finally secured him on top of the lifefloat and told him to rest, checking him periodically. Sometime later, when the AB checked on the OS, he discovered that his face was underwater. The personnel attempted cardiopulmonary resuscitation (CPR) but were unable to revive the OS. They secured his body in the lifefloat and continued to drift. At some point during Saturday night, the lifefloat's strobe light stopped working.

After the OS died, the master decided that those still strong enough would try to swim to the next platform they saw. According to the survivors, the group spotted a platform early Sunday morning, and the master, the mate, the AB, and the QC 1 began to swim toward it. The other men were too weak to swim and stayed with the lifefloat. The four swimmers got close to the platform but were unable to reach it before the wind and seas changed again, pushing them away. The survivors were now split into two groups of four, with the swimmers separated from the group with the lifefloat. The AB told investigators that two of the swimmers—the master and the mate—were exhausted, and that he swam behind them, pushing them along. He said that this went on for hours.

[17] The closest weather buoy to the accident site was located 215 miles to the north-northwest. The buoy measured 9-foot seas around the time of the accident. However, in its "Sea State Analysis Chart" of September 8, 2011, the NHC stated that the wave height in the *Trinity II*'s location may have been as high as 36 feet at the time of the vessel abandonment. (Also see section "1.7 Weather Information.")

The master recalled that after attempting to swim to the platform, the mate's condition began to deteriorate. He was hallucinating, repeatedly sticking his head under water, and would not swim further. Later that morning, the AB thought that he saw an orange-colored vessel in the distance. He and the QC 1 decided to swim toward it, leaving the exhausted master and the mate behind. The vessel was the *Bourbon Artabaze*, one of the vessels Control Marino had dispatched to help in the search.

About 1145 on Sunday, September 11, the crew of the *Bourbon Artabaze* spotted the lifefloat, which held the cook, the QC 2, the day navigator, the cleaner, and the deceased OS. The crew recovered all four persons and the body of the OS. About an hour later, at 1242, the *Bourbon Artabaze* crew found the QC 1 and the AB alive in the water, about 0.8 mile from the lifefloat. About 1500, the *Bourbon Artabaze* crew recovered the body of the mate. About the same time, the crew of another vessel arriving on scene, the Spain-flagged *Arbol Grande*, rescued the master nearby. The men were found about 150 miles to the northeast of the *Trinity II*'s location at the time of the accident. All survivors were transferred by helicopter to the PEMEX hospital in Ciudad del Carmen, where the day navigator later died. A week after the accident, the body of the night navigator was recovered. (Also see section "2.1 Coordination of Search and Rescue Efforts.")

After the *Trinity II*'s two remaining jacking legs fractured and separated, the vessel drifted for several days. During the time the vessel was adrift, Mexican authorities, including the Mexican Navy—Secretaría de Marina, or "SEMAR"—were able to monitor the vessel's track by using automatic identification system (AIS) data transmitted from the vessel.[18] After several days adrift, the *Trinity II* threatened oil production platforms. SEMAR personnel then boarded the vessel and arranged to have it towed to Ciudad del Carmen. When SEMAR boarded the *Trinity II*, it was still afloat and stable in the water (figure 9).

[18] AIS is a maritime navigation safety communications system. At 2- to 12-second intervals on a moving vessel, the AIS automatically transmits vessel information, including the vessel's name, type, position, course, speed, navigational status, and other safety-related information, to appropriately equipped shore stations, other vessels, and aircraft. The rate at which the AIS information is updated depends on vessel speed and whether the vessel is changing course. The AIS also automatically receives information from similarly equipped vessels.

Figure 9. Photo of the adrift *Trinity II*, taken while SEMAR personnel boarded the vessel.

A diver's examination of the hull determined that a section of the stern leg remained and that it would need to be cut off so that the vessel could enter port (because of draft restrictions at the port). After about a 4-foot section of the stern leg was removed, the *Trinity II* was towed into Ciudad del Carmen and remained berthed there until mid-March 2012.

1.5 Injuries

The injuries sustained in this accident are summarized in the table below.

Type of Injury	Crew	Other than Crew	Total
Fatal	2	2	4
Serious	2	4	6
Minor/none	0	0	0
Total	4	6	10
Title 49 *Code of Federal Regulations* (CFR) 830.2 defines a fatal injury as any injury that results in death within 30 days of an accident. It defines serious injury as that which requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; results in a fracture of any bone (except simple fractures of fingers, toes, or nose); causes severe hemorrhages, nerve, muscle, or tendon damage; involves any internal organ; or involves second- or third-degree burns, or any burn affecting more than 5 percent of the body surface.			

Mexican authorities conducted autopsies on the four deceased men. They listed the cause of death of the two *Trinity II* crewmembers—the mate and the OS—and the Geokinetics night navigator as drowning. Mexican authorities listed the cause of death of the Geokinetics day navigator, who was recovered alive but later died at the hospital, as cardiogenic shock due to severe dehydration and starvation.

1.6 Toxicological Testing

US regulations require that toxicological testing be conducted following serious marine accidents.[19] However, none of the survivors were tested after they were rescued; moreover, at that point, 3 days had passed since the accident. Investigators could therefore not determine whether any of the crew or contractors had used alcohol or drugs prior to the accident.

1.7 Weather Information

According to the NHC, Tropical Storm Nate originated from a frontal trough that moved through the western half of the Gulf of Mexico on Monday, September 5, and became stationary near the Bay of Campeche later that day. Over the course of the next day, Tuesday, September 6, cloudiness and showers increased, and about 1300 that afternoon, a surface low pressure system formed along the southern end of the front, about 185 miles northwest of Ciudad del Carmen. The surface low pressure system officially became Tropical Storm Nate in mid-afternoon of the next day, Wednesday, September 7.

When Nate reached hurricane strength about 1300 on Thursday, September 8, the center of circulation was located about 80 miles north-northwest of Ciudad del Carmen and about 56 miles north-northeast of the *Trinity II*. Nate's broad wind field and slow forward motion over the shallow waters of the Bay of Campeche caused significant upwelling of cool water. This effect, combined with dry air, caused the hurricane's intensity to decrease to tropical storm force shortly after midnight on Friday, September 9 (figure 10).

[19] According to 46 CFR 4.06-3, alcohol testing following a serious marine accident must be conducted within 2 hours of the accident, unless precluded by safety concerns directly related to the accident. If more than 8 hours have passed following the accident, alcohol testing is not required. Drug-test specimens must be collected within 32 hours, unless precluded by safety concerns directly related to the accident. Title 46 CFR 4.03-2 defines serious marine accidents as resulting in any of the following: one or more deaths; injury to a crewmember, passenger, or other person that requires professional medical treatment beyond first aid, and, in the case of a person employed on board a vessel in commercial service, an injury that renders the individual unfit to perform routine vessel duties; damage to property in excess of $100,000; total loss of any vessel subject to inspection under 46 *United States Code* 3301, or total loss of any self-propelled vessel of 100 gross tons or more not subject to said inspection; discharge of 10,000 gallons of oil or more into US navigable waters, or discharge of a reportable quantity of a hazardous substance into US navigable waters or into the environment of the United States.

