***NATIONAL TRANSPORTATION SAFETY BOARD***

*Office of Marine Safety*

*Washington, D.C., 20594*

*March 14, 2008*

# ENGINEERING OPERATIONS GROUP FACTUAL REPORT

**DCA08MM004**

## A. ACCIDENT

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| Vessel: | *M/V Cosco Busan* |
| Date: | November 7, 2007 |
| Time: | 0830 local time |
| Location: | San Francisco Harbor, Oakland Bay Bridge, Span D-E, 37° 48.1 N, 122° 22.5 W |
| Owner/Operator: | Regal Stone Ltd./ Fleet Management |
| Complement: | 24 Crew, 1 Pilot |

## B. ENGINEERING OPERATIONS GROUP

Chairman: Brian Curtis, NTSB
Washington, DC
Lt. Gregory Tozzi, USCG
Oakland, CA
Port Capt. Parminder Singh
Fleet Management

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**SUMMARY OF EVENTS**

On Wednesday, November 7, 2007, about 0830 Pacific standard time, the Hong Kong-registered, 901-foot container ship *Cosco Busan* allided with the fendering system at the base of the Delta tower of the San Francisco-Oakland Bay Bridge (Bay Bridge). The ship was outbound from berth 56 in the Port of Oakland carrying 2,529 containers. It was destined for Busan, Korea.

The vessel was scheduled to depart the berth at 0630. A San Francisco Bar pilot arrived at the vessel about 0620 and met with vessel's master. Fog had restricted visibility in the harbor, and the pilot and master postponed sailing until visibility improved. While waiting for the visibility to improve, the pilot, the master, and the watch mate adjusted (tuned) the ship's two radars with regard to picture display and target acquisition on the ARPA (automatic radar plotting aid) until the pilot was satisfied that the radars were performing acceptably. According to the voyage data recorder (VDR) transcript, the ship's sailing was also delayed by the need to complete some ships paperwork. About 0730, the pilot estimated that visibility had improved to approximately 1/4 mile and, according to the pilot's statement, he consulted with the master before getting underway.

About 0745, the vessel departed berth 56 with the aid of the tractor tug *Revolution* on the port quarter pulling with one line and using the ship's 2,700-hp bow thruster. The bridge navigation crew consisted of the master, the third mate, a helmsman, and the pilot. The chief mate and a lookout were on the bow, and the second mate was on the stern. After the vessel eased off the dock, the pilot had the tug shift around to the center chock on the stern as a precaution because of the reduced visibility and, as the pilot later stated, "for insurance in case I needed help in the middle of the channel." With the tug trailing behind on a slack line, the *Cosco Busan* started making headway out of the estuary. The dredge *Njord* was working toward the end and on the west side of the estuary, and the *Cosco Busan* passed to the right of it without incident.

The pilot stated that as the *Cosco Busan* continued to make its way out of the Inner Harbor Entrance Channel, he could see the No. 4 and No. 6 buoys pass by and noted that their lights were visible. He kept the vessel to the high side of the channel as he departed the estuary in anticipation of the flood current he would encounter. He stated that the visibility again diminished, and that he could not see the No. 1 buoy marking the northern boundary of the entrance to Bar Channel as the vessel passed by. At this time, the vessel was making approximately 10 knots.

The pilot stated that, as was his usual practice, he used the VRM (variable range marker) set at 0.33 nautical mile as a reference off the Island of Yerba Buena as he made his approach to the Bay Bridge. The pilot stated the 0.33 nautical mile distance keeps the vessel at approximately the mid-point of the bridge span between the Delta and Echo towers. As the *Cosco Busan* passed close to the No. 1 buoy off the southwest tip of the island, the pilot issued rudder orders that caused the vessel to start to come left. The ship continued to swing left, and the speed remained at about 10 knots Shortly thereafter, the ship's heading was approximately 241°, which was almost parallel to the bridge.

A Vessel Traffic Service (VTS) controller monitoring vessel traffic noticed that the ship was out of position to make an approach to the bridge's Delta-Echo span. The controller contacted the pilot and informed him that the automatic identification system (AIS) had the *Cosco Busan* on a heading of 235° and asked the pilot if his intentions were still to use the Delta-Echo span. The pilot responded that he still intended to use the Delta-Echo span and that the vessel was swinging around to the northwest with the heading showing 280°.

