United States Coast Guard

Report of Investigation into the Circumstances of the Explosion, Fire, and Sinking of the Tank Barge EMC 423 with One Loss of Life

On the Chicago Sanitary and Ship Canal On 01/19/2005

MISLE Activity Number: 2277817

U.S. Department of Homeland Security
United States Coast Guard

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April 6, 2010

INVESTIGATION INTO THE CIRCUMSTANCES OF THE EXPLOSION, FIRE AND SINKING OF THE TANK BARGE EMC 423 ON THE CHICAGO SANITARY AND SHIP CANAL ON 19 JANUARY 2005 WITH ONE LOSS OF LIFE

ACTION BY THE COMMANDANT

The record and the report of the Formal Investigation convened to investigate the subject casualty have been reviewed. The record and the report, including the findings of fact, analysis, conclusions, and recommendations are approved subject to the following comments.

COMMENTS ON CONCLUSIONS

The conclusions included in the report of investigation are approved subject to my comments on the following conclusion:

Conclusion 24: There is a conflict in the regulations between Title 33 CFR 155.815(b), which states that tank barge cargo tank openings must be authorized/supervised by a licensed officer or Tankerman, and Title 46 CFR 35.30-10, which states that tank barge cargo tank openings must be under the supervision of a senior member of the crew.

Comment: Upon completion of a review of these two regulations we do not agree that there is a conflict between them. 46 CFR 35.30-10 requires the supervision by senior members of the crew on duty when cargo tank openings, such as cargo hatches, ullage openings, etc., are opened and remain opened without flame screens. 33 CFR 155.815 requires that a person authorizing and supervising the opening of closure mechanisms be a licensed or credentialed officer or the Tankerman required by 46 CFR 31.15-5(a). These two requirements, when applied together, require the senior member of the crew on duty who must authorize and supervise the opening of cargo hatches, ullage openings, etc. to also be a licensed or credentialed officer or the Tankerman required by 46 CFR 31.15-(a). As such, the regulations do not conflict, but rather complement each other to establish requirements for the opening of closure mechanisms on tank barge cargo tanks.

ACTION ON RECOMMENDATIONS

Of the 22 recommendations issued by the investigating officer, we note the actions taken by Marine Safety Unit Chicago on recommendations 1 through 3 and those taken by the Commander, Ninth Coast Guard District, on recommendations 4 through 6. The following is the Commandant's Action for the remaining safety recommendations:

Recommendation 7: The U.S. Coast Guard should amend the regulations to require all crew members employed aboard Uninspected Towing Vessels that are towing barges regulated under 33 CFR 104 (Maritme Security: Vessels) to obtain a Merchant Mariner's Document in order to ensure higher qualification/personal standards and track individual drug testing history.

Action: We do not concur with this recommendation. Title 46 USC 8701 currently limits requirements for merchant mariner documents to merchant vessels of at least 100 gross tons and to seagoing barges or barges to which 46 USC Chapter 37 applies. Additionally, while not all crew members may hold merchant mariner credentials, regulations under 33 CFR 155.815 require that they are supervised by credentialed officers and crew who should ensure that the integrity of the tank barge is maintained until a Person-in-Charge or Tankerman arrives on board to assume responsibility for a transfer. As a result, we do not believe there is justification to initiate a legislative change proposal to obtain the authority to require all crew members on uninspected towing vessels towing barges regulated under 33 CFR 104 (Maritime Security: Vessels) obtain a Merchant Mariner Document.

Recommendation 8: The U.S. Coast Guard should develop regulations to require hazardous location plans for all inspected tank barges certificated to carry flammable or combustible cargos.

Action: We concur with the intent of this recommendation. 46 CFR 110.25-1 already contains a plan submittal requirement for tank barges that have hazardous areas as defined in the National Electrical Code (NEC). However, this plan submittal regulation inadvertently conflicts with 46 CFR 111.105-29, because the definition of hazardous area in NEC 500-5 is broader than 46 CFR 111.105-29. Recommendation 18 of this report calls for a re-examination of the requirements in 46 CFR 111.105. We intend to have a study conducted by our Research and Development Center into this issue. Once it is complete, we will re-examine the requirements in 46 CFR 111.105 and will determine if a regulation project to alter them is required.

Recommendation 9: The U.S. Coast Guard should amend Title 46 CFR 2.01-1 (Application for Inspections) to require individuals submitting an Application for Inspection to include a list of all vessel repairs and alterations conducted since last inspection for certification.

Action: We partially concur with this recommendation. We agree that individuals submitting an Application for Inspection should include a list of all vessel repairs and alterations conducted since the last inspection for certification; however, it is not necessary to amend the regulations to achieve this end. Instead, we intend to make the necessary modifications to forms CG-3752, Application for Inspection of U.S. Vessel, and CG-986, Application for Inspection of Foreign Vessel, to ensure that this information is provided.

Recommendation 10: The U.S. Coast Guard should remove or amend Title 46 CFR 36.20-1 to require tank barges and tank ships carrying grade E petroleum based liquids in molten form at elevated temperatures to install flame screens on cargo tank openings.

Action: We concur with this recommendation. While the piping in question was determined to be a fill pipe as opposed to a vent, this investigation identified a conflict between 46 CFR 36.20-1 and requirements in 46 CFR 32.55(d) and 46 CFR 32.55-25(c) that needs to be addressed. We believe all vent lines, and openings as described in 35.30-10, should be protected by flame screens as a minimum, even for Grade E cargoes. Recognizing that flame screens are designed to prevent the passage of flames, a flame screen if fitted in the piping might have prevented flame propagation into the cargo tank and the resulting explosion. We will include the removal of 46 CFR 36.20-1, which allows omission of flame screens in the vent lines on cargo tanks, as an issue in a future regulatory project.

Recommendation 11: The U.S. Coast Guard should amend Title 46 CFR 32.55-25(a) to prohibit the use of PV valves aboard tank vessels carrying Grade E petroleum based liquids in molten form at elevated temperatures.

Action: We do not concur with this recommendation. While the intent of this recommendation is to prevent the accumulation of flammable vapors within the cargo tank, replacing pressure-vacuum (PV) relieve valves with open vents would not accomplish that task and could create a more dangerous situation. Despite the open arrangement through a flame screen, an open vent would not actively ventilate a cargo tank to adequately prevent the accumulation of flammable vapor/air mixture and could, in fact, contribute to it. In addition, the open vent could promote the presence of vapors on deck, thereby increasing the hazard. Finally, due to the fact that barge owners routinely carry Grade E cargoes in higher Grade cargo tanks, changing this requirement would limit their operating abilities. Flame screens are less effective with higher Grade cargoes, which is why the regulations require a PV relief valve or equivalent protection for vessels carrying those Grade cargoes. We do not believe prohibiting the use of PV relief valves when carrying Grade E cargoes to be justified.

Recommendation 12: The U.S. Coast Guard should amend Title 33 CFR 156 to include the definition of grades of cargoes as defined in Title 46 CFR 30.10.

Action: We concur with this recommendation. Including the definitions for flammable liquid and its grades from 46 CFR 30.10 in 33 CFR 156 would increase the visibility of this important information for those industry personnel who would not normally be familiar with vessel-related requirements, such as waterfront facility personnel. We will include this as an issue in a future rulemaking project.

Recommendation 13: The U.S. Coast Guard should amend Title 33 CFR 156.150 (Declaration of Inspection) to include the requirement for tankerman and facility persons in charge to verify one-another's tankerman card/person in charge qualification prior to beginning cargo transfers.

Action: We concur with this recommendation. We view a requirement for Tankerman and persons-in-charge to verify one-another's qualifications as part of the Declaration of Inspection process prior to beginning cargo transfers regulated under 33 CFR 156 as a relative minor action that can improve safety and will include it as an issue in a future rulemaking.

Recommendation 14: The U.S. Coast Guard should amend Title 33 CFR 156.150 (Declaration of Inspection) to include the requirement for facility persons in charge to provide cargo grade (as defined in Title 46 CFR 30-10) to the vessel tankerman.

Action: We concur with this recommendation. While the person in charge of the facility and the tankerman PIC (person-in-charge) should both have full knowledge of the cargo being transferred, adding the requirement to provide full particulars would ensure that they would be discussed to improve the level of safety. Implementation of this requirement should be done in conjunction with our action for recommendation 12 to ensure that facility personnel would be provided with the necessary definitions for cargo grades in the regulations in which they most are most familiar. We will include this issue in a future rulemaking project.

Recommendation 15: The U.S. Coast Guard should amend regulations to resolve the conflict between Title 33 CFR 155.815 and Title 46 CFR 35.30-10, requiring all personnel conducting activities associated with either cite to hold a Merchant Mariner Document with the appropriate tankerman endorsement.

Action: We do not concur with this recommendation. Upon completion of a review of these two regulations we do not agree that there is a conflict between them. 46 CFR 35.30-10 requires the supervision by senior members of the crew on duty when cargo tank openings, such as cargo hatches, ullage openings, etc., are opened and remain opened without flame screens. 33 CFR 155.815 requires that a person authorizing and supervising the opening of such mechanisms be a licensed or credentialed officer or the Tankerman required by 46 CFR 31.15-5(a). These two requirements, when applied together, require the senior member of the crew on duty who must authorize and supervise the opening of cargo hatches, ullage openings, etc. to also be a licensed or credentialed officer or the Tankerman required by 46 CFR 31.15-(a). As such, the regulations do not conflict, but rather complement each other to establish requirements for the opening of closure mechanisms on cargo tanks.

Recommendation 16: The U.S. Coast Guard should amend Title 46 CFR 35.30-15(b) to add the requirement for unmanned tank barges authorized to carry Grade A, B, C, D liquids at any temperature, or grade E liquids at elevated temperature to be equipped with a combustible gas indicator suitable for determining the presence of explosive concentrations of the cargo carried.

Action: We do not concur with this recommendation. We believe that new regulations requiring the carriage of a combustible gas indicator (CGI) on unmanned tank barges are unwarranted. While it could help personnel working on the barge determine whether a flammable atmosphere existing within a cargo tank if used correctly, it may present undesired consequences if used by towing vessel personnel who are not properly trained in its use. The improper use of a CGI by the lesser trained towing vessel crew could result in the crew falsely believing it safe to conduct dangerous operations, such as hotwork. In addition, an untrained person may also mistakenly believe that a CGI can be used as the sole device to determine if confined spaces are safe for entry. We believe these dangers outweigh the possible benefits of implementing such a requirement and do not intend to amend the current regulations.

Recommendation 17: The U.S. Coast Guard should draft guidance to specify minimum information that a Marine Inspector is required to enter into a MISLE inspection activity narrative.

Action: We concur with this recommendation. While certain information is expected to be described within a vessel inspection narrative in a vessel inspection activity record in the MISLE data system, it is not clearly defined and can vary significantly between Coast Guard field units. We have already begun to update, revise, and create a thorough set of guidelines for entering vessel inspection information into the MISLE system. This will provide uniformity between all Coast Guard offices and will make vital inspection details easier to find.

Recommendation 18: The U.S. Coast Guard Research and Development Center should initiate a study into general fire and explosion hazards of Grade E petroleum based cargoes, with particular attention focused on flashpoint and how it relates the flammable vapor generation hazards.

Action: We concur with this recommendation. Additional investigation by the Coast Guard Research and Development Center into the flashpoint characteristics of Grade E cargoes has merit. This study should include examination of the current hazardous area requirements contained in 46 CFR 111.105 and give recommendations on whether or not they need to be altered. We will re-examine the requirements in 46 CFR 111.105 after the results of an investigation by our Research and Development Center and determine if a regulation project to alter them is required.

Recommendation 19: The U.S. Coast Guard should contact American Waterways Organization representatives and recommend that they restrict Responsible Carrier Program auditors from conducting audits on companies for which they provide other services, or that may otherwise create a conflict of interest.

Action: We concur with this recommendation. If the Responsible Carrier Program is conducting audits for companies that they also provide other services to, there is a possible conflict of interest that should be avoided. We will contact the American Waterways Operators and ensure they receive a copy of this investigation and that the issue is discussed.

Recommendation 20: The U.S. Coast Guard should work with the Occupational Safety and Health Administration to amend MSDS requirements to address shipment of cargo in bulk by water, i.e. grade of cargo, regulatory and transportation information.

Action: We do not concur with this recommendation. Material Data Safety Sheets (MSDS) are required for hazards in all areas of employment and are not specific to marine transportation. The maritime industry represents a small percentage of the millions of employees and first responders who regularly use MSDS and it is not feasible to have OSHA make amendments just to accommodate one segment of industry. The inherent physical and chemical properties need to remain the focus of MSDS so that shippers, crewmembers, facility operators, and CG officials can assign the proper grade and regulatory transport requirements.

Recommendation 21: The U.S. Coast Guard should work with the Occupational Safety and Health Administration to add requirement for MSDSs to more precisely reflect chemical and physical properties of cargos.

Action: We concur with this recommendation. OSHA is considering a revision of their Hazardous Communications Standards to be in line with the internationally accepted "Globally Harmonized System (GHS) of Classification and Labeling of Chemicals." To assist this change, the Coast Guard is leading the efforts within the International Maritime Organization (IMO) to adopt these standards for all MARPOL Annex I oil and bunker fuels. This was initiated due to the concerns of several IMO organizations and members that the existing MSDS for oil cargoes was not specific enough. We will continue to work with the international community and assist OSHA on their effort to adopt the "Globally Harmonized System (GHS) of Classification and Labeling of Chemicals.

Recommendation 22: Recommend that this casualty investigation be closed.

Action: We concur with this recommendation. This investigation is closed.

[redacted]

KEVIN S. COOK
Rear Admiral, U.S. Coast Guard
Director of Prevention Policy

U.S. Department of Homeland Security

United States Coast Guard

Commander
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Ninth District

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16732
APR 28 2008

FIRST [redacted]fficer's memo 16732 of 24 Mar 2008

From: JOHN E. CROWLEY JR., RADM
CGD NINE (d)

To: COMDT (CG-5451)

Subj: ONE MAN FORMAL INVESTIGATION INTO EXPLOSION, FIRE, AND SINKING OF THE T/B EMC 423, O.N. 547814 ON 19 JAN2005; MISLE #2277817

Ref: (a) MARINE SAFETY MANUAL VOLUME V, COMDTINST M1600.8B

1. Approved, subject to the following comments.

2. For clarification; Findings of Fact 132, 133, and 134, the Investigating Officer found that on the night of the casualty the Master of the M/V LISA E stated that there was a propane torch on the barge, that the purpose of the torch was to warm up the cargo pump and that the deceased was operating the cargo pump at the time of the explosion. In Findings of Fact 142 and 143 the Investigating Officer found that on the night of the explosion a Deckhand stated that the deceased may have been using a propane torch to heat the cargo pump at the time of the explosion. The relevant conclusions to be drawn from these statements are that there was a propane torch on board the T/B EMC 423 the night of the explosion, that deceased used it to heat the cargo pump, and that the propane torch was the source of ignition for the explosion. (Conclusions 2 & 3).

3. For clarification; In Findings of Fact 146 the post-mortem examination of deceased revealed multiple broken bones, lacerations, and ruptured and lacerated organs. Findings of Fact 147 states that the Cook County Coroner determined the cause of deceased's death to be drowning because his body was found in the river. Findings of Fact 148 states that a Department of Defense Armed Forces Institute of Pathology medical examiner determined the cause of deceased's death to be blunt force trauma due to the explosion. In spite of conflicting Findings of Fact, the Investigating Officer concluded that the cause of death was blunt force trauma. (Conclusion 19).

4. I concur with Recommendations 1-22.

5. Recommendation 2 will also be considered by the Ninth District for action.

6. Further investigations have been initiated to address Recommendations 5 and 6.

7. I recommend this casualty investigation be closed.

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U.S. Department of Homeland Security

United States Coast Guard

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16732
24 Mar 2008

MEMORANDUM

From: H. M. Hamilton, [redacted] eply to
Investigating Off[redacted]ttn of:

To: CG-5451

Thru: CGD Nine (d)
CGD Nine (dp[redacted]-21-08

Subj: ONE MAN FORMAL INVESTIGATION INTO EXPLOSION, FIRE AND SINKING OF THE T/B EMC 423, O.N. 547814 ON 19 JAN 2005; MISLE #2277817

Ref: (a) CGD Nine (d) Jan 20, 2005 Memorandum – Designation of Investigating Officer

1. Investigation of the subject case is completed; a narrative report is submitted as correspondence document #66643 of the subject MISLE activity.

2. This investigation is indebted to the efforts of Lieutenant [redacted] while serving as my assistant and Recorder to the Formal, One-Man Investigation. Lieutenant [redacted] timely and insightful on-scene actions proved crucial to capturing invaluable information from the crewmembers which in combination with his tireless effort as Recorder from January 2005 to March 2008 made the immutable difference in determining the probable cause of this casualty.