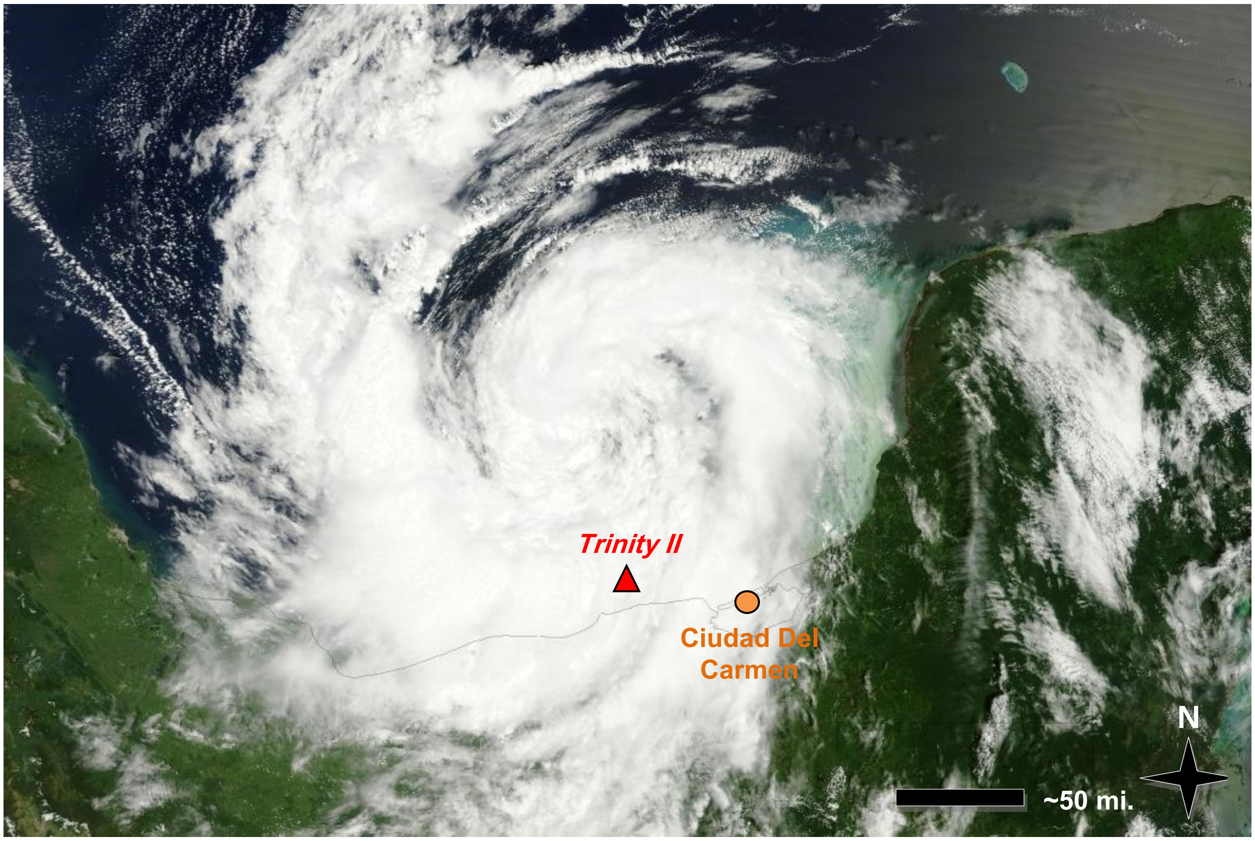

Figure 10. Tropical Storm Nate over the Bay of Campeche, September 9, 2011. Original satellite image by the National Aeronautics and Space Administration (NASA).

On September 11, about 1100, Nate made landfall north of Veracruz, Mexico, about 270 miles west-northwest of the accident location. The storm, which had sustained winds of about 45 mph at landfall, weakened rapidly. Later the same evening, the NHC classified Nate as a remnant low pressure system with winds less than 30 mph.

In a poststorm review, the NHC found that the formation and strengthening of Nate was "not particularly well forecast." On Tuesday morning, September 6, about 30 hours before the weather system reached tropical storm force, forecasters gave it only a 20 percent chance of tropical cyclone development. About 6 hours later, or only about 24 hours before the weather system reached tropical storm force, the likelihood had increased to "medium," or about 30–50 percent chance. Only about mid-morning on Wednesday, September 7, or about 6 hours before the storm officially formed, did the likelihood reach "high," or greater than 50 percent chance of tropical cyclone development. The actual wind speeds and wave heights associated with Nate were significantly greater than forecast.

1.8 Damage and Postaccident Testing

Damage to the *Trinity II* resulted from the high wind and waves that impacted the vessel before and after the stern leg failed. In addition, some damage likely resulted from the salvage actions undertaken after the men had abandoned the vessel and the storm had subsided. When the NTSB and Coast Guard investigators examined the vessel several weeks after the accident, it was not possible to determine exactly when and how the observed damage had occurred. In addition, after the vessel was returned to port in Ciudad del Carmen, Trinity Liftboats placed a caretaker crew on board who performed various housekeeping tasks that somewhat altered the postaccident condition of the vessel. The caretaker crew reported that a number of personal items and vessel equipment had been pilfered during the time when no Trinity personnel were on board the vessel after the accident.

The *Trinity II* remained berthed in Ciudad del Carmen until mid-March 2012, and was then returned to the United States. NTSB investigators examined the vessel during two separate visits to Mexico, each time with the cooperation of the Secretaría de Comunicaciones y Transportes (SCT; similar to the US Department of Transportation), whose role included overseeing vessel inspections. NTSB investigators also examined the *Trinity II* while it was drydocked in the United States before being repaired. The stern leg had fractured about 10 feet below the hull (figure 11). The two forward legs had broken off just below the hull, which occurred at some point after the stern leg failed as the vessel continued to be pounded by seas and winds (figure 12).

The Coast Guard originally intended to conduct metallurgical failure analysis of the stern leg, but as of the date of this report, testing had not occurred.

Figure 11. A section of *Trinity II*'s fractured stern leg.

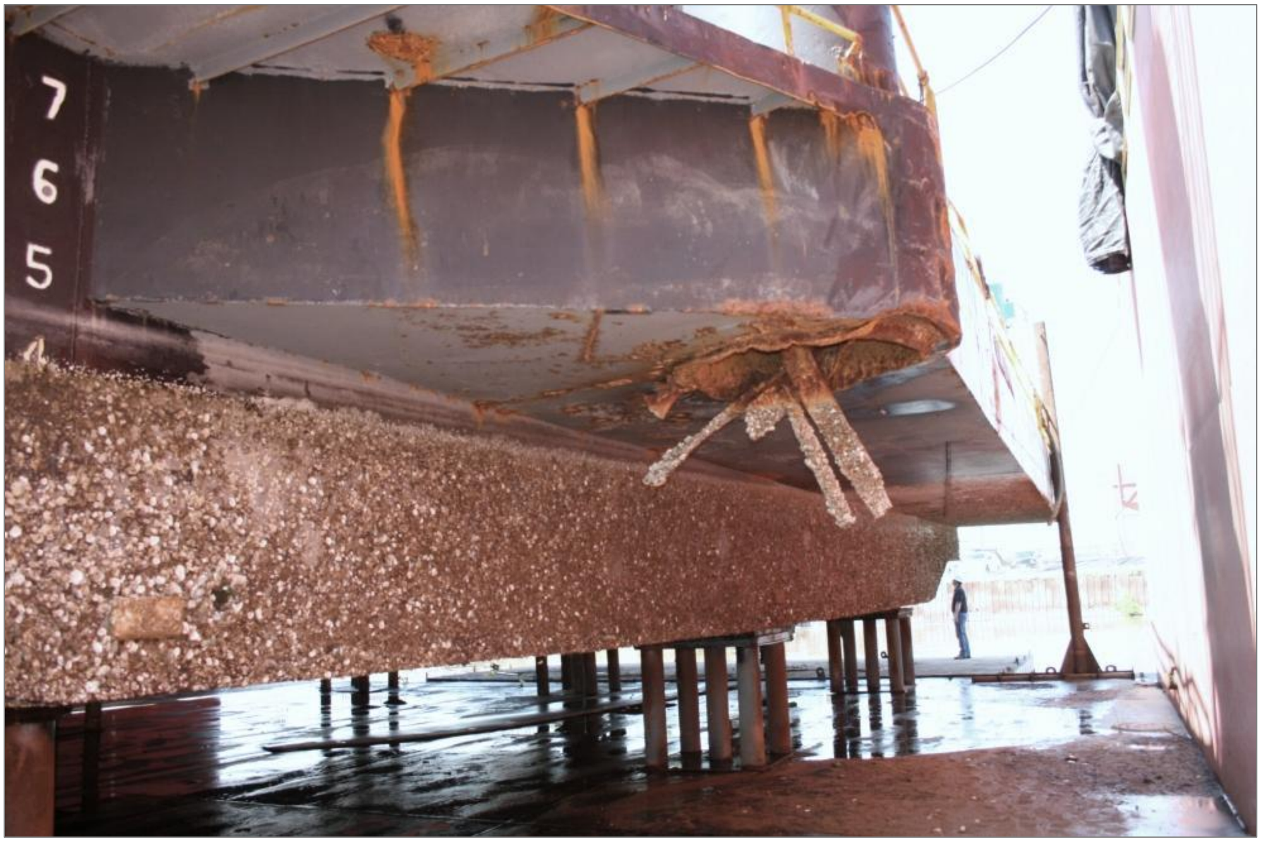

Figure 12. The fractured starboard-side leg at the lower end of the tower support structure.

Because the *Trinity II* was jacked up at the time of the accident, its propulsion and steering systems were not in use. Therefore, investigators did not test the functionality of those systems after the accident.

Several feet of sea water had flooded the machinery spaces, resulting in damage to the engineering systems.

The total damage to the *Trinity II* was estimated to be $1.5 million.

1.9 Waterway Information

The Bay of Campeche covers about 6,000 square miles of the southern Gulf of Mexico. The bay is fairly shallow, with most depths ranging between about 130 and 165 feet. Because large petroleum reserves lie underneath its sandy, gently sloping seafloor, the Bay of Campeche is one of Mexico's largest oil and gas producing areas. As a result of the high level of production, the Bay of Campeche is a busy waterway with dozens of oil and gas platforms. About 200–300 vessels, including fishing and charter vessels, operate in the area each day.[20]

[20] Information about the Bay of Campeche was obtained from Kongsberg Norcontrol IT; available at http://www.kongsberg.com/en/kds/kncit/systems/offshore-surveillance/collision_avoidance_system/bay%20of%20campeche/, accessed February 28, 2013.