According the ship's master, he estimated the visibility to be very low—about 30 meters—as the *Cosco Busan* started coming right to make its way under the bridge. As the vessel continued its approach to the bridge, the pilot ordered hard starboard rudder. Shortly thereafter, the chief mate on the bow called the master via UHF radio, pointing out that the Delta tower was very close. The vessel struck the corner of the fendering system at the base of the Delta tower at approximately 0830. Immediately upon realizing the vessel had allided with the base of the tower, the pilot ordered hard to port on the rudder in an attempt to lift the stern of ship away from further impact.

Shortly afterward, the pilot radioed the VTS controllers and informed them that his ship had allided with the tower and that he was proceeding to Anchorage 7, located just west of Treasure Island, where he planned to anchor the vessel. He notified his pilot office of the incident and stated that when he saw a sheen of oil in the water at the anchorage, he immediately notified the VTS.

Another San Francisco Bar pilot relieved the pilot of the *Cosco Busan* while the ship was at Anchorage 7, and the accident pilot was tested for alcohol using a saliva strip before he departed the ship. The accident pilot was then taken to the pilot office for mandatory drug and alcohol testing. About 1002 and due to the relief pilot's concern over the vessel's draft and the water depth at Anchorage 7, the *Cosco Busan* heaved anchor and shifted to Anchorage 9, located just south of the Bay Bridge, where the vessel again anchored.

## ENGINEERING PERSONNEL INFORMATION

According to the *Cosco Busan*'s crew list, the engineering department consisted of four licensed engineers: a chief engineer and second, third, and fourth assistant engineers. Additionally, the engineering staff consisted of three oilers and one wiper. Staff was unable to interview any engineering crewmembers in light of the ongoing Department of Justice investigation following the allision. All of the engineering staff had joined the vessel on October 24, 2007, except for the chief engineer, who signed on October 25.

Staff was able to obtain a copy of the chief engineer's license. He was certificated to operate ships powered by main propulsion machinery of 3,000 kilowatts (4,023 horsepower) or more. His license was issued on September 5, 2005. His license was valid for ships whose machinery included internal combustion engines. His license was not valid for tankers, passenger ships, rollon/rolloff ships, or "high speed craft."

The chief was 36 years old, and of Chinese nationality.

## VESSEL INFORMATION

### General Vessel Description

The Hong Kong-flagged *Cosco Busan* was built in Ulsan, Korea, at Hyundai Heavy Industries shipyard, and was delivered on December 21, 2001.

The vessel was 901 feet in length, had a beam of 131 feet, and a maximum draft of 46 feet, 6 inches. Its container capacity, according to vessel particulars documents supplied by the operator, was 5,447 TEU's.[1] The vessel was 65,131 Gross Registered Tons (GRT) international, and had a maximum speed of 25.6 knots.

Along the length of the vessel, its frames[2] were numbered 0 through 193, 0 being at the stern of the ship with the numbers increasing toward the bow. Starting at the bow working aft, frames 193 to 112 comprised the bow area and all of the forward container storage areas, a distance of about 595 feet. This area had a cargo capacity of 2,056 containers below the main deck, with an additional 1,884 containers stacked above the main deck and exposed to the weather. These numbers are based on the containers being TEU, or 20 feet in length.

Aft of the forward deck, from frames 112 back to 87, about 600 feet from the bow, was the superstructure. Aside from housing the bridge on the upper deck and the lifeboats on its exterior, the superstructure also contained the crew's berthing and recreational areas, galley, office areas, and the vessel's fuel and ballast control room.

The vessel's engineering spaces, which housed the main and auxiliary engines, power generation equipment, and all associated engineering systems, occupied the four decks below the main deck under the superstructure.

Aft of the superstructure and engineering spaces, from frames 87 to 0, the vessel extended for another 240 feet to the stern. Located in this area were steering gear and line-handling winches and equipment. This part of the ship could also accommodate an additional 547 containers below the main deck and 960 containers above it. These numbers, once again, are based on 20-foot containers.