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***Note** – Parenthetical references imbedded throughout the report refer to evidence exhibits or transcript page numbers from formal hearing.

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CHAPTER 1: EXECUTIVE SUMMARY

At approximately 1640 on January 19, 2005, the EMC 423, a Coast Guard certificated tank barge, exploded while underway in the Chicago Sanitary and Ship Canal while carrying 14,272 barrels (599,424 gallons) of Clarified Slurry Oil (CSO). The explosion occurred just after the tow passed under the Cicero Avenue Bridge at mile marker 317.5, and resulted in a fire, the barge sinking and a loss of life. The weather at the time of the casualty was approximately 30° F with 10 mph winds out of the North.

At the time of the explosion the EMC 423 was being pushed ahead by the M/V LISA E. The M/V LISA E was built in 1963 and is a 61' 7" long, 75 gross ton single push knee river tow boat with a retractable pilot house. The EMC 423 is a single bottom, double side, 20,739 barrel (bbl) capacity barge with four center line cargo tanks, four port and starboard wing tanks, and bow rake and stern box voids. Both the LISA E and the EMC423 were owned and operated by Egan Marine Corporation at the time of the explosion.

On January 18, 2005 the EMC 423 moored at the ExxonMobil facility in Joliet, IL to take on the third consecutive load of CSO. Upon commencing barge loading, the facility experienced some difficulty due to the cold weather solidifying the highly viscous cargo within a valve transfer line immediately adjacent to storage tank 516. Facility personnel bypassed the valve by gravitating product from tank 516 to tank 515 through an alternate line, ultimately loading the barge from the latter tank. The temperature of the CSO at the time of loading was approximately 185° F.

At approximately 0700 on the morning of January 19, 2005 the transfer was complete and the M/V LISA E departed pushing the EMC 423 up the Des Plaines River toward Ameropan, Inc., in Chicago, IL, where it was to offload. The vessel crew consisted of [redacted] (Captain), [redacted] (Deckhand), [redacted] (Deckhand) and Alexander Oliva (Deckhand). The outside temperature was approximately 33° F.

At approximately 1520, [redacted] and Alexander Oliva boarded the EMC 423 while underway to start the thermal fluid heater and to prepare the barge to be discharged. Alexander Oliva was tasked with getting the cargo pump ready for the offload. Alexander Oliva "bumped the clutch" to see if the cargo pump was going to turn, and found that it would not due to the cold temperatures solidifying CSO within the pump (Figure 1-1). The heat tracing lines to the cargo

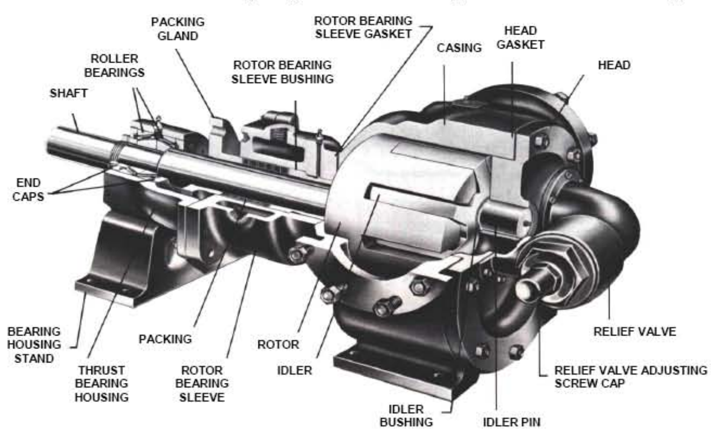

Figure 1-1: Pump Schematic (CG Exhibit 112)

pump head were not connected, so the heating system was not available to heat the congealed CSO within the pump casing. Instead Alexander Oliva used a propane torch (rosebud) to heat the pump casing, with the intention of heating the solidified cargo inside enough to allow the pump to turn freely (Figure 1-2).

Within the EMC 423 cargo tanks, just prior to the explosion, the CSO was approximately 175° F and was generating flammable vapors that consisted of hydrocarbons ranging from C_2 to C_{12}. These "light ends" constituted a vapor because residual fuel oils, such as CSO, have trace amounts of light hydrocarbons. The light hydrocarbons are extremely explosive and are emitted via occluded vapor bubbles or cracking as a result of localized heating (hot spots) within a tank. The explosive vapors concentrated in the cargo tanks and were released from an unobstructed standpipe located adjacent to the cargo pump discharge outlet. The standpipe was recovered after the explosion without a closure device in place; a condition that would provide unrestricted communication between cargo tank #4 and the outside environment.

Figure 1-2: CG Exhibit 66 - Propane Torch

During the course of heating the cargo pump with the rosebud, Alexander Oliva accidentally ignited the vapors escaping through the standpipe. The flame traveled through the standpipe into cargo tank #4, causing the vapors contained within the headspace to ignite and over pressurize the tank. The over pressurization carried into cargo tank #3 and the inertia of the explosion tore the tank top off cargo tank #2.

The explosive over pressurization of cargo tank #4 caused the tank top to lift rapidly resulting in Alexander Oliva receiving numerous blunt force trauma injuries to the head, torso, lower extremities and internal organs. The injuries suffered by Alexander Oliva were fatal, and the force of the explosion threw him from the barge into the Chicago Sanitary and Ship Canal.

The EMC 423 caught fire and remained afloat for approximately 41 minutes. The barge sunk at mile 317.5 of the Chicago Sanitary and Ship Canal due to progressive flooding resultant from explosion damage. The progressive flooding was accelerated by the loss of the barge tank top and improperly secured void hatches.

USCG Station Calumet Harbor received a distress call from the M/V LISA E via VHF channel 16, reporting that there had been a large explosion on the EMC 423. USCG Station Calumet Harbor dispatched a search and rescue boat crew. CG-255057 arrived on scene and commenced searching for missing crewman Alexander Oliva. Chicago Marine Police Unit M2, Chicago Fire Department vessel VICTOR SLAGER, a Chicago Fire Department Helicopter, M/V LISA E and the M/V WINDY CITY were also searching. CG-255057 recovered a severely burnt and torn work boot that subsequently matched the opposite boot found on Alexander Oliva's body. No life jacket or work vest was recovered during the search. Alexander Oliva was not located during the search and after several hours his next of kin was notified that the Coast Guard search was to be suspended. The search was suspended and CG-255057 departed scene.

Alexander Oliva's body was recovered from the Chicago Sanitary and Ship Canal on February 4, 2005 about a half mile downstream from the location of the casualty. He was not wearing a lifejacket or work vest.

CHAPTER 2: VESSEL PARTICULARS

The purpose of this chapter of the investigative report is to present a critical profile of the tug and the barge involved in the casualty. This description includes the identification of the vessel owners/operators, the status of required documentation, a description of the vessels themselves, and a description of the equipment onboard.

<u>Barge (Figure 2-1)</u>

Name:	EMC 423 (Ex. CBC 323)
Official Number:	547814
Service:	Tank Barge, Grade B and lower cargoes
Gross Tonnage:	1397
Registered Length, Breadth and Depth:	295' x 50' x 10'3"
Cargo Capacity:	20,739 Barrels (approx.)
Year Built:	1973
Place Constructed:	Decatur, AL
Hull Material:	Steel
Hull Construction:	Single bottom, double side
Compartmentation:	4 cargo tanks, 8 wing tanks (4 per side), bow rake void, stern box void
Machinery:	Cargo Pump – 10" Viking Positive Displacement, Model P332 Cargo Pump Prime Mover – Detroit Diesel Model 6V-71 with Faulk Reduction Gear, Model 100FC2A Generator – Delco 60 Kw (brushless), Model 66609 Generator Prime Mover – Detroit Diesel Model 4V-71 Thermal Fluid Heater – Volcanic 5 million BTU, S/N 5S-7106-378
Homeport:	Lemont, IL

Certification Date:	September 20, 2004 – MSO Chicago
Route:	Lakes, Bays and Sounds
Certificate of Documentation:	Valid (CG-05)
Last Inspection:	September 20, 2004 – MSO Chicago
Last Drydock:	May 8, 2003 – MSO Chicago
Last Internal Structural Exam:	May 8, 2003 – MSO Chicago
Last Cargo Tank Internal Exam:	May 8, 2003 – MSO Chicago
Owner/Operator:	Egan Marine, Inc. 15200 Canal Bank Road PO Box 669 Lemont, IL 60439
Purchase Date:	August 2, 1994
Previous Owner:	Canal Barge Company 835 Union Street New Orleans, LA 70112

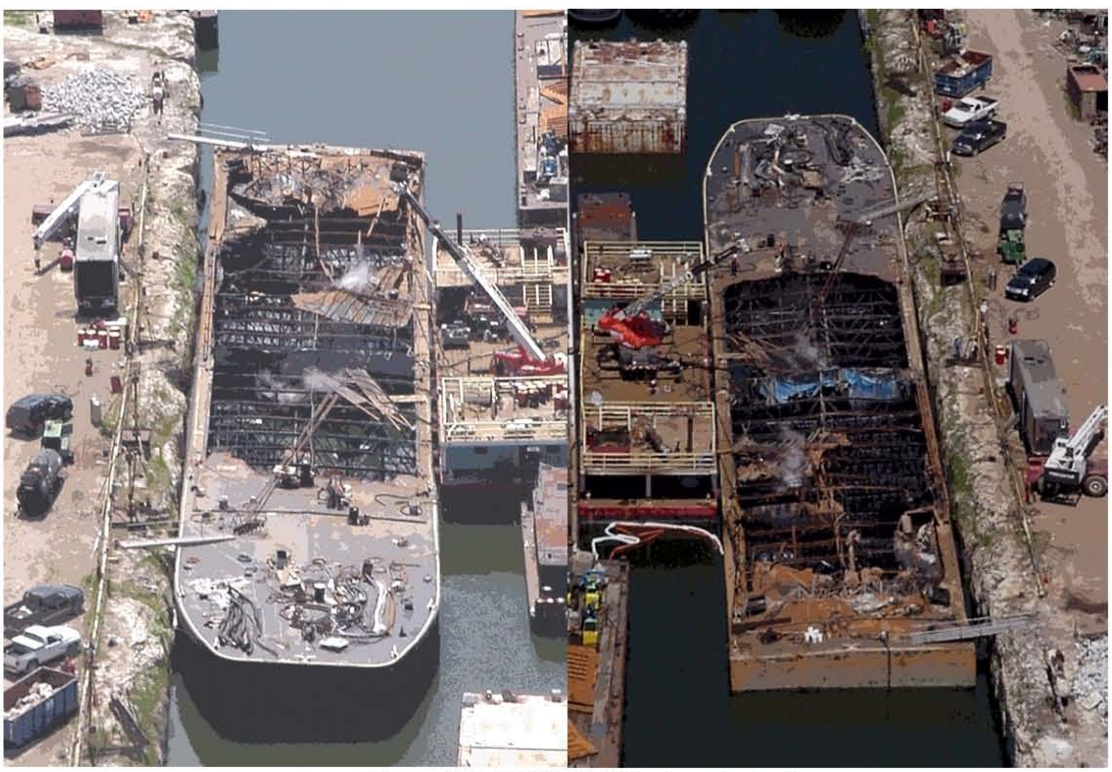

Figure 2-1: EMC 423 (Post-explosion)

Towing Vessel (Figure 2-2)

Name:	LISA E
Official Number:	290450
Service:	Uninspected Towing Vessel (UTV) with hydraulic lifted pilot house
Gross Tonnage:	75
Registered Length, Breadth and Depth:	61’7” x 20’ x 8’4”
Year Built:	1963
Place Constructed:	Houma, LA
Hull Material:	Steel
Hull Construction:	Single skin, single push-knee
Propulsion:	2 – 400 HP Detroit Diesel, Model 12V-71
Electrical:	2 – 20 Kw Lima generators, powered by GM 371 diesel engines
Homeport:	Lemont, IL
Certificate of Documentation renewal date:	November 19, 2004
Owner/Operator:	Egan Marine, Inc. 15200 Canal Bank Road PO Box 669 Lemont, IL 60439

Figure 2-2: M/V LISA E

CHAPTER 3: LICENSED AND DOCUMENTED MARINER INFORMATION

The purpose of this chapter of the investigative report is to present a profile of the individuals who had direct involvement in the marine casualty. This description includes a summary of each member's work experience, qualifications and highlights any additional items of interest relevant to the investigation.

[redacted]	Position:	Master
	License:	Master - Steam and Motor Vessels < 100GT - Great Lakes/Inland Waters. Master Towing Vessels < 100GT – Great Lakes/Inland Waters/Western Rivers Issued - August 3, 2004, Toledo, OH (2nd Issue)
	MMD:	OS-Wiper, Tank-PIC (Barge DL) Issued - December 14, 2001, Toledo, OH (2nd Issue)
	Experience:	Master – 5 years Tankerman – 8 years Industry Total – 9 years
	Residence:	Topeka, IL

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[redacted]	Position:	Deckhand/Engineer ("Deck-ineer")
	License:	None
	MMD:	Tank-PIC (Barge DL) Issued – April 14, 1997, Memphis, TN (1st Issue) MMD SURRENDERED to MSO Chicago in 2001 as the result of a positive drug test. MSO Chicago never received return to work clearance from Medical Review Officer (SAP) for [redacted] to hold safety sensitive position aboard vessels

	Experience:	Industry Total – 10-12 years
	Residence:	Topeka, IL

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[redacted]	Position:	Deckhand
	License:	Master - Steam and Motor Vessels < 100GT - Great Lakes/Inland Waters, Commercial Assistance Towing Issued – June 13, 2001, Toledo, OH (1st Issue) License SURRENDERED to MSO Chicago on June 2, 2005 for failing random drug test after EMC 423 explosion
	MMD:	OS SD (FH) Tank-PIC (Barge DL) EXPIRED – July 23, 2003
	Experience:	Master – 3 years Tankerman – 5 years Industry Total – 7 years
	Residence:	Oak Lawn, IL

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Alexander Oliva	Position:	Deckhand
	License:	None
	MMD:	None
	Experience:	Industry Total – 5 years
	Residence:	Oak Lawn, IL

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[redacted]	Position:	Tankerman
	License:	None
	MMD:	OS, Wiper, SD (FH) Tank-PIC (Barge-DL).

	Issued – March 12, 2003, Toledo, OH. (3rd Issue)
Experience:	Tankerman – 12 years Industry Total – 12 years
Residence:	Lemont, IL

CHAPTER 4: APPLICABLE REGULATIONS

The EMC 423, M/V LISA E, Egan Marine, and the vessel crews are all regulated by the Coast Guard to some extent due to their involvement in the maritime transportation industry. These regulations cover a broad range of different aspects pertaining to the operation of vessels and the companies that own/operate them. Among other things, the regulations outline the requirements for vessel inspections and operations, cargo classification and carriage, and personnel licensing and drug testing. The following table offers a general summary of the major pertinent regulations for each involved subject; however, it is by no means inclusive of all requirements:

Regulation	Description	Regulated Subject
46 CFR Part 30-39 (Subchapter D)	Tank Vessel Regulations	EMC 423
46 CFR Part 50-64 (Subchapter F)	Marine Engineering	EMC 423
46 CFR Part 110-113 (Subchapter J)	Electrical Engineering	EMC 423
33 CFR Part 155	Oil or Hazardous Material Pollution Prevention Regulations for Vessels	EMC 423
33 CFR Part 156	Oil and Hazardous Material Transfer Operations	EMC 423, ExxonMobil
46 CFR Part 24-28 (Subchapter C)	Uninspected Vessels	M/V LISA E
33 CFR Part 164	Navigation Safety Regulations	M/V LISA E
46 CFR Part 16	Chemical Testing	Egan Marine
49 CFR Part 40	Procedures for Transportation Workplace Drug and Alcohol Testing Programs	Egan Marine
33 CFR Part 154	Facilities Transferring Oil or Hazardous Material in Bulk	ExxonMobil
46 CFR Part 10 (Subchapter B)	Merchant Marine Officers and Seaman	Egan Marine
46 CFR Part 13	Certification of Tankerman	Egan Marine
46 CFR Part 4	Marine Casualties and Investigations	Egan Marine

a. Specific regulations important to investigative findings: Listed below are a number of specific regulations that were found to have been relevant in one way or another, leading up to, during, and after the barge explosion. These regulations are not necessarily identified because they directly contributed to the marine casualty; rather, it is important to understand the regulations in order to get a complete picture of the casualty.

1. Inspections, Repairs, Alterations and Configuration.

- **46 CFR 31.10-21a(b) (Periodic gauging of tank vessel midbodies more than 30 years old that carry certain oil cargoes – (TB/ALL))** – *Midbodies of all tank* *vessels certificated to carry a pollution category 1 oil cargo listed in 46 CFR Table 30.25-1 must undergo an initial gauging survey and periodic regauging surveys as follows:*

(1) An initial midbody gauging survey must be accomplished no later than the next drydocking inspection after the midbody becomes 30 years old.