1.10 Company Information

1.10.1 Trinity Liftboats

Trinity Liftboat Services, LLC, was formed in December 2009 and based in New Iberia, Louisiana. At the time of the accident, the company employed about 50 people ashore and afloat, including 11 masters and 10 mates, and operated five liftboats in the Gulf of Mexico.

1.10.2 Geokinetics

Geokinetics was formed in 1980 and specialized in seismic exploration along the US Gulf Coast, the US mountain regions, and Canada. Headquartered in Houston, Geokinetics operated in 29 countries, with employees from over 60 countries, providing primarily petrochemical exploration. The company's services included operations both on land and in shallow ocean water, transition zone seismic data acquisition, advanced processing, interpretation services, and an extensive multi-client data library.

As of the date of this report, Geokinetics was undergoing bankruptcy reorganization.

1.11 Personnel Information

1.11.1 *Trinity II*

Master. The *Trinity II* master, age 39, began working offshore at age 21 on small jack-up rigs that carried only two crewmembers. He earned his first Coast Guard license, a master's 100 gross tons, in October 1996 and began working as master in 1998. He worked on board vessels employed in construction, diving, and seismic surveys. In 2000, he began working on board the Global Industries vessel *Stingray* for a period of 10 years. Global sold the *Stingray* to Hercules, and the master then became a Hercules employee.

In late 2009, the master upgraded his Coast Guard license to a 200-ton master endorsement. About this time, Hercules began to cut back operations, and the president of Hercules left to form Trinity Liftboats. He then hired his former employee as the master of the *Trinity II*. The master was joined by the crew that was on board the *Trinity II* at the time of the accident; they were also former Hercules employees. On joining Trinity Liftboats, the master completed an offshore safety class. He had also received various other training, including but not limited to water survival, crane safety and maintenance, medic first aid, CPR, and liftboat stability.

The master told investigators that the work tour on board the *Trinity II* before the onset of the storm was uneventful and that operations went well. He was normally on duty from 0600 to 1200 and from 1800 to 2400 (the mate covered the other times). The master said that, because of the severe weather leading up to the accident, he had last slept on Tuesday morning, more than 48 hours before the accident. He had tried to sleep on Wednesday night but was unable to.

Mate. The mate of the *Trinity II*, age 31, died while awaiting rescue. His father, who was the Trinity Liftboats president, provided investigators with the following information.

The mate had worked through the ranks from deckhand before obtaining his Coast Guard license (a mate's 200 gross tons). He had worked on board the *Trinity II* from the time Trinity Liftboats took ownership of the vessel in November 2009. As mate, he was responsible to the master for the safe navigation and operation of the *Trinity II*, including elevating and lowering the vessel. In addition, he supervised the OS and the AB.

The mate had completed a variety of safety training courses. His license, which included a medical waiver, was most recently renewed in September 2009.

The mate's last sleep period ended at midnight on the morning of September 8, about 12 hours before the men abandoned ship. It is not known whether he slept during that period, and, if so, for how long.

Able-Bodied Seaman. The AB, age 32, joined Trinity Liftboats in December 2009 after leaving Hercules. His previous work experience included engine utility work on a jack-up rig for 4 years and vessel engine room work. He held a Coast Guard merchant mariner's document issued in February 2009, and had completed a variety of safety training courses.

The AB and the OS worked 12-hour shifts. The AB went to bed at 2130 on Wednesday evening before the abandonment and arose just before 0600 for his scheduled 0600 to 1800 shift. He told investigators that he had slept normally that week.

Ordinary Seaman. The OS, age 32, died while awaiting rescue. He held a Coast Guard merchant mariner document issued in December 2008, and had taken a variety of safety training courses.

1.11.2 Geokinetics

Six Geokinetics contractors (all of them non-US citizens) were on board the *Trinity II* at the time of the accident. A Bangladeshi citizen and an Australian citizen worked as the vessel's day and night navigators, respectively, directing the *Trinity II* during positioning and helping to obtain seismic data. Both navigators died following the vessel abandonment.

Two other Geokinetics contractors, both Mexican citizens, worked as QCs, checking the quality of the data received by the seismic cables. One of them also served as the Spanish-language translator, primarily during radio transmissions.

The remaining two Geokinetics contractors, also Mexican citizens, worked as the vessel's cook and cleaner.

1.12 Vessel Information

The *Trinity II* was built in 1982 as the *Southern Cross III* by Blue Streak Industries in Chalmette, Louisiana. A few years later, the vessel was renamed *Superior Focus* when Superior Energy Services LLC of New Iberia, Louisiana, purchased it. Trinity Liftboats bought the vessel in November 2009 and renamed it *Trinity II*. The company requested a new certificate of inspection for the vessel in January 2010.

The *Trinity II*'s gross tonnage was 185 tons. The hull was constructed of steel and was similar to that of a barge, in that its width-to-length ratio was fairly high, its draft relatively shallow, and the underside of the hull flat. Each of the vessel's two propellers was driven by a 12-cylinder, medium-speed diesel engine, rated at 450 horsepower, contained in two separate (port and starboard) rooms in the hull below the main deck. Also within the hull below the main deck were two electrical generators, other machinery, and various tanks (for fuel, fresh water, and saltwater ballast). The vessel had twin rudders positioned by an electro-hydraulic steering gear.

A welded steel, three-level deckhouse structure was fitted on the hull above the main deck. The first level contained the galley, mess area, laundry room, and food storage spaces. The second level had two multi-bunk spaces for the onboard personnel, a single-person cabin, a crew lounge area, and toilet/shower facilities. The third level contained the wheelhouse and individual cabins for the master, the mate, and the AB, along with toilet/shower facilities.

The vessel was equipped with two hydraulically operated pedestal cranes, one rated at 35 tons and the other at 7 tons. The 35-ton crane was mounted at the forward portside main deck and had a 90-foot-long fixed boom. The 7-ton crane was fitted on the starboard side, directly across from the larger crane, and had a 50-foot-long telescoping boom (see figure 3). The cranes were routinely used for transferring personnel on and off the vessel while it was jacked up, as well as for loading cargo. Stowed on the main deck of the hull was a portable container that housed the operating space for the seismic equipment operators.

The vessel's electronic equipment included a very high frequency (VHF) radio, a VHF radio telephone, an INMARSAT (International Maritime Satellite) telephone, a McMurdo AIS, a SI-TEX depth sounder, two global positioning system (GPS) units (Garmin and Furuno), a Furuno radar, a Furuno loudhailer, a Davis Vantage VUE anemometer, and a tilt alarm.

The Coast Guard certificated the *Trinity II* in accordance with 46 CFR Chapter I, Subchapter I, as "an offshore supply vessel with moveable legs capable of raising its hull above the surface of the sea." Because of the *Trinity II*'s length and gross tonnage, the vessel was not required to comply with the International Convention for the Safety of Life at Sea (SOLAS).[21] The Coast Guard had imposed the following restrictions on the vessel:

- Maximum operational water depth: 100 feet
- Maximum allowable draft: 6 feet
- Maximum wave height [when afloat/under way]: 5 feet
- Vessel shall not be trimmed by the bow at any time (draft at forward draft marks deeper than after draft marks)
- Route: Oceans, limited to Gulf of Mexico not more than 12 hours from harbor of safe refuge or location where the vessel may elevate to survive 115 mph winds.

[21] SOLAS is a major international treaty addressing the safety of merchant ships. The first version of the treaty was adopted in 1914 in response to the sinking of RMS *Titanic*; there have been a number of amendments since.

> [Therefore, when the vessel traveled between Louisiana and the Bay of Campeche, it transited along the coast on the western side of the Gulf of Mexico.]

With regard to operating restrictions, the *Trinity II*'s operating manual stated, "When elevated and operating, [the] vessel must be able to achieve a minimum 20 [foot] air gap [between the underside of the hull and the surface of the water] in the event of inclement weather. If this is not possible, due to a combination of water depth and penetration, the vessel master shall contact dispatcher immediately. … [If the weather was expected to deteriorate while the vessel was elevated, and sea conditions were such that elevating much higher would put the vessel at risk] then the vessel master shall jack the hull clear of expected maximum wave crests. If minimum leg length is available, jack as high as possible and consider a 15-foot air gap when no other limitation is applicable." The vessel's operating manual also included detailed procedures for various jacking and load testing.