<u>Propulsion and Associated Engineering Equipment</u>

The *Cosco Busan* was propelled by one main engine, a MAN B&W model 10K98MC-C manufactured by Hyundai.. This was a 10-cylinder, 2-cycle, direct-reversible, crosshead diesel turbocharged engine. It produced a maximum 77,600 horsepower. The engine was capable of propelling the ship to an approximate top speed of 25 knots and consumed approximately 220 metric tons (~68,000 gallons) at sea per day under full power. The *Cosco Busan* crew conducted

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[1] Containership capacity is measured by design capacity of 20-foot-long containers, or twenty-foot-equivalent units (TEU's). Although most containers are 40 feet in length, TEUs are based on the smaller 20 x 81/2 x 81/2-foot units.
[2] *Frames* are transverse structural members terminating at, and welded to, the ships hull plating.

forward and astern main engine propulsion tests at 0620 before departing the dock the morning of the allision and recorded the engine as operating satisfactorily.

The pilot who had taken the *Cosco Busan* out of Long Beach 2 days before the allision told Safety Board investigators he had had not problems maneuvering the ship and that all equipment functioned as it should.[3] The pilot on board the *Cosco Busan* when the allision occurred told investigators he was not aware of any propulsion or steering problems with the vessel.[4]

The vessel also had a tunnel bow thruster located approximately 75 feet aft of the bow to assist the vessel during slow-speed maneuvering and docking. The bow thruster was rated at 2,700 horsepower.

The vessel employed a conventional single propeller and single rudder configuration for propulsion and steering. The steering gear system was an electro-hydraulic twin ram design. Investigators tested the steering gear dockside on November 14, 2007, as part of the documentation of wheelhouse equipment. As a test of its functionality and its compliance with the requirements of the International Convention for the Safety of Life at Sea (SOLAS), 1974, investigators had the helmsman input the command at the wheelhouse steering station for a hard port to a hard starboard rudder movement. The rudder moved from hard-over port to hard-over starboard in 19 seconds, which was less than the 28 seconds allowed under SOLAS.[5]

SOLAS additionally requires that the steering gear be tested for proper operation no less than 12 hours before departure.[6] According to ship's documents, the crew tested the steering gear at 0620 the morning of November 7, 2007, about 1 1/2 hours before getting underway and

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[3] 2007 Dec 20 - Interview Transcript - Captain Grant, page 15, lines 10-15
[4] 2007 Nov 16 - Interview Transcript - Captain Cota, page 30, line 18.
[5] SOLAS Chapter V, Regulation 26.1
[6] SOLAS Chapter II-I, Regulation 2.3.2

slightly less than 2 hours before the allision. The test was completed with satisfactory results and logged accordingly.

Review of Engineering Data Collected On Scene

A review of the *Cosco Busan*'s engine room logbook[7] from November 1 through 7, 2007, revealed no indications of steering, propulsion, or engineering equipment failure or abnormalities at any time in the week before the allision. All rounds of the engine and steering spaces were reported as normal. All pre-departure tests conducted of the propulsion and steering equipment for the same period were documented as satisfactory.

The *Cosco Busan's* engine room electronic alarm logger was on the main operator's console in the engine control room. Investigators retrieved the alarms pages of the times surrounding the allision, and nothing on the records indicated a propulsion or steering malfunction. The alarm log recorded only alarms and did not track the status (stop, start, running conditions) of engine room equipment such as pumps, engines, and valves.

Investigators reviewed the *Cosco Busan's* chief engineer's night orders written between October 29 and November 7, 2007. The chief engineer uses night orders to provide daily written instructions for engine room watchstanders regarding any problems or concerns the chief engineer may have regarding the operation of the engineering plant. The watchstanders must sign the orders and attest that they have been read. None of night orders written during the week before the allision mentioned any propulsion, steering, or machinery problems that would give rise to concerns as to the control or maneuverability of the *Cosco Busan*.

[7] Docket item "2007 11 11 - Fleet Management - Eng. Rm. Logbook Nov. 1-7"

Fuel Capacity/Tank Arrangement

The *Cosco Busan* carried and burned two types of fuel oil for its main engine: marine diesel oil (MDO) and intermediate fuel oil (IFO-380). MDO is the less viscous and cleaner-burning of the two fuels. The MDO fuel oil was used during the vessel's transits into and out of ports because of its lower emissions, whereas the IFO was consumed while the vessel was at sea because of its higher heat energy and lower cost.