- **46 CFR 30.01-10 (Application of Regulations governing alterations or repairs)** – *"When Major alterations or repairs of tank vessels become necessary the work shall be done under the direction of the Officer in Charge Marine Inspection, and shall be in accordance with the regulations in effect for new construction insofar as possible. When minor alterations or minor repairs of tank vessels become necessary such work shall be under the direction of the Officer in Charge, Marine Inspection, and shall be in accordance with the regulations in effect at the time the vessel was contracted for or build, or in accordance with the regulations in effect for new construction insofar as possible."*

- **46 CFR 31.10-25 (Inspection covering repairs and alterations involving safety) –** *"No extensive alterations involving the safety of a tank vessel either in regard to hull or machinery shall be made without the approval of the Commandant. Before such alterations are carried out, copies of plans and specifications in triplicate for the work involved shall be forwarded to the Officer in Charge, Marine Inspection, in whose zone the repairs will be made, for submission to Headquarters for approval. If approved one set of the plans and specifications, properly stamped and dated, shall be returned to the owner or to the repair yard designated by the owner; one set to the Officer in Charge, Marine Inspection, who forwarded the plans and specifications to Headquarters; and one set shall be retained at Headquarters. If such plans and specifications are not approved, the Commandant shall promptly notify the owner or designated shipyard wherein they fail to comply with the regulations in the chapter. No extensive repairs to the hull or machinery which affect the safety of a vessel shall be made without the knowledge of the Officer in Charge, Marine Inspection."*

- **46 CFR 35.01-1(b)(3) (Inspection and testing required when making alterations, repairs, or other such operations involving riveting, welding, burning, or like fire-producing actions – TB/ALL) –** *"Until an inspection has been made to determine that such operation can be undertaken with safety, no alterations, repairs, or other such operation involving riveting, welding, burning, or like fire-producing actions shall be made... to pipe lines, heating coils, pumps, fittings, or other appurtenances connected to such cargo or fuel tanks."*

2. Classification and carriage of cargoes.

- **46 CFR 30.10-22 (Flammable liquid – TB/ALL) –** *"The term flammable liquid means any liquid which gives off flammable vapors (as determined by flashpoint from an open-cup tester, as used for test of burning oils) at or below a* *temperature of 80 degrees Fahrenheit. Flammable liquids are referred to by grades as follows:*

(a) Grade A. Any flammable liquid having a Reid vapor pressure of 14 pounds or more.

(b) Grade B. Any flammable liquid having a Reid vapor pressure under 14 pounds and over 8 ½ pounds.

(c) Grade C. Any flammable liquid having a Reid vapor pressure of 8 ½ pounds or less and a flashpoint of 80 degrees Fahrenheit or below.

- **46 CFR 30.10-15 (Combustible liquid – TB/ALL)** – *"The term combustible liquid means any liquid having a flashpoint above 80 degrees Fahrenheit (as determined from an open-cup tester, as used for test burning of oils). In the regulations of this subchapter, combustible liquids are referred to by the grades as follows:*

  (a) Grade D. Any combustible liquid having a flashpoint below 150 degrees Fahrenheit and above 80 degrees Fahrenheit.

  (b) Grade E. Any combustible liquid having a flashpoint of 150 degree Fahrenheit or above."

- **46 CFR 30.10-27 (Flashpoint – TB/ALL)** – *"The term flashpoint indicates the temperature in degrees Fahrenheit at which a liquid gives off a flammable vapor when heated in an open-cup tester. For the purpose of the regulations this subchapter, flashpoint determined by other testing methods will be equivalent to those determined with an open-cup tester, as follows:"*

TABLE 30.10–27—EQUIVALENT FLASHPOINTS

[In degrees Farenheit]

Open-cup tester	Tag closed-cup tester (A.S.T.M.)	Pensky-Martens closed tester (A.S.T.M.)
80	75	....
150	....	140

3. Hazardous Locations, piping and venting.

- **46 CFR 111.105-29(c) (Combustible liquid cargo carriers)** – *"Where the cargo is heated to within 15 degrees Celsius of its flashpoint…the weather locations must meet 46 CFR 111.105-31(l)."*

- **46 CFR 111.105-31(l) (Weather Locations)** – *"The following locations in the weather are Class I Division 1 (Zone 1)…and may have only approved intrinsically safe explosion-proof, or purged and pressurized electrical equipment, and through runs of marine shipboard cable if the location is-*

  (1) Within 10 feet (3 m) of:

(i) A cargo tank vent outlet;
(ii) A cargo tank ullage opening;
(iii) A cargo pipe flange;
(iv) A cargo valve;
(v) A cargo handling room entrance;
(vi) A cargo handling room ventilation opening… "

- **33 CFR 155.815 (Tank vessel integrity) –**
  "(a) Except as provided in paragraph (b) of this section, a tank vessel underway or at anchor must have all closure mechanisms on the following openings properly closed:
  (1) Expansion trunk hatches;
  (2) Ullage openings;
  (3) Sounding ports;
  (4) Tank cleaning openings; and
  (5) Any other tank vessel openings that maintain the seaworthy condition of the tank vessel and prevent the inadvertent release of oil or hazardous material in the event of a tank vessel accident.
  (b) No person may open any of the closure mechanisms in paragraph (a) of the section while the tank vessel is underway or anchored except when authorized and supervised by a licensed officer or the tankerman required by 46 CFR 31.15-5(a)."

- **46 CFR 56.50-60(c) (Systems containing Oil) –** *"Filling pipes may be led directly from the deck into the tanks or to a manifold in an accessible location permanently marked to indicate the tanks to which they are connected. A shutoff valve must be fitted at each filling end..."*

- **46 CFR 32.55-25 (Venting of cargo tanks of tank barges constructed on or after July 1, 1951 – B/ALL)** –
  (b) Grade A, B, or C liquids. Cargo tanks in which Grade A, B, or C liquids are to be transported shall be fitted with either individual pressure-vacuum relief valves which shall extend to a reasonable height above the weather deck… "
  (c) Grade D or E liquids. Cargo tanks in which Grade D or E liquids only are to be transported shall be fitted with gooseneck vents and flame screens

- **46 CFR 36.20-1(a) (Flame Screens – TB/ALL) –** *"Flame screens may be omitted in the vent lines on cargo tanks"* (applies to transportation of Grade E materials when shipped in molten form at elevated temperatures).

4. Drug and alcohol testing.

- **46 CFR 4.06-5 (Responsibilities of individuals directly involved in serious marine incidents) –** *"Any individual engaged or employed on board a vessel who is determined to be directly involved in a serious marine incident shall provide blood, breath, or urine specimens for chemical tests required by 46 CFR 4.06-10 when directed to do so by the marine employer or a law enforcement officer."*

- **46 CFR 4.06-10 (Required specimens)** – *"Each individual required to submit to chemical testing shall, as soon as practicable, to provide a specimen for testing."*

- **46 CFR 4.06-5(c) (Responsibility of individual directly involved in serious marine incidents)** – *"No individual may be forcibly compelled to provide specimens for chemical tests required by this part; however, refusal is considered a violation of regulation and could subject the individual to suspension and revocation proceedings…."*

5. Cargo transfer and carriage operations.

- **33 CFR 155.700 (Designation of person in charge)** – *"Each operator or agent of a vessel with a capacity of 250 or more barrels of fuel oil, cargo oil, hazardous material… or each person who arranges for and hires a person to be in charge of a transfer of fuel oil, of a transfer of liquid cargo in bulk, or of cargo-tank cleaning, shall designate, either by name or by position in the crew, the person in charge (PIC) of each transfer to or from the vessel and each tank cleaning."*

- **33 CFR 155.710(b)(2) (Qualifications of person in charge - vessel)** – *"Each tank barge required to be inspected under 46 U.S.C. 3703, the operator or agent of the vessel, or the person who arranges and hires a person to be in charge of a transfer of fuel oil, of a transfer of liquid cargo in bulk, or of a cargo-tank cleaning, shall verify to his or her satisfaction that each PIC - …holds a Tankerman-PIC or Tankerman-PIC (Barge) endorsement issued under 46 CFR part 13.113(a) or (c), that authorizes the holder to supervise the transfer of fuel oil, the transfer of liquid cargo in bulk, or cargo-tank cleaning, as appropriate to the product and vessel"*

- **33 CFR 154.710 (Persons in charge: Designation and qualification)** – *"No person may serve, and the facility operator may not use the services of a person, as person in charge of facility transfer operations unless:*
  (a) The facility operator has designated that person as a person in charge;…"

- **33 CFR 156.150 (Declaration of Inspection)** – *"No person may transfer oil or hazardous material to or from a vessel unless each person in charge, designated under 154.710 and 155.700 of this chapter, has filled out and signed the declaration of inspection form…"*.

- **46 CFR 35.30-10 (Cargo tank hatches, ullage holes, and butterworth plates – TB/ALL)** – *"No cargo tank hatches, ullage holes or butterworth plates shall be opened or shall remain open without flame screens, except under the supervision of the senior members of the crew on duty, unless the tank opened is gas free."*

- **33 CFR 155.815(b) (Tank vessel integrity)** – *"no person may open any of the closure mechanisms in paragraph (a) (expansion trunk hatches, ullage openings,* *sounding ports, tank cleaning openings, or any other openings that maintain seaworthy condition or prevent release of oil or hazardous material) while the tank vessel is underway or at anchor except when authorized and supervised by a licensed officer or tankerman... ".*

- **46 CFR 35.01-10 (Shipping papers – TB/ALL)** – *"Each loaded tank vessel shall have on board a bill of lading, manifest, or shipping document giving the name of the consignee and the location of the delivery point, the kind, grades, and approximate quantity of each kind and grade of cargo, and for whose account the cargo is being handled... in the case of unmanned barges where shipping papers are not available, an entry in the logbook of the towing vessel giving the shipping point, the name of the consignee and the location of delivery point, the approximate kind, grade, and quantity of cargo in each barge of the tow and for whose account the cargo is being handled, shall be considered as complying with the requirements of this section."*

CHAPTER 5: EMC 423 - HISTORY, DESCRIPTION AND CONDITION

The purpose of this chapter is to examine the history and service of the EMC 423. This will include the construction, modification, alteration and repair to both the barge and associated equipment that was original, removed or added to the EMC 423. Each section includes an evaluation as to the status of the barge and equipment at the time of the casualty based on the assembled and examined physical evidence, interviews and hearing testimony.

a. <u>EMC 423 History</u>: The EMC 423 was a 295' x 50' x 10' 3" tank barge built in 1973 by Ingalls Iron Works Company (Hull #1825) in Decatur, Alabama for Canal Barge Line. The name of the barge at the time of construction was the CBC 323 (Exhibit CG-05). The barge was constructed as a part of a three barge tow and was designed to be the lead barge (Pgs. 2920-2924).

The EMC 472 (Ex. CBC 172/Hull #1827) was a 150' x 50' x 10' 3" tank "box" barge designed to be middle barge in the tow. The cargo piping, pumping and heating arrangements were practically identical to that of the EMC 423 (Ex. CBC 323). The only major difference with regard to the type and location of the "as built" equipment was the EMC 472 was outfitted with a two and a half million BTU "Vapor" thermal fluid heater verses a five million BTU "Vapor" thermal fluid heater installed on the EMC 423 (Pgs. 2920-2923). The EMC 424 (Ex. CBC 324/Hull #1826) was designed to be the trail barge in the tow. It was nearly identical to the EMC 423 (Pgs. 2920-2923).

The entire three barge tow (CBC 323, CBC 172 and CBC 324) was purchased by Egan Marine in August, 1994 (Pg. 2921). The barge names were changed to the EMC 423, EMC 472, and EMC 424, respectively (Pgs. 2921-2924, Exhibit CG-05). At the time of the explosion, Egan Marine was still operating the EMC 423 and the EMC 472, but it had sold the EMC 424 (Pgs. 2921-2924).

Although Egan Marine was the sole operator of the EMC 423 from the time of purchase until the explosion, January 19, 2005 ownership was transferred between Egan Marine, [redacted] and different banks numerous times during that period. At the time of the explosion, the recorded owner of EMC 423 was Egan Marine Corporation (Exhibit CG-05).

b. <u>EMC 423 Description</u>: The EMC 423 was a 295' x 50' x 10' 3" tank barge based at Egan Marine, Inc., in Lemont, IL (Exhibit CG-07). The barge was engaged in transporting CSO and other heavy oils throughout the Chicago area (Pg. 29). In regulatory terms, the EMC 423 was a tank barge certificated to transport Subchapter D (oil) cargoes, grade B and lower (Exhibit CG-07). EMC 423 was a black barge with a yellow safety strip around the perimeter. Additionally, the two fuel tanks, fuel piping and metal flashing covering the above deck cargo piping were red, the thermal fluid heater and piping were green, and two spill boxes located on the port side were yellow. The only white found on the EMC 423 was the vessel name and warning signs located midship (Pgs. 3105-3107).

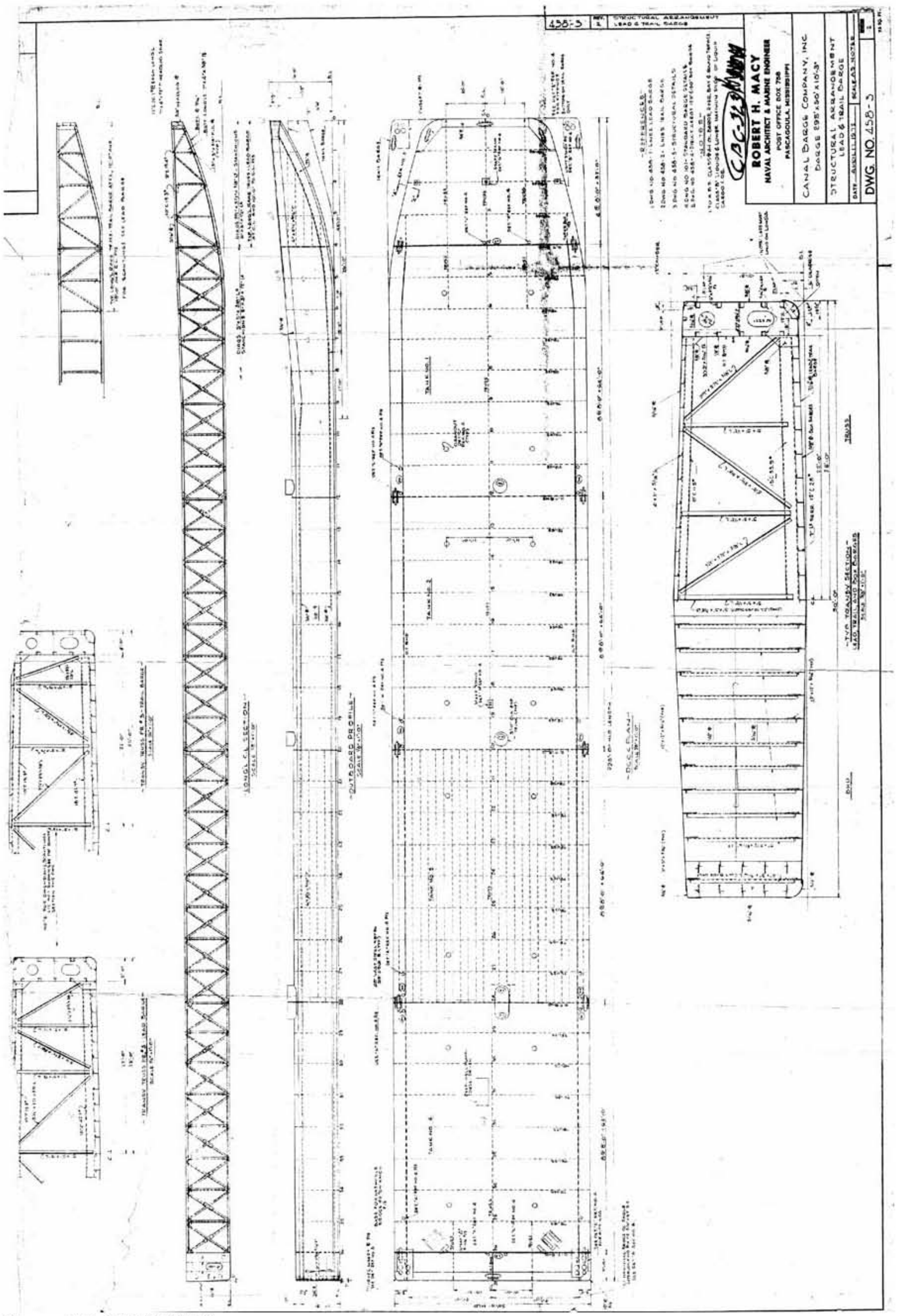


Figure 5-1: EMC 423 Plans

c. Construction: The EMC 423 was an all welded steel constructed tank barge with single bottom, double side, bow rake and box stern. It was divided transversely into 4 separate cargo tanks, numbered 1-4 from bow to stern, with port and starboard wing voids corresponding with each cargo tank. The barge had a rake bow void forward of the cargo tank #1, and a box stern void aft of the cargo tank #4 (Figure 5-1). The total cargo capacity of the EMC 423 was approximately 20,739 barrels with each cargo tank holding approximately 5,200 barrels. The hull was originally constructed with 3/8" mild steel plate, with the frames consisting of 5/16" – 3" x 5" steel angle (Pg. 38).