Near the end of 2008, just 3 years before the accident, the *Trinity II*'s jacking legs and related gears had undergone an extensive examination. This type of examination, conducted at 10-year intervals, included removing the legs from the vessel, visually examining their interior and exterior, and measuring the steel thickness of the leg walls. According to information in the Coast Guard's vessel inspection file, the *Trinity II* had most recently undergone its annual inspection in February 2011. The Coast Guard did not find any problems with the leg elevation system.

2. Investigation and Analysis

2.1 Coordination of Search and Rescue Efforts

In accordance with an August 1989 diplomatic agreement between the United States and Mexico (Appendix B), Mexican authorities were in charge of the search and rescue (SAR) in the *Trinity II* accident because the vessel was located in Mexico's area of responsibility. The US Coast Guard began monitoring the case about 1240 on Thursday, September 8, after the Trinity vice president called the Eighth Coast Guard District ("Eighth District") in New Orleans, Louisiana, and told the staff that the vessel and some of its personnel were American.[22] About 10 minutes later, Eighth District staff contacted SEMAR's rescue coordination center in Tampico, Mexico (the designated center for the Eighth District to contact regarding activity in the Bay of Campeche). Eighth District staff relayed the information it had received and offered to assist in the response. The Coast Guard did not have any vessels near the accident location that could arrive in a reasonable amount of time, but did offer to send a C-130 aircraft from Clearwater, Florida, to the scene. SEMAR replied that it did not need assistance. About 1630 that afternoon, Eighth District staff followed up with SEMAR personnel, who stated that two SEMAR vessels (the 45-foot-long MLB-104 and MLB-105) were on scene and searching the accident area.[23]

During the morning of Friday, September 9, Eighth District staff applied additional pressure on SEMAR for information after hearing from a Louisiana senator's office expressing concern about the accident. At 1300, SEMAR informed the Eighth District that in addition to the two 45-foot-long vessels, it now also had three helicopters involved in the search. Later in the investigation, SEMAR provided the Eighth District with the following list of additional assets deployed on September 9:

- One MI 17 helicopter (AMHT-223)
- Two Panther helicopters (AMHP-151 and AMHP-152)
- Two motor lifeboats (BR-104 and BR-105)
- Five Interceptor patrol vessels (PI-1104, PI-1403, PI-1404, PI-1205, and PI-1406)
- One fixed-wing aircraft (AMT-212)

Also on September 9, in tropical storm-force conditions, searchers recovered two empty liferafts believed to be from the *Trinity II*. No persons were spotted in the water.

Eighth District staff continued to request SAR information from SEMAR. About 1120 on Saturday, September 10, SEMAR reported that its assets had searched 12,500 square miles of the

[22] The Eighth District's SAR area covers the Gulf of Mexico south of the United States down to the Mexico/Texas border, and eastward from the border across the Gulf.

[23] SEMAR managed the SAR effort from its main office in Mexico City, using local assets in Ciudad del Carmen and the Bay of Campeche.

16,900-square-mile search area, using six cutters, six helicopters, and one fixed-wing aircraft. SEMAR stated that it had also contracted five commercial helicopters to assist in the search, for a total of 12 aircraft conducting more than 80 search flights.

NTSB investigators later interviewed a Geokinetics manager who along with other company representatives traveled to Ciudad del Carmen to offer support. On Saturday, September 10, and Sunday, September 11, this manager observed some of the SAR activities, including PEMEX helicopter operations, but was not privy to planning and rescue strategy.

Eighth District watchstanders knew that SEMAR used the same SAR computer software program (the Search and Rescue Optimal Planning System, or “SAROPS”) that the Coast Guard uses for searches and for calculating potential drift patterns. During the SAR, Eighth District staff requested electronic files of SEMAR’s ongoing search patterns. SEMAR replied that it was unable to provide electronic files, but did send screen shots of its search patterns to the Eighth District. Eighth District staff later informed the NTSB that SEMAR’s Windows computer software was out of date, which prevented SEMAR from using the full functionality of its SAROPS software program, and was the reason SEMAR could provide only screen shots of its search patterns. Nevertheless, the search patterns in the SEMAR screen shots closely matched the search patterns that the Eighth District had calculated.

The Eighth District continued to request SEMAR’s permission to send the C-130 aircraft from Clearwater to assist in the search, including applying pressure through the Coast Guard’s attaché in Mexico City. Finally, at 1237 on Sunday, September 11, after receiving SEMAR’s approval, the aircraft departed Clearwater for the Bay of Campeche and eventually flew a search pattern generated by the Eighth District staff. About 10 minutes after the C-130 left Clearwater, SEMAR notified Eighth District staff that it had recovered the five persons at the lifefloat (four alive and one, the OS, deceased). Several hours later, searchers rescued three additional men and recovered the body of the mate.

In the following days, another Coast Guard C-130 from Clearwater conducted two search flights to help locate the final missing person, the night navigator. At 2043 on Thursday, September 15, SEMAR notified Eighth District staff that his body had been recovered.

2.2 Investigative Challenges

After the conclusion of the *Trinity II* SAR, the Coast Guard requested that the government of Mexico grant travel clearance for a team of Coast Guard and NTSB accident investigators (“joint team”) to enter Mexico and visit the accident area. About 5 weeks passed until the travel clearance was granted. Once in Ciudad del Carmen, the joint team requested to interview SEMAR personnel and obtain information about their SAR effort, but SEMAR declined.[24] In addition to SEMAR, PEMEX had played a prominent role in the *Trinity II* SAR, both through its Control Marino entity and its emergency response operations center, the Centro Regional de Atención a Emergencias (CRAE) in Ciudad del Carmen, which had been activated

[24] Several months later, after numerous requests through various channels, SEMAR provided NTSB some limited information, including a PowerPoint presentation containing basic information about the search and the assets that were deployed.

in response to the *Trinity II* accident.[25] During the visit in Mexico, the joint team was given a tour of the facilities at both Control Marino and CRAE, and was able to ask general questions about CRAE's capabilities and its *Trinity II* response. A CRAE representative told the joint team that, like SEMAR, CRAE had created search patterns based on the assumed drift direction of the *Trinity II*, and that SEMAR had stationed two of its personnel in the CRAE facility during the response. The CRAE representative also provided the joint team with a rough log of CRAE's response in the accident, which the Coast Guard's lead investigator translated to English. However, neither CRAE nor Control Marino permitted the joint team to collect pertinent documents/evidence or interview anyone who had been on watch during the search for the *Trinity II* personnel. Therefore, neither Coast Guard nor NTSB accident investigators were able to ascertain the training and background of the personnel who handled the search effort.

In addition, Coast Guard SAR personnel—a different group than the Coast Guard accident investigators[26]—conducted a review with SEMAR, per the latter's request, of SEMAR's proficiency in the SAROPS software, using the *Trinity II* response as part of the review. The Coast Guard SAR personnel produced a brief summary of the review, which they initially told both Coast Guard and NTSB accident investigators that they were unable to share with them. In March 2013, NTSB investigators were finally allowed to view the summary at Coast Guard headquarters in Washington, DC; however, investigators were not permitted to take a copy with them. The summary was limited in scope and suggested that SEMAR expand its proficiency in using all functions of SAROPS.

As a result of the limited information available from Coast Guard SAR personnel, SEMAR, and PEMEX, the NTSB's investigation of the *Trinity II* accident was hampered.[27] Neither Coast Guard nor NTSB accident investigators were able to ascertain how the search was planned and coordinated, and how this may have affected the rescue of the *Trinity II* personnel. (Also see section "3.4 Marine Investigative Cooperation.")

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[25] CRAE was originally founded to respond to a variety of emergencies, including terrorist threats, severe weather, oil spills, and vessel casualties. CRAE had developed plans for any type of situation that its responders were to follow.

[26] This team included personnel from the Eighth District and the Coast Guard's SAR school in Yorktown, Virginia.

[27] The NTSB also encountered difficulty obtaining SAR-related information from Mexican authorities while investigating the July 3, 2011, sinking of the fishing vessel M/V *Erik* in Mexican waters. Eight American citizens died in the accident. Neither Coast Guard nor NTSB investigators were granted travel clearance to enter Mexico to interview any of the 16 Mexican crewmembers, all of whom survived the sinking. Further, Mexican authorities did not allow investigators to interview the vessel's management company or the Mexican government about any safety standards that the *Erik* was required to meet.

2.3 Hurricane Planning

The *Trinity II* master had three sources of guidance for hurricane planning, including Trinity Liftboats' "Hurricane Preparation Plan" and Geokinetics' "Hurricane Response Plan." If neither Trinity Liftboats nor Geokinetics activated its hurricane plan during a severe weather situation—as was the case in this accident—then the master could consult the vessel-specific marine operations manual.