The *Cosco Busan* had an aggregate fuel capacity of 7,833.6 metric tons (~2,069,400 gallons) of IFO and 405.1 metric tons (~107,000 gallons) of MDO. According to tank sounding sheets obtained from the vessel, the last IFO fuel oil tank soundings[8] taken before the allision occurred at 0900 on November 6, 2007, the day before the allision. Those soundings indicated that the *Cosco Busan* had a total of 4,098.9 metric tons (1,082,806 gallons) of IFO on board.

The IFO was stored in eight large storage tanks, four along each side of the vessel. The tanks were designated No. 3 port and No. 3 starboard, No. 4 port and No. 4 starboard, No. 5 port and No. 5 starboard, and No. 6 port and No. 6 starboard. The forward-most IFO tanks, Nos. 3 port and starboard, were 290 feet from the bow. Nos. 4 and 5 tanks were aft of the No. 3 tanks along each side of the hull, ending just forward of the superstructure. Collectively, these 6 tanks ran a distance of 281 feet along each side of the hull. The forward ends of Nos. 6 port and starboard IFO tanks were 62 feet aft of the superstructure and ran along the hull for approximately 47 feet, ending about 140 feet forward of the stern. All of the IFO storage tanks contained steam heating coils to reduce the oil's viscosity in colder weather.

[8] *Sounding* is the act of using a tape or rod to measure the depth of liquid in the tank.

**VESSEL DAMAGE**

Damage to the *Cosco Busan* from its allision with the Bay Bridge was confined to the port side of the vessel, forward of the superstructure, above the waterline. The Nos. 3 and 4 port fuel oil tanks were breached, as was the No. 2 port water ballast tank.

The *Cosco Busan's* class society, Germanischer Lloyd, surveyed the vessel's damage on November 13, 2007. The forward-most point of the damage was approximately 237 feet aft of the ship's bow. The damage was found to have occurred between vessel frames 128 and 150, a distance of approximately 212 feet. The damage vertically spanned a distance of approximately 10 feet.

The hull's shell plating was torn open along the entire length of the damaged area. All the internal web frames in the damage area were deformed to some extent. In all three of the damaged tanks, pipes, ladders, handrails, and gratings were damaged or destroyed.

Additionally, a mooring bit inset into the hull at frame 139 1/2 was destroyed during the allision. The damage did not extend inward past the inside tank boundaries of the three breached tanks.[9]

Temporary repairs were effected to the *Cosco Busan* during a 30-day shipyard period after the allision. The repairs consisted of fitting a plate over the shell opening and did not involve repairs to the hull's frames. These repairs were carried out in the Bay area at the San Francisco Ship Repair shipyard. The cost of the temporary repairs totaled $1,239,792, according to a Fleet Management company official.

After completion of the temporary repairs, the vessel transited to China for permanent repairs. The final repairs were completed in 13 days and cost an additional $812,000.[10]

[9] Germanischer Lloyd Survey Statement dated 01-19-2008
[10] M.S. Nagarajan email of 2-28-08

**CALCULATED VOLUME LOSS FROM PORT FUEL OIL TANK**

About 1300 the day of the allision, some 4 1/2 hours after the accident, an oil pollution prevention specialist employed by the California Department of Fish and Game, boarded the *Cosco Busan* to calculate the volume of IFO spilled into the bay as a result of the allision. He made his calculations with the assistance of the chief engineer and a Coast Guard sampler (sent on board to collect samples from tanks) onboard at the time. The following is a description of the method used by the specialist in arriving at his calculated volume of spilled fuel:

Arriving on board the *Cosco Busan*, the pollution prevention specialist sought out the vessel's chief engineer. The chief engineer told him that soon after the allision, he began transferring oil from the Nos. 3 and 4 port fuel storage tanks to another IFO tank. in an effort to minimize the amount of oil spilled.