The EMC 423 was equipped with a variety of appurtenances, machinery and equipment as illustrated below (Figure 5-2). This drawing was created after the casualty using the

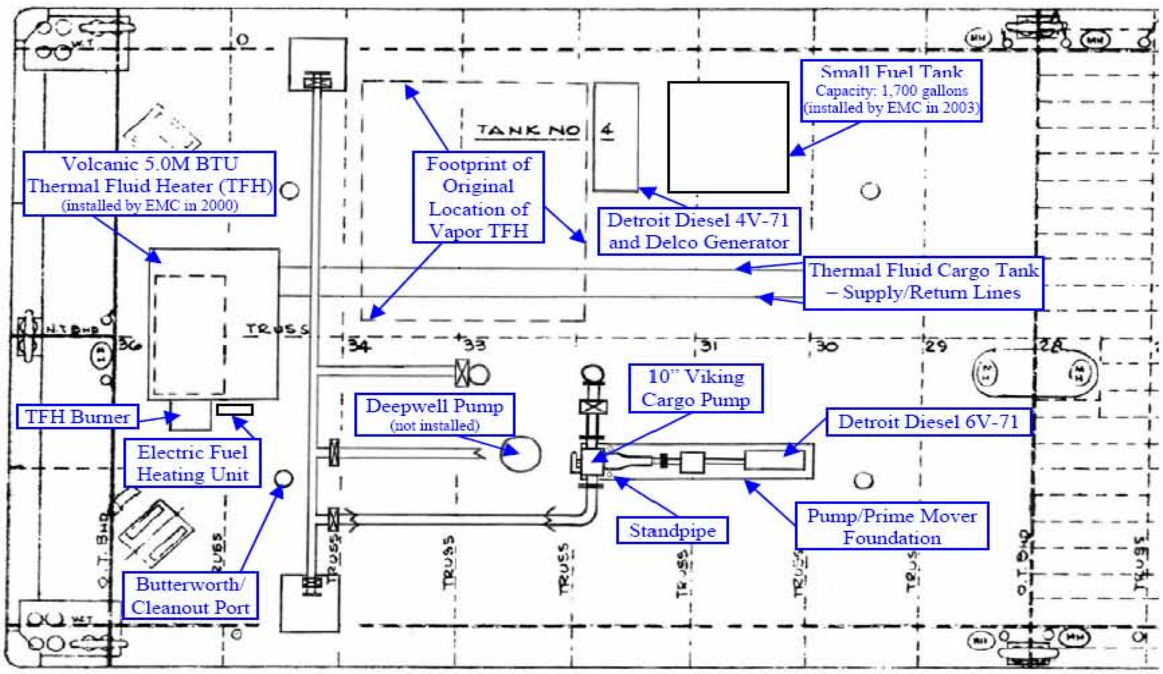


Figure 5-2: Plan drawing of appurtenances, machinery and equipment

aft portion of the plan view of the structural plans (Figure 5-1) upon which to locate the key equipment on board. The configuration and location of each item is based on testimony, exhibits and field observations and measurements

Cargo Tanks: Each cargo tank had one cargo expansion dome located just to the starboard side of amidships (Figure 5-3). Each cargo dome was approximately 2' tall and 3' in diameter, with a standard cargo hatch and four dogs to secure each hatch cover. The cargo

Figure 5-3: Cargo dome/Expansion trunk

Figure 5-4: Ullage opening/Sounding port

hatch covers had a 9" ullage opening /sounding port, which was equipped with a cover and one dog (Figure 5-4). Additionally, each cargo tank had a cargo level indicator, four raised cleanout or butterworth plates and a restricted sounding tube that penetrated the deck plating.

Physical evidence indicates that at the time of the explosion the condition of the cargo hatches was as follows:

#1 Cargo Hatch – Closed/One dog secured
#2 Cargo Hatch – Closed/No dogs secured
#3 Cargo Hatch – Closed/One dog secured
#4 Cargo Hatch – Closed/No dogs secured

Physical evidence indicates at the time of the explosion the condition of the ullage opening/sounding port was as follows:

#1 Ullage Cover – Closed/Dog secured
#2 Ullage Cover – Closed/Dog secured
#3 Ullage Cover – Closed/Dog secured
#4 Ullage Cover – Unable to Determine

Voids: The wing voids, based on construction plans, originally had one hatch per void. Since the barge's construction an additional hatch was installed at the opposite end of each wing void. The bow rake void was found to have three hatches (port, amidships and starboard) while the plans originally called for one amidships hatch. The stern box void had only one centerline hatch, which is consistent with the construction drawings. The hatches were designed to have a hatch coaming of approximately 6" and each was equipped with four dogs to secure the hatch cover (Figure 5-5).

Figure 5-5: Void hatch

d. <u>Fuel System Overview:</u> EMC 423 was equipped with two topside diesel fuel tanks to supply fuel to the barge's machinery, which included the cargo pump prime mover, generator prime mover, and the thermal fluid heater (Pgs. 52-53). It was also equipped with an electric jacket heater that Egan Marine installed on the barge with the intention of heating heavy oils to be burned in the thermal fluid heater (Pg. 56).

Figure 5-6: Large fuel tank

Large fuel tank: The larger fuel tank (Figure 5-6) was on the barge when Egan Marine purchased it (Pg. 52). The tank was located over cargo tank #3, on the port side, having a capacity of approximately 8,000 gallons (Pgs. 52-53). The large fuel tank was not in service at the time of the explosion and was empty, but not gas freed (Pgs. 52-53, 1361).

Small fuel tank: The small tank (Figure 5-7) was constructed by Egan Marine and had a capacity of approximately 1,700 gallons (Pgs. 53-54). It was installed on the EMC 423 in approximately 2003 (Pgs. 54-55) along with the associated piping. It was located transversely in line and forward of the drip pan manifold on the port side of the barge over cargo tank #4 (Pgs. 52-53, Exhibit CG-40). The 1,700 gallon tank was in service at the time of the explosion, and contained approximately 500 gallons of diesel fuel at that time (Pg. 1362). When the fuel tank was recovered from the bottom of the Chicago Sanitary and Ship Canal, only one of the fuel tank access hatch dogs was installed.

Figure 5-7: Small Fuel Tank

Fuel heating system: Egan Marine installed an electric jacket heater (Figure 5-8) on the EMC 423, with the intent of heating heavy/waste oils to the point where they would flow easily and could be burned in the thermal fluid heater (Pg. 56). Their plan was to partition off the large fuel tank so that it could be used to store diesel fuel as well as heavy oils (Pg. 59).

Figure 5-8: Electric fuel heating unit

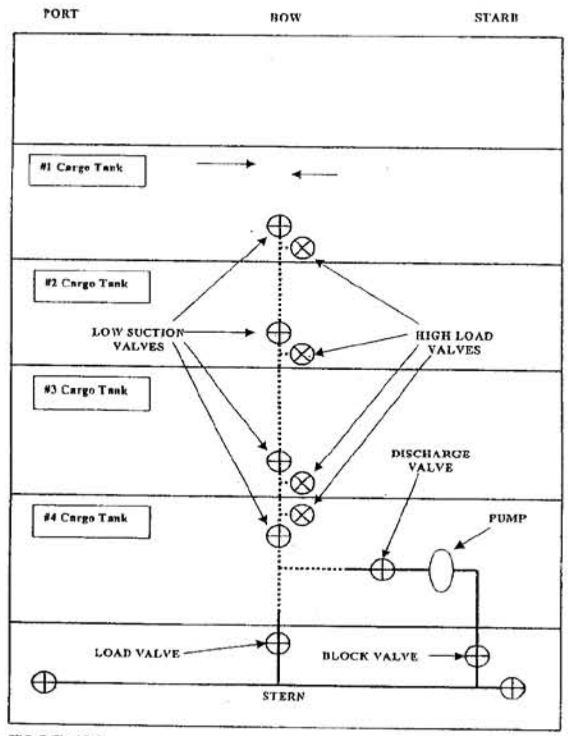
Figure 5-9: Power converter

The fuel heater was not in use at the time of the explosion (Pg. 59). The jacket heater was plumbed and had fuel running through it, but was not yet electrically wired (Exhibit CG-134, Pgs. 462, 498). The heater was mounted forward on the burner end of the thermal fluid heater. In conjunction with the installation of the heater, Egan Marine had placed a power converter on board the EMC 423 for the purpose of stepping up the generator voltage required by the heating unit (Figure 5-9). The power converter was not installed or in service at the time of the explosion (Pgs. 2940-2941).

The Volcanic heater installed aboard the EMC 423 was not designed to burn heavy oils (Exhibit CG-18) The burner (Model C4-OB) was not original to the thermal fluid heater (Exhibit CG-90A). It was purchased by Egan Marine on July 30, 1998 (Exhibit CG-90a) and installed around 2001 (Pg. 45, Exhibit CG-17). The burner was designed to burn #2 diesel oil (Exhibit CG-18).

e. <u>Cargo System Overview</u>: Figure (5-10) is a simple line diagram that illustrates the cargo piping system utilized aboard the EMC 423 at the time of the casualty.

Cargo Piping: EMC 423 cargo piping is of welded construction using ½" mild steel pipe. A single 10" load/discharge line runs along the port side of centerline, below deck, to each cargo compartment. As this 10" line passes through the bulkhead between cargo tanks #1/#2 the line reduces to an 8" line. The 8" athwartship cargo header, located near the stern running above deck its full width, serves as both the cargo load and discharge header. Both port and starboard header manifolds are outfitted with block valves and drip pans were located under each to contain any spillage. The drip pans were plumbed to drain back into cargo tank #4 and were fitted with both a check and a globe valve. The portion of the cargo piping that is dedicated to the loading of the barge is attached to the cargo header nearly amidships and runs forward approximately 11' where the load valve is installed before dropping below deck. The discharge line is the nearest cargo line junction to the starboard manifold and runs longitudinally forward approximately 19' before elbowing into the discharge side of the cargo pump.



EMC 423

Figure 5-10: Piping diagram (dotted line below deck)

Figure 5-11: Low Suction

The discharge line attached to the supply side of the pump runs inboard about 6' ultimately tying into the cargo load line inside the cargo tank #4 and includes the discharge valve, a check valve and a strainer. All cargo lines located above deck were wrapped in insulation and covered by a red cowling. Each cargo tank was outfitted with a low suction valve located at the

Figure 5-12: High Load Valve

bottom of each tank (Figure 5-11) and a high load valve elevated approximately 3' from the bottom of the cargo tank bottom, (Figure 5-12). The valves were fitted with reach rods located on deck to facilitate their operation.

Cargo pumping: The primary cargo pump aboard the EMC 423 was a jacketed head 10" Viking (Model P332) positive displacement pump (Figure 5-13), powered by a Detroit Diesel 6V-71 engine via a Faulk reduction gear The prime mover was not located after the explosion. Jacketed head (R and P models) and rotor bearing sleeve provide large chambers at both ends of pumping chamber through which a heating medium is circulated for temperature control of cargo in the pump. The head was equipped with two fittings that served as an inlet and an outlet for the medium's circulation path Figure 5-13 (A)).

Figure 5-13: Viking Cargo Pump

The EMC 423 was designed to have a deep well pump installed in the #4 cargo tank, but the pump well had been blanked off and no pump was installed at the time of the casualty (Pg. 39).

Bleed Valve: On the top of the cargo pump casing, discharge side, was a non-standard "bleed valve" mechanism (Figure 5-14). According to the manufacturer this arrangement was not necessary because the pump was a positive displacement/self priming pump (Pg. 2444). The valve was still attached to the pump and was in the closed position when it was recovered from the CSSC after the explosion.

Figure 5-14: Bleed Valve

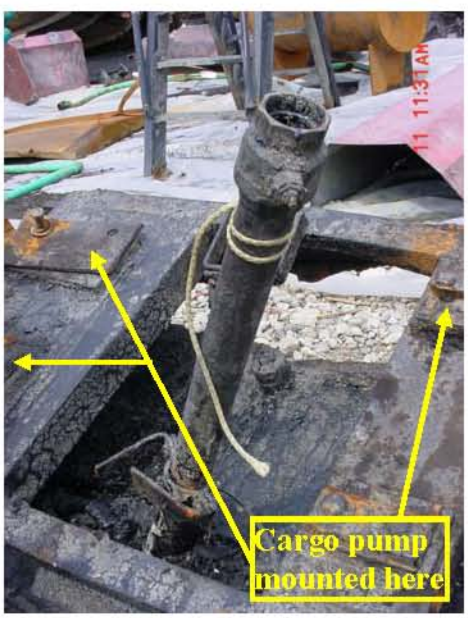


Figure 5-15: Stand pipe attached to #4 cargo tank top within cargo pump foundation

Standpipe: Located adjacent to the cargo pump, on the starboard side, within the pump/prime mover's base frame was a "standpipe" that stood approximately 37 7/8" tall with a 2 ½" nominal diameter (Figure 5-15). The standpipe, which was welded to the barge's tank top, had direct communication with cargo tank #4 (Figure 5-16).

Testimony by several witnesses indicated that the standpipe was used to drain product generated from the bleed valve back into the cargo tank (Pgs. 3098-3099). The standpipe was loosely attached to the cargo pump frame when it was recovered from the canal and the internal surface of standpipe and the standpipe threads were coated with a thick, black petroleum product.

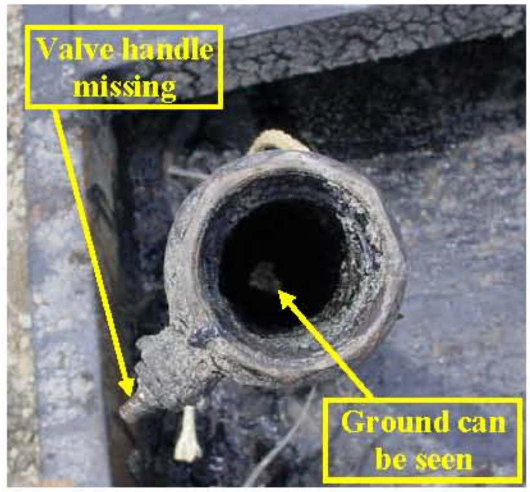


Figure 5-16: Standpipe penetrates remnant of deck plating

The end of the standpipe was threaded, but it did not have a closure device (cap or plug) in place when it was recovered. Employees of Egan Marine testified that the standpipe was fitted with various closure devices and/or fittings. [redacted] stated that the standpipe fitted with 3" to 2" "funnel" at the top, and no additional fittings, while [redacted] stated that the standpipe was fitted with a threaded cap. The owner, [redacted] stated the standpipe was fitted with three additional fittings; a cap, a reducer fitting, and a nipple (Pgs. 3014-3015, 3019-3023, 3097).

The only fitting found on the standpipe when recovered was what appeared to be a ball valve. There was no valve handle nor was there any apparent damage to valve/handle stem or threads and the valve was in the open position (Figure 5-16). No check valve was installed in the standpipe. [redacted] a Bureau of Alcohol Tobacco, Firearms and Explosives (ATF) agent testified that the standpipe or the threads did not appear to have any damage that would indicate that there were any fittings as described in place at the time of the explosion. The ATF expert also testified that there were no indications of mechanical damage to the valve (Pgs. 3239-3240).

Figure 5-17: Cargo tank #1 P/V valve

Cargo Venting: Each cargo tank aboard the EMC 423 was equipped with a 3" Vac-Rel Pressure Vacuum (PV) valve set at 1 pound pressure, 0.5 pound vacuum. The barge was outfitted with PV valves to comply with the certification requirements to carry grade B and lower cargoes. However, the regulations permit barges carrying elevated temperature Grade E cargoes in molten form (CSO) to utilize gooseneck vents (without flame screens) as adequate cargo tank venting.

Figure 5-18: Cargo tank P/V valve

After the explosion it was discovered that one of the bolts holding cargo tank #1 PV valve in place was partially backed out (Figure 5-17). Three additional PV valves were recovered after the explosion with similar conditions found on those also (Figure 5-18). Additionally, the flame screen was largely clogged (Figure 5-19).

Figure 5-19: Cargo tank #1 P/V flame screen

f. Cargo Heating Overview: EMC 423 was equipped with a five million BTU "Volcanic" thermal fluid heater at the time of the explosion. The thermal fluid heater provided heating to the cargo tanks through coils installed in the bottom of the tanks. The above deck portions of the cargo line and cargo pump received heat from trace lines that ran along the cargo pipe and through the cargo pump casing (Figure 5-20 - Green lines represent the heat trace line). This heating system allowed the barge to carry heavy, high viscous oils. The heat trace system line diagram is based on the reconstruction and examination of physical evidence. Reconstruction of the system was necessary because no plans existed of the system; nor could the employees or crew provide a description of the systems configuration.