2.3.1 Trinity Liftboats

Trinity Liftboats' hurricane plan identified actions for the company vessel crews and shoreside personnel to take when weather threatened their operations. The plan had five action phases: Phase I was a general preparation phase for the hurricane season (June 1 to November 30). Phase II would be activated when the National Weather Service determined that a tropical disturbance or hurricane was entering "or going to enter the Gulf of Mexico." Shoreside management and vessel masters were then to heighten their weather monitoring. In Phase III, Trinity Liftboats was to decide whether to evacuate nonessential personnel based on the individual storm's projected path and severity. Phase IV would be activated when gale force winds (39–54 mph) were expected within 36 hours, and Trinity masters were to complete the removal of any remaining nonessential personnel from the vessels. Finally, Phase V would be activated when sustained winds of 55–73 mph were expected within 24 hours. At that stage, all aforementioned actions should have been completed.

In the case of Tropical Storm and then Hurricane Nate, Trinity Liftboats' management did monitor the weather conditions near the *Trinity II*; however, the rapid, local onset of storm conditions did not conform to the storm development described in the company's hurricane plan, so the plan was never activated.

2.3.2 Geokinetics

Similar to Trinity Liftboats' hurricane plan, Geokinetics' hurricane plan included phases and was based on the assumption that storms would enter the company's area of operation from the east, not developing locally. Stage 1 of the plan was a weather assessment and monitoring phase. Stage 2 was a partial evacuation phase should a storm's track come within 500 km of the project area. Stage 3 was a complete evacuation phase should a storm's track come within 250 km of the project area. Geokinetics' hurricane plan identified each vessel involved in the seismic operation, and suggested ports of refuge (including Ciudad del Carmen) for liftboats *Trinity I* and *Trinity II*. The plan acknowledged that the vessels Geokinetics employed in its work had varying abilities to maneuver and addressed these separately, but did not account for the extra time necessary to move the liftboats to safety.

Like Trinity Liftboats' hurricane plan, Geokinetics' hurricane plan was never activated in this accident, because the rapid local onset of storm conditions did not follow the pattern of a storm approaching from the east, as prescribed in the plan. (Also see section "2.5.2 Postaccident Action; Geokinetics.")

2.3.3 Vessel-Specific Marine Operations Manual

In the absence of an activated hurricane plan, Trinity masters could consult the Coast Guard-approved vessel-specific marine operations manual. Section 6 of that document provided guidance both for operating in tropical weather systems (hurricanes) and in general "heavy weather." The manual outlined four phases. Phase 1 was an alert phase once a disturbance had been identified and appeared to be headed for the Gulf of Mexico. In this phase, the master would begin preparations and closely track the storm. Phase 2 was a preparation and shutdown phase, in which the master would either jack down the vessel and move to a safe refuge, or jack up the vessel to an air gap that would exceed the predicted maximum wave height. Phase 3 was the storm phase, which specified that if the vessel was in the direct path of the storm, the master should have the vessel evacuated, the generator prepared for an extended time on line, and all watertight doors secured, with locks if possible. Phase 4 was a recovery phase, during which personnel were to report back to their vessels.

It is not known whether the *Trinity II* master specifically referenced the vessel operations manual while the storm developed. Regardless, given that the wave height had already exceeded the vessel's 5-foot sea state restriction by the time it was evident that the surface low pressure system was strengthening further, his only options were to jack the liftboat higher and, subsequently, request an evacuation, both of which he did. (Also see section "3.5 Weather Preparedness.")

2.4 Previous NTSB Action on Liftboat Accidents

On July 30, 1989, the US liftboat *AVCO V* sank off the coast of Leeville, Louisiana, as a result of severe weather associated with Hurricane Chantal (NTSB 1991). When the accident occurred, the master was attempting to return the vessel, which had been conducting work for Chevron, to port in Leeville. However, rough waves impacting the starboard-side hull caused equipment on deck to shift, which in turn made the vessel list, capsize, and sink. Ten of the 14 persons on board died in the accident. As a result of its investigation of the *AVCO V* accident, the NTSB issued Safety Recommendation M-91-13 to the Coast Guard:

> Require that liftboats have on board a severe weather action plan that is tailored to the operating characteristics and limitations of the vessel.

In November 1996, after the Coast Guard issued regulations (codified at 46 CFR 134.170(b)(6)) requiring heavy weather-related guidance to be included in liftboat operations manuals, the NTSB classified Safety Recommendation M-91-13 "Closed—Acceptable Action."

The NTSB also issued Safety Recommendation M-91-16 to the owner of *AVCO V*, Avis Bourg & Company, Inc., asking the company to provide its liftboats with weather action plans. Because the company went out of business after the accident, the NTSB classified the recommendation "Closed—No Longer Applicable" in June 1993.

Finally, the NTSB issued Safety Recommendation M-91-19 to Chevron, the company that had chartered the *AVCO V*:

> Prepare and include in the Chevron Hurricane Action Plan a system that considers the sea and weather operating limitations of liftboats; use this system as guidance for evacuating personnel from such vessels or for releasing such vessels to seek shelter during predicted deteriorating weather.

Chevron concurred and informed the NTSB that it had implemented a revised plan that complied with the recommendation. As a result, the NTSB classified Safety Recommendation M-91-19 “Closed—Acceptable Action” in June 1992.

2.5 Postaccident Action

2.5.1 Trinity Liftboats

Following the accident, the Trinity president informed the NTSB that before operating in international or foreign waters again, Trinity Liftboats would consider the adequacy of its customer’s emergency/evacuation plans; the local and national government’s emergency assistance capability; adding an additional EPIRB to each Trinity vessel; assessing the feasibility of adding personal locator beacons on each lifejacket; and the feasibility of Trinity Liftboats to employ a standby vessel under the control of a Trinity master. These steps, if implemented as the Trinity president stated, would improve safety. However, as of the date of this report, Trinity Liftboats had operated only in US waters since the *Trinity II* accident, and had thus not implemented the proposed improvements. Further, the company’s hurricane plan—which was not specific to foreign or US domestic operations—remained unchanged.

2.5.2 Geokinetics

After the accident, Geokinetics halted all operations at the worksite in the Bay of Campeche to review its operational safety. According to Geokinetics, the company implemented several organizational and procedural changes to improve safety, including but not limited to:

- Hiring a dedicated marine operations manager for improved oversight of offshore operations,
- Relocating project managers offshore,
- Appointing dedicated fleet managers and stationing them offshore,
- Creating a dedicated weather monitoring department, including a meteorologist,
- Providing training in accordance with the International Convention on Standards of Training, Certification and Watchkeeping (STCW) for all personnel,
- “Re-auditing” all vessels and subcontractors, and
- Replacing liftboats with four-point-anchored vessels because of the operating limitations liftboats are subject to.

Geokinetics also revised its hurricane plan for the Bay of Campeche operations to include a watch circle instead of an east-facing tropical storm watch area, which was an improvement. However, the revised plan still required the actual formation of a named storm before implementation, stating that personnel "shall activate [the] hurricane plan once the radius of tropical storm force winds or greater begin to have an effect on the prospect area." The revised plan did not address the risk posed by surface low pressure systems. (Also see section "3.5 Weather Preparedness.")

3. Safety Issues

The surviving two *Trinity II* crewmembers (the master and the AB) told investigators that the crew had not experienced any mechanical problems with the vessel before the stern jacking leg jammed. Further, the vessel's log books and daily reports did not mention any mechanical problems leading up to the leg jamming. The vessel had undergone its most recent Coast Guard inspection in February 2011, and the Coast Guard had approved the vessel for service. Therefore, the NTSB concludes that the mechanical condition of the vessel before the onset of the storm was not a factor in the accident.

3.1 Stern Leg Failure

Neither previous nor current design standards require that liftboats be able to sustain waves impacting the hull (only the legs). The standards assume that liftboats will be able to elevate the hull above the waves. However, although liftboat design standards do not consider the effect on the jacking legs when waves impact the hull, a recent study (El Moctar, Schellin, and Zorn, 2011) has shown that the theoretical loads on legs of a large jack-up platform are about two times higher when the hull is impacted by waves compared to waves impacting the legs only.

In the case of the *Trinity II* leg failure, the vessel was subjected to wave impact forces on its hull. These forces, combined with the weight of water on deck from the boarding seas, likely caused the stern leg to fail. However, because of lack of information on the magnitude of the waves and the extent of the vessel's lateral movement, and because the condition of the seafloor and the exact amount of leg penetration are unknown, the leg failure could not be validated through modeling. In addition, the Coast Guard's design review files contained "incomplete calculations provided by industry," and metallurgical examination of the stern leg had not been conducted. As a result, other factors, such as design errors or fabrication/material defects, could not be excluded. Therefore, the NTSB concludes that the stern jacking leg of the *Trinity II* likely failed because it was subjected both to lateral forces from waves impacting the vessel's hull and to additional weight from water on deck, and this loading exceeded the stern leg's strength.