The specialist then obtained the previous day's IFO tank soundings from the chief engineer, taken at 0900 on November 6. The group then set about sounding the Nos. 3 and 4 port IFO storage tanks. They found that the No. 3 port IFO storage tank could not be sounded because the sounding tube had been crushed in the allision. According to the ship's engineering staff, the automatic sounding gauge for No. tank was functional and was "fairly" accurate. Soundings of the No. 4 port tank and the tank into which fuel had been transferred were taken using a sounding tape. By comparing the previous day's sounding in the three tanks to the current soundings, the pollution specialist could estimate the volume of fuel that had been lost. At the time the soundings were taken, the vessel was anchored and down by the head by approximately 1 meter, or 3.2 feet, and listed to starboard by one and half degrees.

The quantity remaining in the No. 3 tank was determined to be 32.86 cubic meters, the quantity in No. 4 tank was determined to be 264.75 cubic meters, and the quantity in the transfer tank was determined to be 354.30 cubic meters, for a total of 651.91 cubic meters.

By subtracting 651.91 cubic meters from the previous day's quantity of 871.54 cubic meters, the pollution control specialist calculated that 219.63 cubic meters, or 58,020.107 gallons, of IFO fuel had leaked from the vessel.

The following day, November 8, 2007, the pollution control specialist again boarded the vessel in order to gauge all the IFO tanks and recalculate the quantity of spilled fuel oil. He was accompanied by a superintendent from Fleet Management, a surveyor hired by Fleet Management, and the chief engineer of the vessel. The chief engineer had transferred IFO from the 3 and 4 port tanks into four other IFO tanks, a double-bottom tank, the engine's fuel overflow tank, the fuel oil settling tank, and the fuel oil low-sulfur settling tank. The vessel was stable at an even keel and in an upright condition.

The group began by sounding the Nos. 3 and 4 tanks to get the postaccident and post-transfer quantities in each tank, especially the breached fuel tanks. Eventually, the group sounded all eight IFO storage tanks as well as the double-bottom tank, the overflow tank, the settling tank, the service tank and the low-sulfur settling and service tanks.

Comparisons of before and after sounding indicated that a total of 790.5 cubic meters (208,826 gallons) of fuel oil had been displaced from the Nos. 3 and 4 port IFO fuel storage tanks, either by its having leaked out through the hull's breach as a result of the allision, or its having been transferred to another tank by the chief engineer following the incident.

Soundings were then taken of the tanks the chief was known to have transferred fuel oil to postaccident—the double bottom tank, the overflow tank, the settling tank, and the low-sulfur settling tank. A comparison of before- and after-allision quantities in these tanks indicated a net gain of 587.4 cubic meters (155,173 gallons).

The pollution specialist then subtracted the 587.4 cubic meter net gain of fuel in the tanks the chief engineer had transferred IFO into from the net loss of fuel having leaked or been transferred from numbers 3 and 4 port IFO storage tanks. The result came to 203.1 cubic meters, or 53,653 gallons, that had leaked from the breached hull into the Bay's waters.

## IMO INITIATIVES REGARDING SHIP'S BUNKER FUELS

### MARPOL Regulation Amendment for Protection of Bunker Tanks on Ships

The International Maritime Organization (IMO), headquartered in London, is a United Nations organization that promulgates international regulations directed toward the safety and security of shipping and the prevention of marine pollution caused by ships. The IMO exists to develop conventions, codes, and guidance to be used or implemented by its signatory countries.

The IMO's *International Convention for the Prevention of Marine Pollution from Ships* is referred to as MARPOL 73/78. The original MARPOL convention was signed in 1973, but it never went into effect. It was later absorbed into a subsequent convention, adopted in February 1978, and hence came to be known as MARPOL 73/78. After ratification, MARPOL 73/78 entered into force on October 2, 1983. The convention's goals are to prevent and minimize pollution from ships. Amendments have been added over the years to improve the convention.

MARPOL 73/78 now comprises six annexes addressing the various types of pollution caused by ships:

Annex I - Oil

Annex II - Noxious Liquid Substances carried in Bulk

Annex III - Harmful Substances carried in Packaged Form

Annex IV - Sewage

Annex V - Garbage

Annex VI - Air Pollution

Annex I, covering oil pollution, until recently had no regulations requiring that fuel (bunker) tanks of cargo vessels be located so as to protect them from external damage. An amendment to MARPOL Annex I was adopted in October 2004 regarding this issue, and in January 2007, having been ratified, the amendment went into effect.