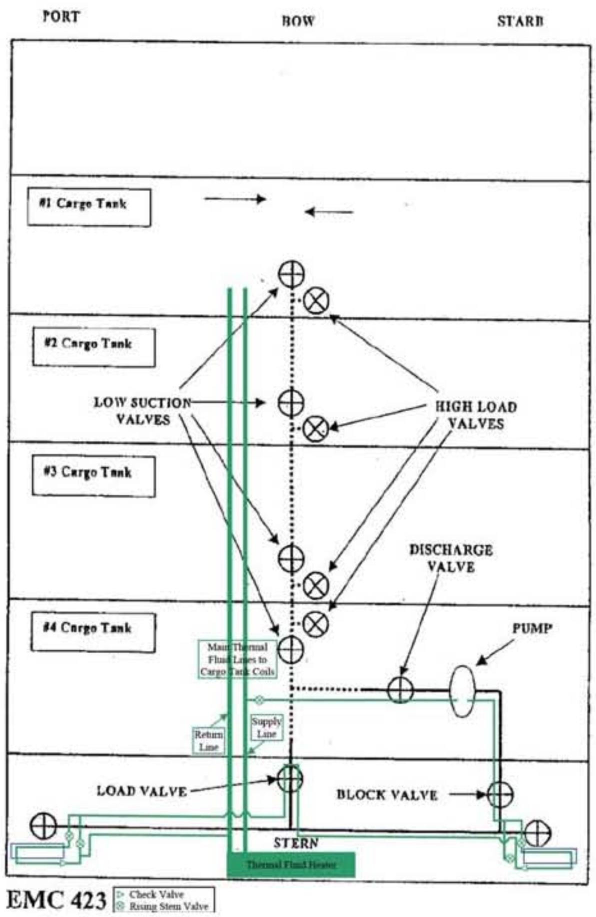


Figure 5-20: Heat trace system - line diagram

Thermal Fluid Heater: The EMC 423 thermal fluid heater was built in 1971 by Volcanic Heater, Inc., and was originally sold for installation on a different barge (Exhibit CG-90). The thermal fluid heater was rebuilt by Egan Marine and then installed on the EMC 423 between 2000 and 2001; replacing the original five million BTU "Vapor" thermal fluid heater (Pgs. 41-42). The heater fluid medium used was Thermia © Oil. The Volcanic heater was positioned athwart ship on the EMC 423, slightly port of the centerline on the stern of the barge. At the time of the explosion, the heater was running and appeared to be operating normally

Figure 5-21: Thermal fluid heater recovery

(Exhibit CG-90). The heater was jettisoned from the EMC 423 during the explosion and was later recovered from the canal largely intact (Figure 5-21).

Heating Coils: The cargo heating system included heating coils that circulated the Thermia © Oil throughout all four cargo tanks. There were 2 sets of coils per tank, one upper and one lower (Figure 5-22). The lower coils ran along the cargo tank bottoms, and the upper coils were elevated approximately 21 inches above the tank bottoms. At the time of the explosion only the lower coils were in operation (Pg. 1380).

Figure 5-22: Cargo Tank Heating Coils

Heat tracing: The EMC 423 was outfitted with a heat tracing system to minimize cargo solidifying and clogging the piping/pumping system during cold weather. The tracing system consisted of a variety of steel piping and thin walled stainless steel tubing (approximately ½ inch diameter) that ran along the above deck cargo piping underneath the piping insulation. The heat tracing also served as the supply of heated oil for the cargo pump casing. At various points along the system valves were installed to isolate individual areas of the heat tracing system. The stainless steel tubing sections were connected to one another and to the mild steel piping with compression fittings.

Figure 5-23: Heat trace valve

Of the heat trace valves recovered after the explosion, 3 of 4 were in the closed position (Figures 5-23, 5-24). Other valves were found of a similar size in the closed position but could not be clearly associated with the heat trace system.

Figure 5-24: Heat trace valve

The crew of the M/V LISA E stated that the EMC 423 heat tracing system was in use at the time of the explosion (Pgs. 3103, 3105). Visual examination of the physical evidence after reconstruction of the transfer header, loading discharge piping and cargo piping heat trace system, including the cargo pump (Figure 5-25), indicated that a section of the heat trace piping/tubing between the cargo pump and transverse header was apparently not connected at the time of the explosion. Specifically, the examination of the debris revealed several factors that indicated that this section of the heat trace piping/tubing was not connected when the barge suffered the casualty.

Figure 5-25: Reconstructed transfer header, loading and discharge piping including cargo pump

The first factor that was considered was the disproportionate extent of damage sustained between the cargo pump, (including suction and discharge piping) relative to the thin walled stainless steel tubing used for the cargo pump heat trace system. Damage to the pump consisted of: 1) the pump casing flange on the suction side being broken off, 2) the pump discharge pipe (approximately 8 inch diameter mild steel pipe with approximately ½ inch wall thickness) was rent just past the elbow from the portion of pipe that leads to the discharge block valve (Figure 5-27(A), 3) the cargo pump's cast feet and pump bracket feet were broken off and 4) the cargo pump, The pump, Faulk reduction gear and prime mover were all separated from the foundation and thrown from the barge and all but the prime mover were later recovered from the Chicago Sanitary Ship Canal. This massive damage to the cargo pump and appurtenances significantly contrasted to apparent little to no damage incurred by the heat trace tubing on the EMC 423 cargo pump (Figure 5-27(B)) with its smooth bent shape, nearly identical to that found on the EMC 427, still intact. [redacted] (ATF) testified that he compared the heat trace line configuration from the EMC 472 (Figure 5-26) with that of the EMC 423 and concluded that the EMC 423 heat trace line (Figure 5-27(A)) was not bent or damaged at all during the explosion, despite the cargo pump being thrown from the barge during the explosion (Pgs. 3247-3250).

Figure 5-26: EMC 427 Cargo pump with heat trace tubing

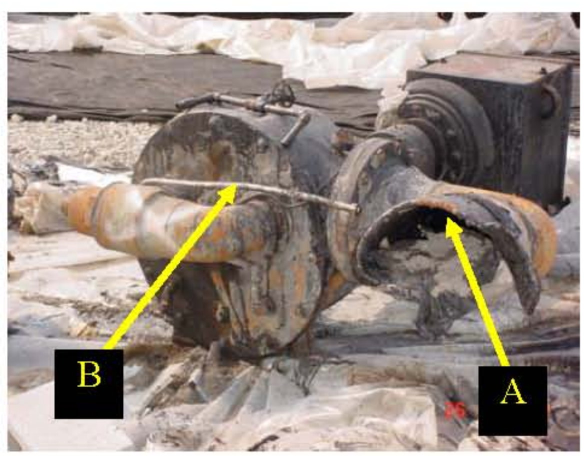


Figure 5-27: Cargo pump heat trace tubing, post-explosion

Figure 5-28: Header compression fitting

The second key factor that was discovered was the condition of the compression fittings found at the end of the tubing that remained connected to the cargo pump (Exhibit CG 131, Figure 5-29) and the fitting found at the intersection of the discharge pipe and the athwart ship cargo header (Exhibit CG 132, Figure 5-28). Field reconstruction of the above deck cargo piping and associated heat tracing piping/tubing allowed for not only determining how the heat tracing system was routed (Figure 5-20) but also where key components fit into the configuration. In the case of the section between the starboard header valve and the pump discharge piping connection, the determination was based on the matching length of the piece relative to the length of cargo piping between the starboard discharge valve and the intersection of the discharge pipe and the athwart ship cargo header. The last factor was the branch line similarities to the port end of the header (Figures 5-30 and 5-31). The port heat trace piping was still banded in place when that section of the cargo header was recovered.

Figure 5-29: Compression fitting on cargo pump

[redacted] examination of the compression fitting on the end of the cargo pump heat trace line (Figure 5-29) revealed that the "compression ring has necked down the tubing as it was designed to do" so that the nut was captive and would not come off. He also indicated that upon an examination of the internal threads of the nut that no "deformation of the pitch of the threads due to some mechanical forces or explosives" was observed (Pgs. 3244-3245). With regard to the compression fitting found on the section of heat trace piping that ran along the starboard end of the cargo header adjacent to the discharge pipe, disassembly of the fitting found that the two key components, the nut and the olive, were present and undamaged (Figure 5-32). [redacted] also testified that he examined this compression fitting finding no mechanical damage was sustained by the fitting and that he did not find any evidence of any tubing remaining in the fitting (Pg. 3246). Using

Figure 5-30: Starboard header with heat trace piping

Figure 5-31: Port header with heat trace piping

a close up of a section of the heat trace line diagram (Figure 5-20) the location of the undamaged/unconnected compression fittings and the apparent unconnected section of heat trace piping/tubing has been illustrated (Figure 5-32).

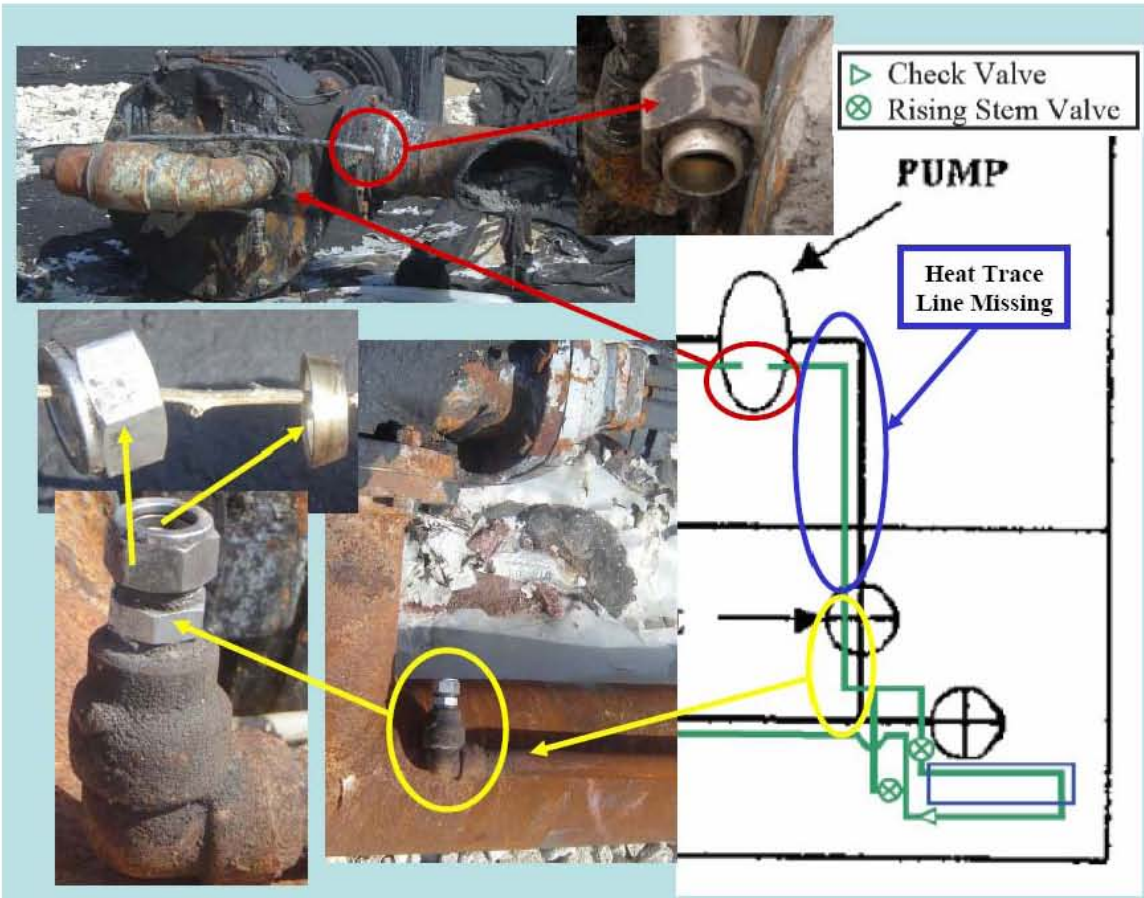


Figure 5-32: Illustration of the location of the unconnected/undamaged compression fittings and the missing section of heat trace piping/tubing (location of each indicated on close up section of heat trace line diagram)

In contrast to the two undamaged/unconnected compression fittings (Figures 5-28 and 5-29) are the many other similar fittings that were found amongst the debris. These fittings, upon examination, were found to be of the same nature as those discussed above in that both the stainless steel tubing to tubing fittings were found as well as the mild steel piping to tubing connections (Figure 5-33). In each of these other instances, the fitting was still intact and the tubing or piping remained firmly in place. This remained true even where the severest of damage to the fittings and attached piping/tubing was observed. [redacted] finding, with regard to the other fittings available for examination, was that "[t]ubing was destroyed, bent, mashed, torn, but the fittings were in place" (Pg. 3250).

Neither the fitting at the pump nor the fitting located at the junction of the discharge line and the main header had any indication of being connected immediately preceding the

Figure 5-33: Pictures of other fittings found intact amongst the recovered debris

explosion. It is impossible to determine by the physical evidence when and why the heat trace system had been dismantled in this area but without this segment connected, according to [redacted] the heat trace system for the cargo pump and likely for the above deck piping, would not have been functional (Pg. 3043). [redacted] testified that based on his evaluation of the evidence, "there was nothing there or it was disconnected somehow, so that when this event occurred, it could not be pulled or destroyed or bent by the insulation in the shroud and the other piece of stainless that would have to have [been] connected to that fitting." (Pgs. 3248-3249).

g. Electrical System Overview: The EMC 423 was equipped with a 60 kilowatt Delco brushless generator, powered by a Detroit Diesel 4V-71 prime mover. Figure (5-34) depicts an identical unit from the EMC 472. The generator was used exclusively to provide power to the thermal fluid heater control panel although there were plans to power the electric fuel heating element when the wiring was completed. The barge used portable navigation lights powered by 12 volt batteries. All wiring was run in conduit and was located above deck. The EMC 423 generator was located on the port side of the barge just forward of truss 32, above cargo tank #4.

Figure 5-34: EMC 472 generator/4V-71 Detroit Diesel

The generator was running at the time of the explosion and was recovered from the canal after the explosion. The generator prime mover was examined after the explosion by representatives from Detroit Diesel Corporation, who concluded that the engine appeared to be in good condition and operating properly at the time of the casualty (Exhibit CG-140).

h. <u>EMC 423 Alterations</u>: Over the years that Egan Marine owned and operated the EMC 423, there were several alterations made to the barge and its equipment.

Steel plate: In 2000, Egan Marine replaced the steel plate and longitudinal framing on the port and starboard side of the EMC 423 between the aft bulkhead of the bow rake and the forward bulkhead of the stern void (Pg. 457). The existing plate was 3/8" and was replaced with 3/8" plate on both sides, with the exception of the plate 60' forward and aft of the amidships on either side which was replaced with 1/2" plate. The existing 1/2" 4" x 6" longitudinal framing was replaced with 5/16" 3" x 5" angle (Pgs. 36-38). There is no record that the Coast Guard was notified, approved or inspected the side shell alterations (Exhibit CG-08).

Egan Marine replaced the EMC 423 cargo tank #1 top around 2000 (Exhibit CG-17, Pg. 36). There is no record that the Coast Guard was notified, approved, or inspected the tank top replacement (Exhibit CG-08).

There were several improper repairs noted on the EMC 423 tank top (Figure 5-35). These repairs consisted of various size steel inserts in the cargo tank tops. The inserts were not installed over frames, did not have radius/rounded corners, and included steel backing strips installed on the cargo side of the tank top. The owner of Egan Marine stated that his understanding was that "small" tank barge repairs did not need to be reported or inspected by the Coast Guard (Pg. 69).

Figure 5-35: Cargo tank top repairs

Thermal Fluid Heater: When Egan Marine purchased the EMC 423 it was equipped with a 5 million BTU Vapor thermal fluid heater. The Vapor thermal fluid heater was replaced by Egan Marine with a 5 million BTU Hopkins Volcanic thermal fluid heater in 2000 (Pgs. 40-41, Exhibit CG-08). Figure (5-36) depicts the EMC 472 thermal fluid heater, which was nearly identical to the original location and configuration aboard the EMC 423. According to [redacted] owner of Egan Marine, the only difference between the original EMC 423 thermal fluid heater installation and that of the EMC 472 heater was the heating capacity of the two thermal fluid heaters (Pgs. 2921-2922). [redacted] had previously testified that the Volcanic thermal fluid heater was installed in the exact same location on the EMC 423 as the Vapor unit that was removed (Pg. 41). However, upon examination of the EMC 423 the remnants of the Vapor thermal fluid heater "house" foundation were

Figure 5-36: EMC 472 Vapor thermal fluid heater

found forward of the cargo header, on the port side of the barge, adjacent to the generator (Figure 5-37).