3.2 Survival Aspects

3.2.1 Personnel Abandonment of the *Trinity II*

Although the stern leg collapsed, causing the vessel to heel significantly, the *Trinity II* did not end up capsizing as the master feared it would. In hindsight, riding out the storm on board the vessel would therefore have been an option, and, in this case, likely the best one. However, given the circumstances and the conditions that the men were experiencing at the time, it is understandable that the master ordered everyone on board to abandon ship. First, they were relatively close to shore, only about 15 miles, and their location was known to others in the area and to Geokinetics and Trinity Liftboats management. Further, several oil platforms, vessels, and helicopters were in the area to assist once the weather improved. Also, the water and air temperatures were very mild, and the personnel likely did not expect to be in the water for a long time. The NTSB therefore concludes that the master's decision that all personnel on board the *Trinity II* abandon the vessel once the stern leg failed was understandable, given the context of the situation.

Investigators examined the steps that the personnel took leading up to the vessel abandonment and during their time in the water to determine how their actions affected their survivability.

According to the master, he briefed everyone on board about the possibility of abandoning the vessel and the procedures for doing so. This type of planning is essential because reviewing procedures allows all involved to prepare and reduces the possibility of mistakes being made. The master and the AB told investigators that they and the other crewmembers began preparing for the abandonment by gathering essential items like food, water, and flares. These actions were appropriate, but unfortunately, in gathering supplies, the crewmembers did not take the EPIRB with them, an essential piece of lifesaving equipment.

When the master gave the order to abandon ship after the stern leg failed, all persons on board made their way to the main deck. After both of the inflatable liferafts were lost, the cook and another Geokinetics contractor took the initiative to retrieve one of the three lifefloats carried on board. All personnel then abandoned the vessel into the water and held on to the lifefloat grab lines. The fact that all 10 persons were able to remain together for several hours in heavy seas and high winds was a noteworthy accomplishment. However, the failure to take essential supplies with them—such as the EPIRB and the food, water, and emergency flares that the men had prepared before abandoning the vessel—greatly affected their survivability. The master told investigators that he forgot about the EPIRB until he was down on the main deck. He said that he went back to retrieve it but that the crane was moving so much in its cradle that he did not believe he could safely retrieve the EPIRB. After the accident, investigators examined the EPIRB, which they located in its case on the bridge wing, undamaged. The master had not been able to sleep for about 48 hours at the time of the abandonment, and some of the other men were likely sleep-deprived as well. Their aggregate exhaustion and stress level may explain why the safety equipment and supplies were left behind. Therefore, the NTSB concludes that the actions taken by the *Trinity II* crewmembers when abandoning the vessel were of limited effectiveness because the stressed and exhausted crew did not make use of all available safety equipment and supplies, and this reduced the personnel's probability of survival.

According to the EPIRB manufacturer, the typical time for the signal to reach authorities was less than 1 hour, with a resulting search radius of about 2.6 miles. If the *Trinity II* crewmembers had taken the EPIRB with them and activated it when abandoning the vessel, the signal from the EPIRB would have allowed SEMAR to narrow its search area and reduce the search time significantly. The NTSB therefore concludes that, had the *Trinity II* crewmembers brought along and activated the EPIRB when the personnel abandoned the vessel, it would have aided the Mexican SAR effort and shortened the time the personnel had to spend in the water, thus increasing their probability of survival.

3.2.2 Inflating Liferaft on Deck

The two inflatable liferafts, which were equipped with nonperishable food, drinking water, thermal protection sheets, and other important lifesaving supplies, had been newly installed on board the *Trinity II* as a Coast Guard requirement for the voyage to Mexico. The four Trinity crewmembers had received prior training in using lifesaving equipment such as liferafts. However, whenever new safety equipment is installed on board a vessel, it is important for crews to review the procedures for operating it. In this case, the crewmembers should have reviewed how to launch the liferafts from the vessel's elevated position and incorporated these procedures into emergency drills, but the crew did not do so effectively.

Moreover, the instructions for launching the liferafts were posted below the cradles that contained the liferafts, and illustrated that the liferaft canisters should be thrown into the water before inflating the rafts. Had the crewmembers inflated the first (starboard) of the two liferafts in accordance with the instructions, that liferaft likely would have been available when the men abandoned the vessel. However, because the crewmembers inflated that liferaft on deck, they exposed it to hurricane-force winds that caught the liferaft and blew it away from the vessel. The second liferaft (port) was also lost after inflating while still on board the vessel. Both liferafts vanished in the rough seas, along with the vital supplies they contained. The NTSB therefore concludes that the inappropriate decision to inflate the starboard-side liferaft on deck, and the inadvertent loss of the portside liferaft, led to the loss of both of the vessel's available out-of-water flotation devices and the additional lifesaving supplies contained therein. Inflating a liferaft on deck risks puncturing the liferaft on vessel structures and equipment, especially if deck space is limited. Also, as seen in this case, liferafts out of the water are very vulnerable in windy conditions. The only time a liferaft should be inflated out of the water is if the liferaft is launched by a davit.

As a result of the breakdowns identified in this vessel abandonment, the NTSB issued a safety alert to mariners covering several important aspects of survival.[28] The NTSB recommends that the Coast Guard distribute the NTSB's safety alert to mariners, and make clear that non-davit-launched liferafts should not be inflated out of the water, especially in high wind conditions, as this may lead to the loss of the liferaft. The NTSB also recommends that the Offshore Marine Service Association (OMSA) inform its members about the circumstances of this accident, and make clear that non-davit-launched liferafts should not be inflated out of the water, especially in high wind conditions, as this may lead to the loss of the liferaft.

3.2.3 Survival at Sea

The severe weather that the personnel experienced following the abandonment forced them to expend a great deal of energy to stay together. Because they did not have out-of-water flotation, the men were submersed in the water, which slowly lowered their body temperatures. Coupled with a lack of food and water, the toll that these factors took on the personnel became evident on Friday evening, when the night navigator became separated from the group and later died. His described behavior is consistent with both exhaustion and the early stages of hypothermia. The condition of the other men also deteriorated as time progressed. On Sunday, half of the remaining personnel decided to swim toward a platform in the distance; however, this attempt served only to further weaken them. The swimmers did not reach the platform, expended a great deal of energy in the process, and split themselves up further, making it more difficult for searchers to locate them. In fact, the group that remained with the lifefloat was found several hours before the group that swam. Despite a sustained effort by all of the men in extremely challenging circumstances, four of them died. The NTSB concludes that the

[28] The safety alert, titled "Mariners: Improve Your Chances of Survival When Abandoning Ship" (SA-024), can be accessed at http://www.ntsb.gov/safety/safety_alerts.html.

fatalities resulted from prolonged exposure due to lack of out-of-water flotation, combined with no available food and water.

3.3 Search and Rescue

The Eighth Coast Guard District in New Orleans learned of the accident from Trinity Liftboats. After reviewing the accident location, Eighth District personnel determined that it lay within Mexico’s jurisdiction in accordance with the international SAR agreement. Eighth District personnel contacted SEMAR to be sure that it knew about the accident and offered assistance if needed. SEMAR was already aware of the situation, had begun SAR efforts, and declined Coast Guard assistance. The Coast Guard continued to monitor the Mexican response and offered assistance repeatedly over the entire 3-day search. It created its own drift patterns, compared them to those received from SEMAR, and found them to be similar. Three days into the search, SEMAR consented to the Coast Guard sending a C-130 aircraft to take part in the search.

While in Ciudad del Carmen, Coast Guard and NTSB investigators attempted to interview SEMAR personnel and obtain information about their SAR effort, but SEMAR declined to participate. After numerous requests through various official channels, SEMAR provided investigators with a PowerPoint presentation containing basic information about the search and the assets that were deployed. Investigators were not able to ascertain the training and background of the SEMAR personnel who handled the search effort, nor any additional information about how the search was planned and coordinated. The NTSB therefore concludes that limited access to information about the Mexican SAR effort prevented accident investigators from assessing its effectiveness.

3.4 Marine Investigative Cooperation

The challenges that Coast Guard and NTSB accident investigators encountered during the *Trinity II* investigation were also evident during the 2011 investigation of the sinking of fishing vessel M/V *Erik* in Mexican waters. In that case, the government of Mexico never even granted investigators travel clearance to enter the country. Investigators were also not permitted to interview any of the *Erik*’s 16 surviving crewmembers or the vessel’s management company. In the *Trinity II* case, neither NTSB nor Coast Guard investigators were able to access enough information to determine the roles and responsibilities in the Mexican SAR effort and the details of how the search was conducted. The NTSB concludes that, going forward, marine safety would be better served by improved marine investigative cooperation between the governments of Mexico and the United States. The NTSB therefore recommends that the Coast Guard work with the US Department of State to develop a written agreement between the government of Mexico, the US Coast Guard, and the NTSB that will ensure mutuality with regard to: timely accident notification; expeditious access to accident sites; unimpeded ability to gather evidence, interview witnesses, and establish facts; logistical assistance on scene; and continuing liaison so that problems and differences are minimized and promptly resolved. The NTSB further recommends that the US Department of State work with the US Coast Guard to develop a written agreement between the government of Mexico, the US Coast Guard, and the NTSB that will ensure mutuality with regard to: timely accident notification; expeditious access to accident sites; unimpeded ability to gather evidence, interview witnesses, and establish facts; logistical assistance on scene; and continuing liaison so that problems and differences are minimized and promptly resolved.