The amendment consists of the new regulation 12A in Annex I, which applies to all ships with an aggregate fuel oil capacity of 600 cubic meters (158,500 gallons).[11] Fuel oil in the regulation is defined as “any oil used as fuel in connection with the propulsion and auxiliary machinery of the ship in which such oil is carried.” The bunker tanks are defined as “a tank in which fuel is carried, but excludes those tanks which would not contain fuel in normal operations, such as overflow tanks.” The regulation does not apply to bunker tanks with a capacity less than 30 cubic meters (7,925 gallons).

Under the regulation, no one bunker tank can exceed 2,500 cubic meters (660,425 gallons) in capacity. The regulation further contains language for the protection of valves and piping to and from the bunker tanks.

Regulation 12A offers ship designers two alternatives for locating a ship’s bunker tanks to comply with its requirements. The first of the two options calls for double-hull protection for the bunker tanks regardless of whether the tank is located on the side or bottom of the ship. The regulation stipulates, in essence, how far inboard of the shell plating[12] each bunker tank boundary must be located to protect it from external damage that might occur as a result of a collision or allision.

The second alternative calls for the ship's design to "comply with the accidental oil fuel outflow performance standard" specified in the regulation. In this alternative, bunker tanks are strategically located within the ship's hull based on the probability of any particular tank being holed if the ship were to encounter a grounding, collision, or allision. The formulae used in this alternative take into account such parameters as the fuel oil density, the volume of fuel in each tank, and its location in the hull. From these calculations, both the probability of the tank being breached, and the probability of its further leaking fuel outside of its hull are accounted for. According to testimony given by an American Bureau of Shipping (ABS) spokesperson during a U.S. Senate hearing before a subcommittee of the Committee on Commerce, Science and Transportation on March 4, 2008, the IMO developed the second alternative "in order to give designers the freedom to optimize fuel tank arrangements and to deal with the design constraints encountered in different ship types."[13]

The regulation affects ships delivered on or after August 1, 2010, and for those under contract on or after August 1, 2007. There is no retroactivity clause for existing ships to protect their bunker tanks; however, ships would have to comply if they were to undergo "major conversions."[14] These major conversions apply to ships under contract after August 1, 2007, or having a conversion completion date after August 1, 2010.

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[11] Docket item, MARPOL 73/78, Annex I, Regulation 12A
[12] A ship's external steel skin or sheathing.
[13] Statement by the ABS for the hearing on Protecting our Shores from Oil Spills- Operational Procedures and Ship Design, March 4, 2008.
[14] Definition at: IMO MARPOL Consolidated edition 2006, page 46.

Bunker Convention Covering Pollution Damage Liabilities

No IMO treaties are currently in effect covering liability and compensation for pollution damage caused by bunker oil from ships other than for tankers. This will change when IMO's *International Convention on Civil Liability for Bunker Oil Pollution Damage*, adopted in 2001, goes into effect on November 21, 2008.[15]

The convention makes insurance compulsory for ships greater than 1,000 registered tons. Such vessels will "be required to maintain insurance or other financial security, such as the guarantee of a bank or similar financial institution, to cover the liability of the registered owner for pollution damage…." Limits of liabilities are defined in the text of the convention.

Under the requirements of the convention, ships will be required to carry a certificate attesting to their holding the insurance or other financial security meeting the provisions of the convention. Requirements of information to be included on the certificate are detailed in the convention as well.

The bunker convention defines pollution damage as:

> (a) loss or damage caused outside the ship by contamination resulting from the escape or discharge of bunker oil from the ship, wherever such escape or discharge may occur, provided that compensation for impairment of the environment other than loss of profit from such impairment shall be limited to cost of reasonable measures of reinstatement actually undertaken or to be undertaken; and

[15] Docket item, International Convention on Civil Liability for Bunker Oil Pollution Damage

(b) the costs of preventive measures and further loss or damage caused by preventive measures.

The convention will make the ship owner liable for compensation for the damage caused by the spilled bunkers, as well as preventative measures taken following the event to minimize or prevent the pollution damage. The term “ship owner” in the convention is defined as “the owner, including the registered owner, bareboat charterer, manager and operator of the ship.”