Figure 5-37: EMC 423 Vapor thermal fluid heater house foundation

The Volcanic heater was installed aft of the cargo header, slightly to the port side of the EMC 423 centerline, approximately 16' aft of where the original Vapor unit was located (Exhibit CG-36, CG-40 and CG-58). There is documentation that the Coast Guard was aware, in 1999, that the thermal fluid heater was to be changed but there is no record that plans were submitted to the Coast Guard or that Coast Guard inspectors monitored the installation of the new thermal fluid heater (Exhibit CG-08). There is no indication in any inspection reports that acknowledges the thermal fluid heater's replacement or move to a new location on the barge.

The thermal fluid heater, which generates an open flame when in use, was also equipped with motors for the blower, electrical fuel pump and circulation pump that did not meet the requirements to be located in a hazardous location (Exhibit CG-117 and 118, Pgs. 3032-3033). This equipment was located within 10' of the two aft cleanout or butterworth ports for the cargo tank #4. The area within 10' (3 meters) of these cargo tank flanges are classified as a hazardous location for weather locations (Pg. 3032).

Fuel Heater: In August, 2004 Egan Marine installed a heat exchanger on the EMC 423 with the purpose of heating heavy oils to be burned in the thermal fluid heater (Figure 5-8) (Pg. 461). The heat exchanger was mounted on the forward inboard side of the thermal fluid heater. It was plumbed to the fuel tanks aboard the EMC 423, but it was not electrically connected (Pgs. 462, 498). There is no record that the Coast Guard was notified, approved, or inspected the installation of the heat exchanger.

A transformer was installed aboard the EMC 423 to operate in conjunction with the heat exchanger (Figure 5-9). The purpose of the transformer was to step up the generator voltage from 220 volts to 480 volts, which is what the heat exchanger required to operate. The transformer located on board the EMC 423 but was not in operation or installed at the time of the explosion (Pgs. 2940-2941). There is no record that the Coast Guard was notified or approved of the pending installation of the transformer.

Small Fuel Tank: Egan Marine added a 1,700 gallon fuel tank, and associated piping, aboard the EMC 423 in September, 2004 (Figure 5-7) (Pg. 496). The fuel tank was to be used in conjunction with the fuel heating system that Egan Marine was installing. The tank was built by Egan Marine (Pg. 54). There is no record that the Coast Guard was notified, approved or inspected the fuel tank or associated piping during construction or installation.

i. <u>Inspection History</u>: As an inspected tank barge, the EMC 423 was required to be inspected annually by the Coast Guard. In addition, it was required to undergo a Drydock Exam, Cargo Tank Internal Exam, and Internal Structural Exam every five years. The following outlines the EMC 423 inspection history from the time that Egan Marine Corporation purchased the barge until it exploded:

Date	Inspection type	Inspecting Unit	Comments
23 Feb 95	Mid-Period	MSO Chicago	No Deficiencies.
08 Mar 96	Inspection for Certification	MSO Chicago	No Deficiencies.
17 Mar 97	Mid-Period	MSO Chicago	No Deficiencies.
02 Mar 98	Inspection for Certification	MSO Chicago	(2) Deficiencies.
01 May 98	Deficiency Check	MSO St. Louis	Cleared (2) outstanding Deficiencies.
08 Sep 99	Mid-Period, Internal Structural Exam	MSO Chicago	Barge Certificate of Inspection revoked because cargo tank internal and drydock exams overdue.
09 Sep 00	Inspection for Certification	MSO Chicago	No Deficiencies. Vessel issued new 5-year Certificate of Inspection. Overdue cargo tank internal and drydock exams not conducted.
07 Sep 01	Re-inspection	MSO Chicago	(1) Deficiency – corrected.
08 May 03	Drydock Exam, Internal Structural Exam, Cargo Tank Internal Exam	MSO Chicago	No Deficiencies. Inspection was not entered into Coast Guard Database (MISLE) until 02 Mar 2004. Entry was made by the inspector after he transferred to a new unit.
01 Mar 04	Re-inspection	MSO Chicago	(2) Deficiencies - cleared.
20 Sep 04	Inspection for Certification	MSO Chicago	(1) Deficiency. Provide section modulus report. Deficiency overdue at the time of the explosion.

There are a number of notable items contained in the EMC 423 inspection history.

- On September 8, 1999, the EMC 423 Certificate of Inspection was revoked because the barge missed required drydock and cargo tank internal examination intervals.

- The barge was out of service and was not subject to Coast Guard inspection from the time that the Certificate of Inspection was revoked, until it was inspected for certification on September 9, 2000. During that one-year period, Egan Marine replaced the EMC 423 thermal fluid heater and significant portions of the barge's side shell and tank top over #1 cargo tank. There is no record that these alterations were approved or inspected by the Coast Guard (Exhibit CG-08).

- On September 9, 2000, the Coast Guard inspected the EMC 423 for certification and issued a 5-year certificate of inspection. There is no record that the Coast Guard completed the overdue drydock and cargo tank internal exams prior to issuing the Certificate of Inspection. These overdue exams were the original reason that the barge's certificate had been revoked in 1999.

- The EMC 423 missed its required mid-period and annual re-inspections in 2002 and 2003.

- On March 2, 2004 the Coast Guard documented the EMC 423 drydock, internal structural, and cargo tank internal exam. These examinations were conducted on May 8, 2003 but were not documented until over a year later and after the inspector had transferred to a new unit.

Inspection Record Keeping: The Coast Guard maintains an electronic database to record all marine inspections and track vessel histories. The database is named the Marine Information for Safety and Law Enforcement (MISLE) system. This database replaced the existing Marine Safety Information System (MSIS) in 2002.

All vessel inspections are required to be documented in MISLE and before that in MSIS; however, the EMC 423 inspection records vary greatly with regard to the level of detail provided for each inspection (CG-08). The most evident case of this was illustrated in the November 3, 1999 inspection of the EMC 423. The inspector noted that the *"Barge will be adding a thermal fluid heater"*, but provided no details as to what kind of heater, when it would be added, if plans had been approved, etc. All this information is significant to document that proper approval and inspection procedures were followed when adding the new thermal fluid heater. It is also important in order to complete an accurate historical record of the barge and its equipment.

The Coast Guard Marine Safety Manual Volume II, Chapter 3 outlines the documentation of vessel inspections. This manual was last updated in 2000 before the MISLE database came online. Therefore, much of the guidance regarding the documentation of vessel inspections is specific to the MSIS system and does not translate to the new MISLE database. Furthermore, the guidance mostly provides <u>recommended</u> practices to document inspections and is not specific as to what information is <u>required</u> to be documented during a vessel inspection.

CHAPTER 6: CARGO ANALYSIS

The main purpose of this section of the investigative report is to identify the characteristics of Clarified Slurry Oil (CSO) and to examine how the cargo is regulated, whether the current regulations are adequate, and finally whether the regulations (or lack of regulations) were causal factors in the EMC 423 explosion.

CSO is called by many different names throughout the shipping and petroleum industry, to include: Catalytic Cracked Clarified Oil (petroleum), Black Oil, Residual Oil, Carbon Black Oil, Clarified Oil, Catalytic Cracked Fractionator Bottoms, Cat Slurry Oil, FCCU Claroil, FCCU Decant Oil, FCCU Slurry Oil, Carbon Black Feedstock, Fluid Catalytic Cracker Unit Recycle Oil, Syntower Bottom, Catalytic Cracked Decant Oil, Low Sulfur Fuel Oil, Clarified Slurry Oil, Factionator Bottoms – FCCU and FCC Main Column Bottoms.

The only commonality found with regard to identification of this cargo was the *Chemical Abstracts Service* (CAS) number and name - CAS# 64741-62-4; Oil, Carbon Black, or Clarified Oils (petroleum), catalytic cracked. However, regardless of the name chosen to identify CSO, it can be characterized as thick, black, dirty oil with a characteristic aromatic odor and a density which approaches or exceeds that of water.

CSO is the residuum/byproduct of the refining process after virtually all of the higher-quality hydrocarbons have been distilled, cracked, or catalytically removed from crude oil feedstock. The substance may be liquid or semi-liquid and contains mostly asphaltic hydrocarbons (complex high molecular weight compounds of varying properties) having carbon numbers predominantly greater than C20. CSO is not refined to meet any prescribed product specifications; it is essentially everything that remains after all of the "high value" material is removed from the crude oil.

CSO is generated at ExxonMobil – Joliet by employing a catalytic cracking process using Canadian Heavy crude oil as its typical crude oil feed stock. The feed stock crude oil and refinement optimization process has a direct effect on the composition of the CSO. CSO is generated by ExxonMobil at a rate of approximately 0.7 gallons (1.6 to 1.7 percent) for each barrel of crude oil processed; totaling approximately 3,800 barrels (159,600 gallons) per day. This residuum is typically used as a finished residual fuel for industrial boilers or other direct source heating applications. The CSO that is generated at the ExxonMobil refinery is either used locally as a heavy boiler fuel or transported by barge through the western river system to New Orleans, where it is loaded on board tank ships for transport overseas. As a residual product of the refinery process and consistent with one of its principle uses, CSO is best categorized as a residual fuel oil.

According to the Material Safety Data Sheet (MSDS) provided by ExxonMobil, the CSO produced at the Joliet refinery had a vapor pressure of <5.0 mmHg at 20° C (approximately 0.5" Hg or 0.245 psi at 100° F), a flash point of >141° F (61° C) and a pour point of approximately 50° F.

a. Shipment/classification of oil and hazardous materials: The regulations pertaining to the shipment of oil or hazardous materials by barge are largely determined by the cargo and its specific hazards. For the most part these regulations are geared toward the facility that transfers the product, the vessel, and the cargo itself.

Facility: Facilities that transfer bulk liquid hazardous cargoes are regulated by the Coast Guard under Title 33 CFR, Part 154 (Facilities Transferring Oil or Hazardous Material) and Title 33 CFR, Part 156 (Oil and Hazardous Material Transfer Operations). However, these regulations deal primarily with the pollution prevention aspect of transfers and do not grade or delineate cargoes according to their flammability or hazard. The cargoes are simply divided into two groups (oil and hazardous materials) for the purpose of applying specific pollution prevention regulations.

Facilities are not required to provide the flashpoint or grade of a cargo (46 CFR 30.10) to the vessel receiving the cargo. Additionally, facilities develop and use a "regulatory compliant" MSDS, which does not contain the specific grade information regarding the cargo being transferred. Facility persons in charge and tankerman are required to discuss the "identity" of the product to be transferred in accordance with Title 46 CFR 156.120(w) (1). However, the lack of guidance as to what specific information must be provided makes it difficult, if not impossible, for towing vessel captains to fulfill the requirement to record the "approximate kind, grade, and quantity of cargo" contained in each unmanned barge in accordance with Title 46 CFR Part 35.01-10.

Vessel: Tank vessels that transport oil and hazardous materials are regulated by the Coast Guard under Title 46 CFR, Subchapter D (oil) and Subchapter O (hazardous materials). For the purposes of this report, only the regulations specific to oil cargoes and their classification are addressed.

Tank barges that transport oil cargoes are regulated under Title 46 CFR, Subchapter D. The cargo venting, gauging and overfill protection requirements on these barges are determined by the grade of cargo that the barge is allowed to carry; the more flammable or volatile the product, the more stringent the requirements placed on the barge. The cargo grades are based on product flashpoint and/or Reid vapor pressure. The cargo grades range from grade A (most flammable) to grade E (least flammable). According to the ExxonMobil – Joliet Refinery MSDS, the CSO loaded aboard the EMC 423 had a flashpoint of $>141^{\circ}$ F (ASTM D 93 – Pensky-Martens Closed Cup (CC)). Based on the information contained in the MSDS and the definitions in Title 46 CFR Part 30, the Coast Guard would classify this material as a Grade E combustible cargo. The EMC 423 Certificate of Inspection authorized the barge to carry grade B and lower cargos, which would include highly flammable products such as gasoline.

Cargo: Every hazardous cargo is required by regulation to have a corresponding Material Safety Data Sheet (MSDS), which must be published by the chemical manufacturer or importer. In accordance with Title 29 CFR, Part 1910 the MSDS must contain certain information pertaining to a cargo's characteristics and associated hazards. These regulations stipulate the minimum information necessary to be published in an MSDS;

however, there is no restriction against adding additional information. There is also no requirement for an MSDS to be maintained in any specific format. Title 29 CFR, Part 1910.1200 (g) (10) states that *"Material Safety Data Sheets may be kept in any form, including operating procedures, and may be designed to cover groups of hazardous chemicals… "*. According to Title 29 CFR, Part 1910.1200(g)(5) chemical manufacturers are required to update an MSDS within three months of becoming newly aware of *"any significant information regarding the hazards of a chemical or ways to protect against the hazards… "*.

As it pertains to transporting hazardous materials in bulk by vessel, the MSDS has become the document that is intended to be used to fulfill the requirements of Title 33 CFR 154.310 (5) and provide some information required by 46 CFR Part 35.01-10. As such, the MSDS has become the basis upon which a cargo's grade (A-E) is established for the purpose of applying tank barge regulations. Specifically, the flashpoint and/or Reid vapor pressure listed on the MSDS of an oil cargo is used to determine the cargo grade.

Title 29 CFR Part 1910.1200 states that the physical and chemical characteristics of a hazardous chemical (such as vapor pressure, flashpoint) must be listed on an MSDS; however, there is no requirement for the information to be specific to the cargo being loaded at that time. In this casualty, the CSO generated by the ExxonMobil refinery that was loaded on the EMC 423 had an actual flashpoint of 192° F (Exhibit CG-95). The MSDS, which was published by ExxonMobil and, according to OSHA, was in full compliance with the regulations (Exhibit CG-88), merely stated that the flashpoint was >141° F (CC). This value serves merely as a regulatory value in that it reflects the lowest temperature that a cargo can possess in order to be classified as a grade E cargo, given the Reid vapor pressure. The MSDS did indicate that an explosive atmosphere could develop in the headspace of a tank even if the cargo was not above its flashpoint. This warning is consistent with the information found in Chapter 24 of the International Safety Guide for Oil Tankers and Terminals manual with regard to "residual fuel oils." (Reference 4)

In this case the vagueness of the information provided on the MSDS with regard to flashpoint was not significant because the CSO would have been classified as a grade E cargo (flashpoint 150° F or above using ASTM D 92 – Cleveland Open Cup) regardless, but in some instances it could be problematic. Figure (6-1) is an excerpt from an MSDS for gasoline. This MSDS lists the cargo's vapor pressure as "6-15 Reid-psia at 37.8° C (100° F)". The large Reid vapor pressure range identified for this product makes it impossible to determine what grade the cargo is for shipping purposes. In this case, the cargo could be anywhere from grade A (Reid vapor pressure >14) to grade C (Reid vapor pressure <8.5 and flashpoint <80° F). In addition, the ambiguity of the information contained in this MSDS does not provide the information necessary for shoreside or shipboard personnel to evaluate the true dangers of the cargo for precautionary or response purposes. In fact, towing vessel captains are required by Title 46 CFR Part 35.01-10 to record the "approximate kind, grade, and quantity of cargo" contained in each unmanned barge. It would be difficult to fulfill this requirement with any accuracy given the vague nature of the MSDS identified in Figure 6-1.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES (TYPICAL)

Physical State	Liquid.	**Color**	Transparent, clear to amber or red.	**Odor**	Pungent, characteristic gasoline.
Specific Gravity	0.72 - 0.77 (Water = 1)	**pH**	Not applicable	**Vapor Density**	3 to 4 (Air = 1)
Boiling Range	38 to 204°C (100 to 400°F)			**Melting/Freezing Point**	Not available.
Vapor Pressure	220 to 450 mm Hg at 20°C (68°F) or 6 to 15 Reid-psia at 37.8°C (100°F).			**Volatility**	720 to 770 g/l VOC (w/v)
Solubility in Water	Hydrocarbon components of gasoline are slightly soluble in water. Oxygenate components, such as MTBE, are more soluble than the hydrocarbon components. Ethanol has greater solubility in water than hydrocarbon components or other oxygenate components.			**Viscosity (cSt @ 40°C)**	<1
Flash Point	Closed cup: -43°C (-45°F). (Tagliabue [ASTM D-56])				

Figure 6-1: Physical and Chemical Properties of Gasoline

b. Cargo Comparison: Investigative sampling and analysis was conducted on CSO that was in the storage tanks at ExxonMobil, loaded into the EMC 423 cargo tanks and the remaining CSO on board in the undamaged cargo tank #1 after the explosion and fire. The objective of this activity was to obtain analytical data regarding the various media (air, water and cargo) using laboratory analysis (qualitative, quantitative and statistical). The table below lists all of the samples that were available for testing and analysis for composition and similarity (Figure 6-2, Exhibit CG-148).