3.5 Weather Preparedness

In the days leading up to the accident, the *Trinity II* master monitored the weather forecasts, which at first predicted only the development of a surface low pressure system, not a named tropical system. However, in the mere 1-day interval between NHC's and FleetWeather's forecasts of Tuesday morning, September 6, and Wednesday morning, September 7, the surface low pressure system's likelihood of developing into a tropical cyclone changed from "low" to "high." By that time, the wave height in the *Trinity II*'s location had already increased beyond the liftboat's 5-foot sea state restriction (afloat/under way). The crewmembers' option to move the vessel was by that point eliminated, and the remaining alternatives were to elevate the liftboat higher and/or evacuate the personnel.

Although both Geokinetics and Trinity Liftboats had company hurricane plans, these would be activated only if the forecast identified a weather system that would likely become a named tropical storm or hurricane. Neither plan addressed surface low pressure systems, which, from a meteorological perspective, have the potential to further develop and strengthen given the right atmospheric conditions. Further, neither Trinity Liftboats' nor Geokinetics' hurricane plans adequately addressed the concept of a hurricane developing locally near the site, but instead assumed there would be sufficient time to maneuver the liftboats to safe harbor based on the advance warning of storms approaching from the east. Although the majority of named tropical weather systems that affect the Gulf of Mexico travel from east to west, and although vessel personnel usually have sufficient time to prepare, in this case, Tropical Storm and then Hurricane Nate developed locally—and somewhat unexpectedly—from a surface low pressure system in the Bay of Campeche. As a result, few personnel who worked on stationary platforms had enough advance warning to evacuate to shore.

As seen in both the *AVCO V* and *Trinity II* accidents, weather preparedness plans should take into account the time required both to move a particular vessel and/or evacuate its personnel. Further, the plans should not assume that tropical weather systems will approach from the east. As the *Trinity II* accident demonstrated, locally developing weather systems—in this case, a surface low pressure system that strengthened into a hurricane—pose a threat to slow-moving and/or otherwise limited vessels. The NTSB therefore concludes that the weather preparedness plans of Trinity Liftboats and Geokinetics in place at the time of the accident did not adequately address weather systems such as rapidly developing surface low pressure systems and nontropical storms, nor the operational limitations of each individual vessel. The NTSB therefore recommends that Trinity Liftboats and Geokinetics revise their weather preparedness plans to include weather planning for surface low pressure systems, nontropical storms, and vessel operational limitations. The NTSB further recommends that OMSA advise its members to ensure that their weather planning takes into account surface low pressure systems, nontropical storms, and vessel operational limitations.

4. Conclusions

4.1 Findings

1. The mechanical condition of the vessel before the onset of the storm was not a factor in the accident.

2. The stern jacking leg of the *Trinity II* likely failed because it was subjected both to lateral forces from waves impacting the vessel's hull and to additional weight from water on deck, and this loading exceeded the stern leg's strength.

3. The master's decision that all personnel on board the *Trinity II* abandon the vessel once the stern leg failed was understandable, given the context of the situation.

4. The actions taken by the *Trinity II* crewmembers when abandoning the vessel were of limited effectiveness because the stressed and exhausted crew did not make use of all available safety equipment and supplies, and this reduced the personnel's probability of survival.

5. Had the *Trinity II* crewmembers brought along and activated the emergency position indicating radio beacon when the personnel abandoned the vessel, it would have aided the Mexican search and rescue effort and shortened the time the personnel had to spend in the water, thus increasing their probability of survival.

6. The inappropriate decision to inflate the starboard-side liferaft on deck, and the inadvertent loss of the portside liferaft, led to the loss of both of the vessel's available out-of-water flotation devices and the additional lifesaving supplies contained therein.

7. The fatalities resulted from prolonged exposure due to lack of out-of-water flotation, combined with no available food and water.

8. Limited access to information about the Mexican search and rescue effort prevented accident investigators from assessing its effectiveness.

9. Marine safety would be better served by improved marine investigative cooperation between the governments of Mexico and the United States.

10. The weather preparedness plans of Trinity Liftboats and Geokinetics in place at the time of the accident did not adequately address weather systems such as rapidly developing surface low pressure systems and nontropical storms, nor the operational limitations of each individual vessel.

4.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of Trinity Liftboats (the vessel owner/operator) and Geokinetics (the chartering organization) to adequately plan for the risks associated with a rapidly developing surface low pressure weather system, which ultimately subjected the elevated liftboat to hurricane-force conditions, causing the stern jacking leg to fail and the onboard personnel to abandon the vessel. Contributing to the injuries and fatalities was the failure of the *Trinity II* crewmembers to make effective use of the vessel's available lifesaving equipment, resulting in the personnel's prolonged exposure to the elements while awaiting rescue.

5. Recommendations

To the US Coast Guard:

1. Distribute the National Transportation Safety Board's safety alert to mariners, and make clear that non-davit-launched liferafts should not be inflated out of the water, especially in high wind conditions, as this may lead to the loss of the liferaft. (M-13-1)

2. Work with the US Department of State to develop a written agreement between the government of Mexico, the US Coast Guard, and the National Transportation Safety Board that will ensure mutuality with regard to: timely accident notification; expeditious access to accident sites; unimpeded ability to gather evidence, interview witnesses, and establish facts; logistical assistance on scene; and continuing liaison so that problems and differences are minimized and promptly resolved. (M-13-2)

To the US Department of State:

3. Work with the US Coast Guard to develop a written agreement between the government of Mexico, the US Coast Guard, and the National Transportation Safety Board that will ensure mutuality with regard to: timely accident notification; expeditious access to accident sites; unimpeded ability to gather evidence, interview witnesses, and establish facts; logistical assistance on scene; and continuing liaison so that problems and differences are minimized and promptly resolved. (M-13-3)

To Trinity Liftboats and Geokinetics:

4. Revise your weather preparedness plan to include weather planning for surface low pressure systems, nontropical storms, and vessel operational limitations. (M-13-4)

To the Offshore Marine Service Association:

5. Inform your members about the circumstances of this accident, and make clear that non-davit-launched liferafts should not be inflated out of the water, especially in high wind conditions, as this may lead to the loss of the liferaft. (M-13-5)

6. Advise your members to ensure that their weather planning takes into account surface low pressure systems, nontropical storms, and vessel operational limitations. (M-13-6)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

DEBORAH A.P. HERSMAN
Chairman

ROBERT L. SUMWALT
Member

CHRISTOPHER A. HART
Vice Chairman

MARK R. ROSEKIND
Member

EARL F. WEENER
Member

Adopted: April 9, 2013

6. Appendixes

Appendix A

The NTSB learned of the accident from the Coast Guard on September 13, 2011. Three investigators with the Office of Marine Safety arrived in Louisiana on September 16 and joined the Coast Guard's formal investigation. Investigators interviewed some of the survivors at Trinity Liftboats headquarters in New Iberia. On September 25, the NTSB team returned from the initial launch. About 1 month later, October 27–30, a team of NTSB and Coast Guard investigators traveled to Mexico to interview witnesses and to examine the *Trinity II*. Investigators interviewed Geokinetics and Trinity personnel at Geokinetics' project base in Frontera, and examined the vessel at its berth in Ciudad del Carmen. The team made a second trip to Mexico December 5–9 to interview additional Geokinetics personnel in Mexico City and Villa Hermosa, and to once again examine the vessel in Ciudad del Carmen. Both visits to Mexico were coordinated with the SCT. After returning from this trip, investigators also interviewed senior Geokinetics managers in Houston on December 10.

In late January 2012, investigators traveled to New Orleans to interview Eighth Coast Guard District personnel involved in the US search and rescue response. Finally, in early February 2012, investigators made a third trip to Mexico to interview three additional Geokinetics personnel in Villa Hermosa.

In March 2012, the Coast Guard canceled plans to hold formal hearings (normally part of the formal investigation process) and downgraded the investigation category to "informal."

Appendix B

AGREEMENT BETWEEN
THE GOVERNMENT OF THE UNITED STATES OF AMERICA
AND
THE GOVERNMENT OF THE UNITED MEXICAN STATES
ON MARITIME SEARCH AND RESCUE

The Government of the United States of America and the Government of the United Mexican States:

NOTING the great importance of rendering assistance to persons in distress at sea; and

RECOGNIZING that the 1935 Convention between the United States of America and the United Mexican States for the Assistance to and Salvage of Vessels in Territorial Waters, and the 1979 International Convention on Maritime Search and Rescue,[1] provide a sound basis for improving cooperation in the field of maritime search and rescue;

Have agreed as follows:

ARTICLE I

Purpose

The purpose of this Agreement is to set forth guidelines for cooperation between the maritime search and rescue authorities of the Governments of the United States of America (hereinafter United States) and the United Mexican States (hereinafter Mexico) in responding to or coordinating the response to distress cases in which life or property is threatened at sea.

Article II

Operational Entities

A. The United States Coast Guard and the Mexican Navy, respectively, are the recognized authorities in the United States and Mexico for matters relating to maritime search and rescue. As the unified organizations in their nations responsible for the maintenance and safety of life and property at sea, the United States Coast Guard and the Mexican Navy may respond to a wide variety of incidents at sea without regard to the nationality of those in danger or distress. Resources of the Parties for coordinating and responding to such incidents include rescue coordination centers, rescue vessels, and rescue aircraft.

[1] TS 905; TIAS 11093; 9 Bevans 1015.

B. It is recognized that both the United States Coast Guard and the Mexican Navy have other responsibilities in addition to safety of life and property at sea. The availability of resources to respond to specific incidents is understood to be dependent upon funding and the requirements of other missions.

ARTICLE III

Cooperation in Search and Rescue

A. Exchange of Information

To the extent that it contributes to increased effectiveness of maritime search and rescue or to preventing the need for such search and rescue, available information will be freely exchanged between the United States Coast Guard and the Mexican Navy. The exchange will include but not be limited to information about the following areas for each Party:

1. Search and rescue agency organization.

2. Rescue coordination centers, including locations, areas of responsibility, TELEX numbers, telephone numbers, and other capabilities for communications in general.

3. Search and rescue procedures and facilities.

4. Special services available (e.g. the Automated Mutual-assistance Vessel Rescue System (AMVER), Computer-aided Search Planning (CASP), medical facilities, fueling facilities, etc.).

5. International search and rescue projects of common interest.

6. Search and rescue-related technical information, including results of and plans for research and development.

7. Development and operation of vessel reporting systems to be used exclusively for search and rescue purposes.

B. Search and Rescue Operations

The United States Coast Guard and the Mexican Navy will work both jointly and independently to the extent practicable to facilitate cooperation in search and rescue, to improve search and rescue response capabilities, and to enhance safety at sea. Such efforts will include but not be limited to the following areas:

1. Development, establishment, and use of common search and rescue procedures, including procedures for requesting and rendering search and rescue assistance, and ensuring the closest practicable coordination between the maritime rescue coordination centers of the United States Coast Guard and the Mexi-

can Navy. It is understood that, once a rescue coordination center of one Party requests assistance in a search and rescue case from the other Party, each rescue coordination center will keep the other informed of the progress and outcome of the case.

2. Provision for prompt permission for entry of search and rescue units of one Party into or over the territorial sea of the other Party as required.

3. Arrangement for rescue units to respond from both the United States Coast Guard and the Mexican Navy, if appropriate, to effectively handle a case of distress at sea.

4. Establishment of means of communication to be used in joint search and rescue operations, using internationally designated distress and calling frequencies, designating common working frequencies, and providing for checks of communication channels if needed.

5. Establishment of appropriate and reliable lines of communication between the rescue coordination centers of the United States Coast Guard and the Mexican Navy. Such communications will normally be accomplished via TELEX to facilitate translation. However, recognizing the value of timely search and rescue communications, the United States Coast Guard and the Mexican Navy shall each designate two rescue coordination centers, one near the Pacific Coast and one near the Gulf Coast, and arrange to have a bilingual (Spanish and English-speaking) person on call at these rescue coordination centers to assist with search and rescue communications when appropriate.

6. Under guidelines established for the use of AMVER and CASP, or for similar United States or Mexican resources, information will be provided to assist other recognized rescue coordination centers in coordinating search and rescue cases.

7. When necessary to help ensure the continuity or success of a search and rescue case, rescue coordination centers of each Party will make arrangements for rescue vessels or aircraft of the other Party to purchase fuel, to make use of appropriate medical facilities, or to receive other reasonable and appropriate assistance.

C. Liaison

To help satisfy the intent of this Agreement, on-going cooperative relationships will be maintained between the United States Coast Guard and the Mexican Navy. Such liaison efforts should include the following areas:

1. Visits between the United States Coast Guard and Mexican Navy search and rescue program managers and rescue coordination center personnel.

2. Cooperation as appropriate on international search and rescue projects of common interest, particularly those sponsored by the Governments of the United States or Mexico, or the International Maritime Organization.

3. Conduct of regional search and rescue conferences, as necessary, to maintain effective coordination of search and rescue services.

4. Cooperation in search and rescue training efforts with other maritime and aeronautical search and rescue organizations periodically and as opportunities arise.

5. Sharing in the development of state-of-the-art search and rescue procedures, techniques, communications, life support systems, survival equipment, facilities, and emergency care.

ARTICLE IV

Search and Rescue Regions

A. Maritime search and rescue regions are established solely to help ensure that proper and efficient search and rescue coverage and coordination is provided for defined areas, and to effect an understanding between the Parties as to the areas in which each Party has primary responsibility for the coordination of maritime search and rescue cases.

B. Search and rescue regions are not intended to relate to or prejudice the establishment of international boundaries or national jurisdictions. Each Party shall conduct or coordinate search and rescue operations to assist persons and property in danger or distress at sea within its respective search and rescue region, or in the search and rescue region of the other Party, in accordance with the terms of this Agreement.

C. Search and rescue regions of the United States and Mexico will be separated by the international maritime boundary between the two countries, as defined in the exchange of diplomatic notes of November 24, 1976.[1]

ARTICLE V

Implementation

Specific information and procedures regarding implementation of this Agreement will be jointly developed by the United States Coast Guard and the Mexican Navy.

[1] TIAS 8005; 29 UST 196.

ARTICLE VI

Application of National and International Laws

Nothing in this Agreement is intended to amend applicable national laws or regulations. Likewise, nothing in this Agreement shall affect in any way the rights and duties based on treaties and other international agreements and understandings pertaining to the United States or Mexico.

ARTICLE VII

Use of Other Units on Search and Rescue Operations

Both Parties recognize that, at times, the United States Coast Guard makes use of available non-United States Coast Guard units in lieu of, or in addition to, United States Coast Guard units, in responding to existing or potential maritime distress situations. Such units may include, but are not limited to, privately-owned Coast Guard Auxiliary resources and available merchant vessels. Similarly, the Mexican Navy may use non-Navy resources for search and rescue. The United States Coast Guard and the Mexican Navy undertake, for purposes of this Agreement, to treat such units as falling under the terms of this agreement, when they are identified by a United States Coast Guard or Mexican Navy rescue coordination center as acting under the orders and direction of the rescue coordination center on a specific search and rescue mission.

ARTICLE VIII

Diversion of Search and Rescue Units

If, for any reason, units on a search and rescue mission are diverted to another mission while in or near the territory of the other Party, the rescue coordination center of the Party responsible for that territory will be immediately notified by the rescue coordination center of the diverted units, and the units no longer involved in the original mission will immediately depart the territory of the other Party, or follow clearance procedures applicable to the new mission.

ARTICLE IX

Entry into Force, Duration and Amendment

This Agreement shall enter into force on the date both Parties communicate in writing through diplomatic channels that they have satisfied their necessary domestic legal requirements.[1] The Agreement may be amended by mutual written agreement between the Parties, and such amendment shall enter into force on the

[1] June 25, 1990.

date the Parties communicate in writing through diplomatic channels that they have satisfied their necessary domestic legal requirements. This Agreement may be terminated by either Party six months following written notification through diplomatic channels to the other Party. The termination of this Agreement shall not affect the validity or duration of specific activities undertaken hereunder, and not yet completed at the time of termination, unless otherwise agreed by the Parties.

IN WITNESS WHEREOF the undersigned, being duly authorized by their respective Governments, have signed this Agreement.

Signed at Mexico City on the seventh day of the month of August of the year of nineteen hundred and eighty nine, in two originals in the English and Spanish languages, both texts being equally authentic.

FOR THE GOVERNMENT OF THE UNITED STATES OF AMERICA:	FOR THE GOVERNMENT OF THE UNITED MEXICAN STATES:
JAMES A. BAKER III SECRETARY OF STATE	FERNANDO SOLANA SECRETARY OF FOREIGN RELATIONS

Reference List

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