Field Sample ID	Lab ID	Sample Date	Sample Matrix	Sample Location	Sample Description	Analyses Performed	File ID
U.S. EPA 1/27/2006 Investigative Samples - Post Fire							
SUM-CG1	1515-001	1/27/2005	Air	Tank EMC423-T1	Air Above Product in Barge Tank - Post Fire	VOCs - TO-15a	02010506.d
SUM-CG2	1515-002	1/27/2005	Air	Tank EMC423-T1	Air Above Product in Barge Tank - Post Fire	VOCs - TO-15a	02010507.d
SUM-CG3	1515-003	1/27/2005	Air	Tank EMC423-T1	Air Above Product in Barge Tank - Post Fire	VOCs - TO-15a	02010508.d
Cargo-CG1	1515-004	1/27/2005	Product Material	Tank EMC423-T1	Barge Tank Material - Post Fire	VOCs - SW846 8260B SVOCs - SW846 8270C	01280512.d 01280508.d
Cargo-CG2	1515-005	1/27/2005	Product Material	Tank EMC423-T1	Barge Tank Material - Post Fire	VOCs - SW846 8260B SVOCs - SW846 8270C	01280513.d 01280509.d
Cargo-CG3	1515-006	1/27/2005	Product Material	Tank EMC423-T1	Barge Tank Material - Post Fire	VOCs - SW846 8260B SVOCs - SW846 8270C	01280514.d 01280510.d
Product Material Samples - Pre Fire							
CG-515-2	2196-001	1/20/2005	Product Material	ExxonMobil Tank 515	Tank Product - ExxonMobil Tank 515	VOCs - SW846 8260B SVOCs - SW846 - 8270C	02110506.d 02100509.d
CG-515-2DP	2196-003	1/20/2005	Product Material	ExxonMobil Tank 515	Tank Product - ExxonMobil Tank 515	VOCs - SW846 8260B SVOCs - SW846 - 8270C	02110508.d 02100511.d
CG-423-1	2196-002	1/19/2005	Product Material	EMC-Composite	Barge Tank Material - Composite - Pre Fire	VOCs - SW846 8260B SVOCs - SW846 - 8270C	02110507.d 02100510.d
U.S.C.G. 2/4/2006 Investigative Air Samples - ExxonMobil Tanks 516 and 515							
CG-516-1	2112-005	2/4/2005	Air	ExxonMobil Tank 516	Air above Product in ExxonMobil Tank 516	VOCs - TO-15a	02080509.d
CG-516-1D	2112-006	2/4/2005	Air	ExxonMobil Tank 516	Air above Product in ExxonMobil Tank 516	VOCs - TO-15a	02080510.d
CG-515-1	2112-007	2/4/2005	Air	ExxonMobil Tank 515	Air above Product in ExxonMobil Tank 515	VOCs - TO-15a	02080511.d
Heated Headspace Procedure Samples - Product Material Samples							
Cargo-CG1	3076-001	1/27/2005	Air from Heated Headspace Procedure	Tank EMC423-T1	Barge Tank Material - Post Fire	VOCs - TO-15a	03040506.d
CG-515-2	3076-002	1/20/2005	Air from Heated Headspace Procedure	ExxonMobil Tank 515	Tank Product - ExxonMobil Tank 515	VOCs - TO-15a	03040507.d
CG-423-2	3076-003	1/19/2005	Air from Heated Headspace Procedure	EMC-Composite	Barge Tank Material - Composite Sample From All 4 Tanks - Pre Fire	VOCs - TO-15a	03110510.d

Figure 6-2: Summary of samples used in cargo comparison study (Exhibit CG-148)

Cargo: Extensive chemical analysis using gas chromatograph/mass spectrometry (GC/MS) was undertaken to compare the volatile fractions of the cargo from ExxonMobil storage tank 515 and cargo taken from the EMC 423 cargo tank #1 after the casualty (post-fire). Similar testing was also completed on a sample of the multi-tank composite sample taken from the EMC 423 after the load (pre-fire), and was compared to the cargo sample taken from cargo tank #1 after the casualty. The analysis of the test results by STAT Analysis Corporation revealed that "there is no evidence that the post-fire barge samples are different than the ExxonMobil tank samples or the pre-fire barge samples" (Exhibit CG-148).

The analysis of semi-volatile fractions from the ExxonMobil Tank 515, and the multi-tank composite sample from the EMC 423 (pre-fire) indicate the petroleum products are essentially the same. The analyst concluded that "[i]f other petroleum products, such as diesel, kerosene, or more refined crude were present, they would be indicated in this analysis. However, the chromatograms clearly show the same crude product in each of the samples" (Exhibit CG-148).

Vapor: Vapor testing took two paths. The first path was to determine if the headspace vapors in other tank barge cargo tanks loaded at the ExxonMobil – Joliet refinery contained flammable vapors similar to those found in the headspace the EMC 423 cargo tank #1 (post-fire). As part of the process, on January 27, 2005 an Environmental Protection Agency START technician checked EMC 423's cargo tank #1, the undamaged cargo tank and found flammable vapors at 93% of the lower explosive limit (LEL) with oxygen levels at 18.5% and hydrogen sulfide was non-detected (Exhibit CG-146).

In order to complete the comparison process, a marine chemist checked several barges that were loaded at the ExxonMobil – Joliet refinery with CSO after the EMC 423's 19 January load. On 06 February, the marine chemist tested the vapor within three Apex barges loaded at ExxonMobil – Joliet on 24/25 January 2005. The tests on these vapor samples included a test for hydrogen sulfide, of which none was detected (Exhibit CG-147). Additionally, the marine chemist's notes indicated that "samples showed spectra which were consistent with gasoline vapor." These findings are expected, as the volatile hydrocarbon composition of CSO and gasoline is similar; both possessing vapor compounds ranging from C_2 to C_{12}. In fact, gasoline is a complex mixture of over 500 hydrocarbons consisting of chains from C_5 to C_{11} that are blended together. (Reference 1)

Of the seven barges checked on 09/10 March, only the CBC 326 was found to have all cargo hatches still closed, a similar condition to the EMC 423. All five tanks were found to be at 100% LEL with 19.0 to 19.5% oxygen at 175° F (Exhibit CG-142 and CG-143). The CSO was loaded into CBC 326's five cargo tanks on February 27, 2005 at the ExxonMobil – Joliet Refinery with flashpoints ranging from 194° F to 207° F. The load was a split load from both ExxonMobil storage tanks 516 and 515, at approximately 75% and 25% respectively. The flashpoint of the CSO prior to being loaded was 195° F for storage tank 515 and 198° F for storage tank 516 (Exhibit CG-146).

The second path taken with regard to vapor testing was to determine whether the composition of the vapors could have been generated by the cargo. STAT Analysis Corporation developed a testing protocol in order to determine whether the explosive vapors could be produced by the CSO found in the storage tanks and barge cargo tanks (pre/post-fire). The test protocol consisted of generating a vapor by heating a sample of cargo from each source; storage tank 515, EMC 423 multi-tank composite sample (pre-fire) and EMC 423 cargo tank #1 (post-fire), to temperatures consistent with typical storage, transfer and transport. The vapor generated was collected, tested by GC/MS and analyzed at STAT Analysis Corporation (CG Exhibit 146).

The comparison of the laboratory generated headspace vapor from samples taken from EMC 423 cargo tank #1 (post-fire) and storage tank 515 indicates that these "generate essentially the same headspace" consisting of C_2 to C_{12} hydrocarbon compounds (Exhibit CG-146 and CG-147). The comparison between the EMC 423 cargo tank #1 (post-fire) and EMC 423 multi-tank composite (pre-fire) indicate that the "samples generate the same headspace", consisting of C_2 to C_{12} hydrocarbon compounds (Exhibit CG-146, CG-147).

c. Measurement of hazardous properties: The specific tests that characterize the fire and explosion hazard of oil are flashpoint and Reid vapor pressure tests.

Flashpoint: Combustible and flammable liquids generate vapors which, in a closed space, are present in a predictable dynamic equilibrium between the vapor and the liquid. The concentration of vapors is a function of temperature. In a closed space, the vapor concentrations increase as temperature increases. When the vapors reach a certain concentration, they can be ignited by an ignition source, such as an open flame. The temperature at which this momentary ignition occurs is the "flashpoint" of the liquid. This temperature is normally felt to be the temperature of which the cargo becomes hazardous during transportation if the vapors are exposed to a direct source of ignition.

The "flashpoint" though, is not necessarily the lowest temperature at which the cargo can be ignited. If the cargo vapors are confined, as within a cargo tank or storage tank and the tank's contents are heated and/or agitated, flammable vapors may be concentrated in the vapor phase and explosive concentrations can be found at temperatures well below the measured flashpoint. (Reference 2) This does not apply to a pure chemically distinct (refined) product, but does apply to any petroleum mixture such as black oil, residual oil and CSO.

The most realistic flashpoint tests are tests which confine the evolved vapor prior to ignition – so called "closed cup" testers (ASTM D 93 – Pensky-Martens Closed Cup). Open-cup testers permit evolved vapors to escape during the test (ASTM D 92 – Cleveland Open Cup). A closed cup flashpoint can be 3 to 9° C (37 to 48° F) lower than an open cup flashpoint on the same material. (Reference 2) Flashpoints for cargoes "similar" to CSO, as identified in the various MSDS reviewed, varied significantly.

Reid vapor pressure: The Reid vapor pressure test (ASTM D 323) is a standardized test for measuring the volatility of vapors released from a given liquid sample. A chilled (32° F) liquid sample is placed in the liquid portion of the test apparatus, then connected to an air chamber, heated to 100° F, and finally the entire apparatus is sealed. The apparatus is then placed in a 100° F water bath. The container is shaken to rapidly bring about equilibrium between the liquid and gas phase. The increase in internal pressure from 32° to 100° F is observed and roughly indicates the absolute vapor pressure of the sample at 100° F. The ratio of liquid to vapor space in the test apparatus is established as one to four (1:4). Reid vapor pressure does not duplicate the conditions found in transportation. The temperature, as in this case, may be other than 100° F and the liquid to gas volume ration different from 1:4. Both of these factors could significantly alter the true vapor pressure of the liquid in a cargo tank.

Neither the flashpoint nor the Reid vapor pressure tests are absolute indices of the flammability characteristics of a liquid. The 1992 Oil Companies International Maritime Forum report points out that flashpoint data often does not reveal the presence of light hydrocarbons. This is especially true for cargoes that are mixtures, such as CSO, and not homogeneous products. (Reference 3) Typically, this is as a result of cargo cracking at local hot spots or small traces of highly volatile materials such as dissolved or occluded low-molecular-weight hydrocarbon gasses present that are not detected by the flashpoint test. (Reference 2) International Safety Guide for Oil Tankers and Terminals manual - Chapter 24, states that "information on the relationship between the calculated flammability of a headspace atmosphere and the measured flashpoint of the residual fuel oil has shown that there is no fixed correlation. A flammable atmosphere can therefore be produced in a tank headspace even when a residual fuel oil is stored at a temperature below its flashpoint." (Reference 4)

d. Grade E cargo history: The vapors given off by Grade E combustibles are readily flammable, and there have been explosions in shoreside tanks storing these liquids as well as in tank barges transporting them. Over a period of time, sufficient vapors evolve from the liquid and are trapped and concentrated in the vapor space when the tanks are heated – as they might be to reduce the viscosity of a thick liquid. When an ignition source is provided, the vapor space can suffer an explosion.

There are a number of past unusual events and subsequent evaluations of the flammable properties of Grade E product that re-emphasize that the flashpoint test is not an absolute index of hazard potential and vapor explosions can occur at temperatures well below the measured flashpoint.

Explosion Incidents Involving Grade E Type Cargo				
Date	Vessel Name	Vessel Type	Vessel Cargo Certification	Cargo
11/3/1977	INTERSTATE 71	Tank Barge	Grade E	Asphalt
8/23/1981	D-204	Tank Barge	Grade B	Sewage Sludge
8/12/1982	EXXON NEW ORLEANS	Tanker	Grade B	Bunker C Oil
11/18/1983	RECOVERY 1	Tank Barge	None	Oily Waste Water
12/6/1984	BRAZOS SEAHORSE	Offshore Supply	Grade E	Oily Waste Water
10/28/1986	OMI Yukon	Tanker	Grade B	No. 6 Fuel Oil*
8/31/1988	FIONA	Tanker	Grade B	No. 6 Fuel Oil
3/6/1990	CIBRO SAVANNAH	Tank Barge	Grade B	No. 2 Fuel Oil

* OMI YUKON fuel oil was bunker fuel for its own boiler, not cargo.

Figure 6-3: Explosion incidents involving Grade E type cargoes

Figure 6-3 above, lists eight pertinent incidents in which there was an explosion involving either Grade E cargo or some similar high flash point liquid. In six of the eight incidents, the explosion was followed by a fire. (Reference 2) In this case and many of those previous casualties, there was a misperception as to the potential for existence of flammable vapor generation. A brief description of two of these incidents is below.

<u>INTERSTATE 71 Barge Explosions and Fire: 11/3/77</u>

INTERSTATE 71 is 380-ft. (116-m) long and has a cargo capacity of 81,759 barrels in 10 cargo tanks.

On November 3, 1977, the cargo consisted of about 68,000 barrels (11, 000-m3) of asphalt (open cup flash point of 630° F) heated via cargo tank heating coils to a temperature of about 262° F. As the INTERSTATE 71 was approaching its destination in Providence, Rhode Island, one of the tankermen was using a propane torch to melt solidified asphalt in an uninsulated pump drain line. Apparently, asphalt vapors in the drain line were ignited by the hot pipe wall. The auto-ignition temperature for asphalt is reported to be 900° F, which is readily produced by extended heating with the propane torch.

Another, less likely, explanation is that the asphalt residue-in the drain line was heated sufficiently to undergo "coking in which it pyrolyses or oxidizes and glows red hot. Flame initiated in the drain line must have propagated into the ullage space of one of the cargo port tanks. Flames were observed to rise 20' into the air, and the tankerman who had been heating the drain line was killed when he was blown against the pumphouse. The explosions cracked and bulged the main deck, and breached two bulkheads.

Two days after the incident, a marine chemist measured flammable vapor concentrations of 40% to 100% of the lower flammable limit in the undamaged INTERSTATE 71 cargo tanks while the asphalt liquid temperature was 200° F, i.e. about 430° F below the asphalt nominal flash point.

CIBRO SAVANNAH Explosion: 3/6/90

The CIBRO SAVANNAH is a 401 ft long tank barge with a full-load cargo capacity of 136,745 barrels. It had satisfactorily completed a mid-period re-inspection three weeks prior to the accident.

On March 5, 1990, 105,000 barrels of No. 2 Fuel Oil were loaded onto the CIBRO SAVANNAH from an oil terminal in Linden, New Jersey. The flash point of the oil was 146° F to 148° F as measured with samples from the oil terminal storage tank. The oil temperature measured in the CIBRO SAVANNAH tanks prior to the explosion averaged 43.5° F, and the ambient air temperature was 27° F.

Before departure, the fuel oil loading among the CIBRO SAVANNAH tanks was adjusted to produce an even keel. A few minutes after the tugboat maneuvered the CIBRO SAVANNAH away from the dock at the oil terminal, a flash flame about 1 ft wide was observed to propagate from a light fixture atop a kingpost on the barge deck to a point on the deck in the vicinity of a starboard tank vent. The flame was followed immediately by an explosion in the number 4 starboard tank. The explosions caused severe damage to the deck plates over the two cargo tanks involved.

The NTSB/CG investigation determined that the pressure vacuum valve for the number 4 starboard tank vent was not installed at the time of the explosion. This allowed a large flow rate of vapors to be discharged from the tank vent. It apparently also allowed flame to enter the tank even though there was a flame screen in the vent outlet. Thus the flame screen in this incident is not effective without a pressure vacuum valve on the vent.

The NTSB report attributes the flammable vapor space in the number 3 port and number 4 starboard cargo tanks to their partial load condition. This is not consistent with the 147° F flashpoint of the No. 2 fuel oil. Tests with cargo samples obtained after the accident "revealed that all samples met the specifications for No. 2 Fuel Oil." Thus there is no clear explanation of why tank vapor spaces were in the flammable concentration range in this particular incident.

This event and past events reinforce the suggestion that flashpoint may not be an accurate reflection of petroleum based Grade E cargo mixtures' ability to generate explosive vapors.

CHAPTER 7: EGAN MARINE CORPORATION

The purpose of this chapter of the investigative report is to examine Egan Marine Corporation's structure and operations. This description includes a detailed look at the company's internal programs including training, preventative maintenance, safety and drug testing. It also examines how all of the programs relate to Egan Marine Corporation's membership in the American Waterways Association's Responsible Carrier Program.

a. <u>Corporate Structure:</u> [redacted] was the sole owner of Egan Marine Corporation (Pg. 18). Egan Marine Corporation had a written corporate structure that outlined titles for several people within the organization (Exhibit CG-12). There were two additional corporate officers, one was [redacted] Chief Financial Officer, and the other is [redacted] Vice President of Operations (Exhibit CG-12). [redacted] stated that he had no specific duties or a description of duties as Vice President of Operations, and that [redacted] personally directed nearly all aspects of the business (Pgs. 215-216, 241, 330 and 419-420). Egan Marine employed between forty and one hundred employees, depending on the volume of business (Pg. 20).

[redacted] was also the sole owner of Service Welding and Shipbuilding Corporation. This corporation served primarily as the shipyard for Egan Marine Corporation's vessels and equipment, but occasionally conducted work for other customers (Pgs. 21-22). Both of these corporations operated from an office located at 15200 Canal Bank Road, Lemont, IL, at mile 301.2 of the Chicago Sanitary and Ship Canal.

b. <u>Responsible Carrier Program:</u> Egan Marine was an active member of the American Waterways Operators' Responsible Carrier Program at the time of the explosion (Pg. 74). The Responsible Carrier Program is voluntary and is designed to identify sound operating principles and practices that enhance the safety of a company's towing vessel operations (Exhibit CG-22). The program is comprised of three principal parts: management and administration, equipment and inspections, and human factors (Exhibit CG-22). To remain in good standing, companies who are part of the Responsible Carrier Program must be audited by a certified auditor every three years. Auditors must be certified by the American Waterways Operators. Egan Marine's most recent audit was conducted on June 26, 2002 by [redacted]. At the completion of the audit, [redacted] concluded, among other items, that Egan Marine had a written maintenance program and that they had a policy in place regarding the retention of maintenance records (Exhibit CG-23).

[redacted] was also under contract with Egan Marine to conduct safety meetings and serve as the "special agent" for the company's drug and alcohol program (Exhibit CG-23, Pg. 1982).

c. <u>Maintenance/Repair:</u> Egan Marine employees testified that they did not track or keep records pertaining to vessel maintenance, and that there was no preventative maintenance program in place. Maintenance was done at the discretion of employees, or on an emergent need basis (Pgs. 72, 243, 420). Testimony revealed that there was no single person who was in charge of maintaining or supervising work on barges, tows vessels or equipment, and that all tasking was generally initiated by [redacted] (Pgs. 216, 419, 467, 468). Immediately following the EMC 423 explosion the Coast Guard subpoenaed all maintenance records for the barge. None were provided.

[redacted] stated that he relied upon the annual Coast Guard barge inspections to identify maintenance items that needed to be addressed (Pg. 73). In 2004, the Chief of the Marine Safety Office Inspections Department held a meeting with [redacted] to discuss unauthorized alterations made to one of his inspected tank barges. During the meeting, [redacted] was told that the Coast Guard's intention was to hold his company to the regulations. In reply, [redacted] stated that if the Coast Guard was going to hold Egan Marine to the regulations, the company would go out of business – that he could not operate within the regulations (Pgs. 2636-2637).

d. Training: [redacted] stated that [redacted] administered the company's training program (Pg. 25-26). When questioned, [redacted] testified that he did not administer Egan Marine's training program but was hired to hold monthly safety meetings with vessel crews and provided very little position/duty related training (Pgs. 1982, 1989, 2040). [redacted] also stated that he was not aware of nor had he seen a written training manual for Egan Marine Corporation (Pg. 1990). However, in his American Waterways Operators Responsible Carrier Program audit of June 26, 2002, [redacted] stated that that Egan Marine did have a training program. He went on to specifically identify numerous aspects of the program and associated documentation (Exhibit CG-23).

As previously noted, safety meetings were held with vessel crews on subjects such as personal protective equipment, drug and alcohol abuse, and safe work practices (Exhibits EMC-05, EMC-06, EMC 08). In addition, when new employees reported aboard vessels they were required to view various safety training videos and were paired up with a more experienced crewmember for on-the-job training (Pgs. 317, 318). During testimony Egan Marine employees referred to the prominent role that on-the-job training played for deckhands/engineers at Egan Marine, including the importance of observing the behavior and standard practices of more experienced employees (Pgs. 508, 639, 833, 875-876). However, there was no evidence or testimony that the on-the-job training for Egan Marine deckhands/engineers was formalized, consistent, or documented.

e. Safety Manual(s): Egan Marine had several manuals that contained safety information. The Egan Marine Employee Safety Guide (2 versions, both undated), Operations Manual, Employee Manual and Safety Manual were all in existence at the time of the explosion (Exhibits CG-14, CG-14A, CG-15, CG-31, CG-33). Each of these manuals contained various safety information, but testimony revealed confusion among Egan Employees as to which manual was most up to date and most applicable. As a result, employees were using different manuals as their source for safety information (Pgs. 290, 396, 428, 494-495, 649, 1983).

f. <u>Drug Testing:</u> Egan Marine Corporation had the required drug testing program for marine employees in place at the time of the explosion. They administered their own program, but contracted the services of [redacted] as a "Special Agent" for the program (Pg. 2006). Under the arrangement that existed at the time of the explosion, Egan Marine selected and directed employees to be tested for random, post casualty, pre-employment, and probable cause drug testing. [redacted] then accompanied the employees to the drug testing facility and brought them back (Pg. 2006). [redacted] was also responsible for submitting the company's annual Management Information System (MIS) drug testing report (Pg. 2009).

Pursuant to a subpoena during the EMC 423 investigation, Egan Marine provided all drug testing records in their possession for [redacted] and Alexander Oliva. The drug testing records provided dated back to 1997 and included pre-employment and random drug test results. During the time period from 1998 to the time of the casualty, [redacted] both worked aboard Egan Marine vessels and were subject to random drug testing in accordance with Federal regulations (Pgs. 669-670, 1352-1353). Based upon the records provided, [redacted] underwent six random drug tests while [redacted] underwent only one during the same time period (Exhibit CG-135).

After the explosion, the M/V LISA E crew was required to undergo drug and alcohol tested in accordance with Federal regulations. [redacted] were tested the following day with [redacted] results. The other surviving crew member, [redacted] did not take a post-casualty drug test despite being advised to do so on several occasions by the Coast Guard and the owner of Egan Marine shortly after the casualty (Pgs. 1447-1448). [redacted] was unable to be located for several days after the casualty.

[redacted] ultimately took a pre-employment drug test for Egan Marine Corporation prior to returning to work after the barge explosion and tested [redacted] He subsequently surrendered his Merchant Mariner's document to the Coast Guard.

[redacted] was serving as the "engineer" aboard the M/V LISA E at the time of the explosion, but afterward it was discovered that he had tested [redacted] on a random drug test in 1999. He reached a "cure" settlement agreement with the Coast Guard and was required to undergo expanded random drug testing and counseling over the following year. In 2001, [redacted] Merchant Mariner Document was revoked because he failed to complete the rehabilitation required by the settlement agreement. Additionally, [redacted] never received the required clearance from a substance abuse professional to return to work in a safety sensitive position aboard vessels.

A post-mortem toxicology test was conducted on Alexander Oliva (Exhibit CG-115). A blood sample was examined by the Cook County Coroner and was found to be [redacted] for drugs. Traces of alcohol were identified, but were attributed to post-mortem decomposition (Exhibit CG-113). The Cook County Coroner did not test for marijuana.

National Medical Services also conducted toxicology tests using Alexander Oliva's blood. [redacted] The initial test was also [redacted] for cannabinoids (marijuana), but was unconfirmed due to a "sample matrix problem" (Exhibit CG-152).

g. Tankerman: Title 33 Code of Federal Regulations Part 155, requires that persons in charge of the transfer of oil or hazardous material in bulk hold the appropriate Tankerman endorsement. The requirements to obtain a Tankerman endorsement are contained in Title 46 Code of Federal Regulations Part 12 and include on the job training, attending approved tankerman and firefighting schools, and passing a physical examination. After an individual has obtained a tankerman endorsement, he or she is qualified to supervise the shipboard transfer of whatever grade(s) of cargo they are certificated for.

The EMC 423 transported Clarified Slurry Oil, which required a certificated tankerman to load and offload the barge. Egan Marine had three certificated tankerman on their staff to conduct these transfers. On the evening of January 18, 2005 [redacted] was assigned as the certificated tankerman for the loading of the EMC 423. He arrived at ExxonMobil that evening at approximately 1635 (Exhibits CG-62, CG-70). After experiencing difficulties loading due to a frozen valve at the facility, [redacted] departed at approximately 1815 (Exhibit CG-61, Pg.1221). The transfer was resumed at approximately 2310 with Alexander Oliva, an unqualified tankerman, acting as the barge person in charge (Exhibits CG-70, CG-62, Pg. 1758).

After examining the Declarations of Inspection from facilities with whom Egan Marine barges frequently conduct transfers, it was discovered that the transfer of cargo to and from Egan Marine barges without properly certificated Tankerman was a common practice. In the year preceding the EMC 423 explosion, Egan Marine barges conducted at least 16 transfers without certificated tankerman (CG-141).

CHAPTER 8: EXXONMOBIL – JOLIET REFINERY

The primary purpose of this chapter within the investigative report is to examine the ExxonMobil – Joliet refinery; the facility at which the EMC 423 was loaded with CSO prior to the explosion. This description includes the physical lay out and illustrated location of the facility, as well as a detailed look at the company's operations, training and qualification procedures.

a. <u>General Information:</u> ExxonMobil – Joliet refinery is located in Channahon, Illinois at mile 278.0 of the Des Plains River (Figures 8-1 and 8-2). The refinery produces a variety of different petroleum products, including but not limited to various grades of gasoline and diesel fuel, number 4 fuel oil, number 6 fuel oil, heavy gas oil, light cycle oil, and various forms of asphalt. During the refining process select components of crude oil are removed in order to produce products that meet certain specifications.

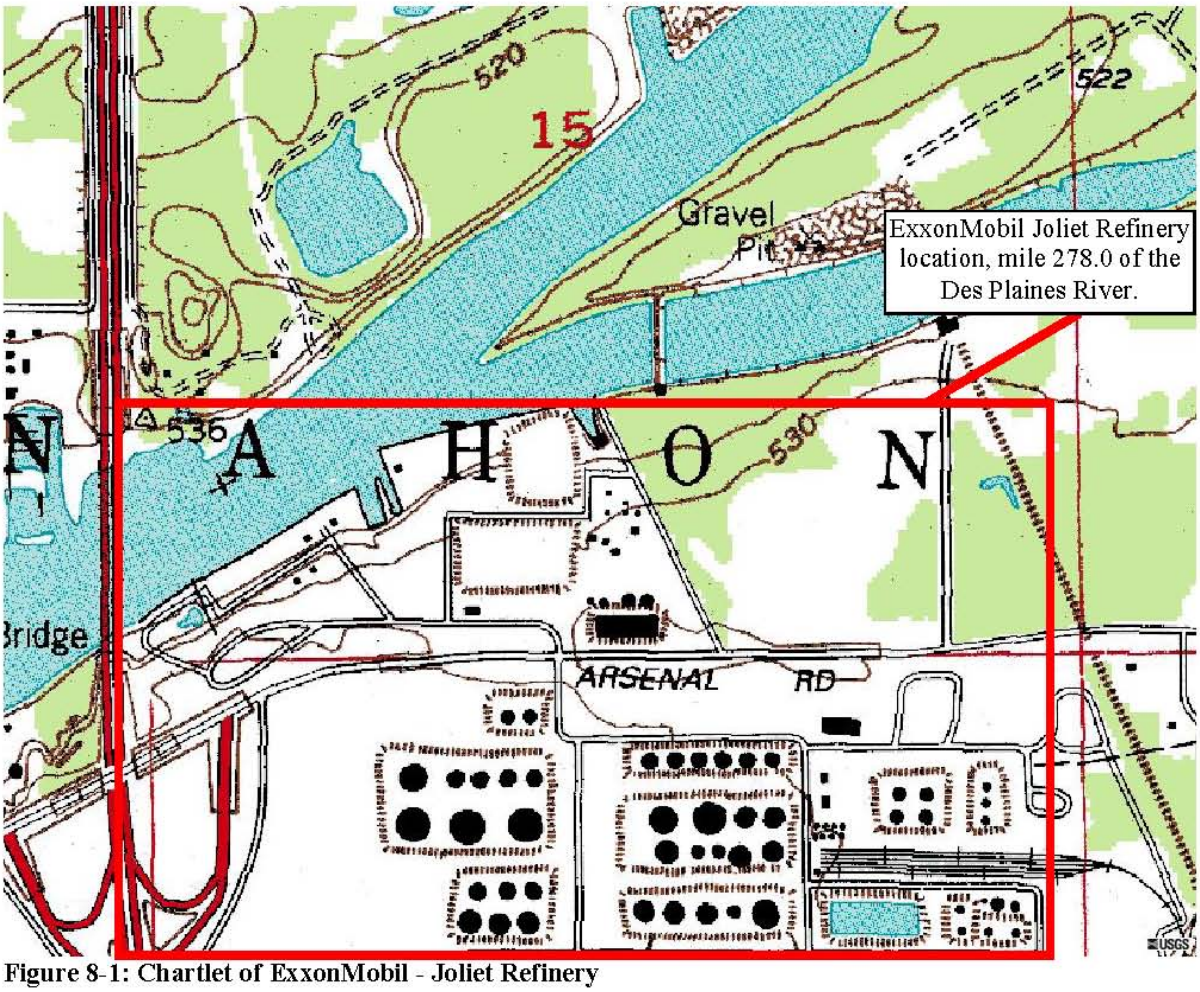


Figure 8-1: Chartlet of ExxonMobil - Joliet Refinery

ExxonMobil – Joliet typically utilizes Canadian heavy crude oil, which arrives via pipeline, in its refinery process. The refinery process, including the use of a catalytic cracking process, extracts the desired components to produce "high dollar" petroleum products leaving a by-product which is not processed to meet a desired specification and is sold as Clarified Slurry Oil.

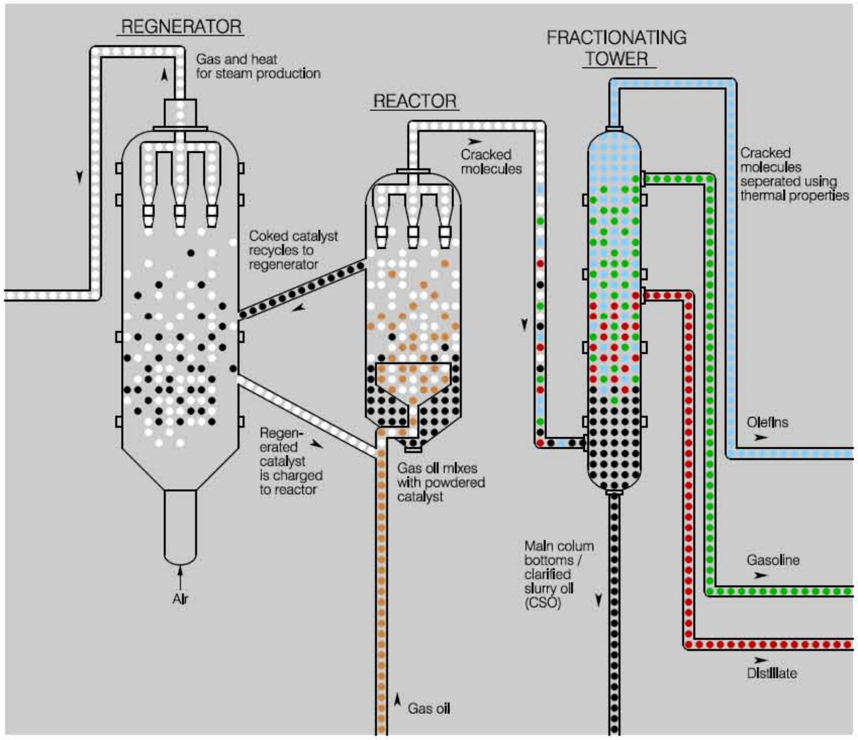


Figure 2- 2: Simplified Fluidized Catalytic Cracker Process Flow Diagram

Catalytic cracking breaks complex hydrocarbons into simpler molecules in order to increase the quality and quantity of lighter, more desirable products and decrease the amount of residuals. This process rearranges the molecular structure of hydrocarbon compounds to convert heavy hydrocarbon feedstocks into lighter fractions such as kerosene, gasoline, LPG, heating oil, and petrochemical feedstocks. The most common process is Fluidized Catalytic Cracker (FCC), in which the oil is cracked in the presence of a finely divided catalyst which is maintained in an aerated or fluidized state by the oil vapors (Figure 8-2). (Reference 5)

Clarified Slurry Oil is generated at a rate of approximately 0.7 gallons for each barrel of crude oil processed at the ExxonMobil – Joliet refinery. The CSO that is generated at the Joliet refinery is either used locally as a heavy boiler fuel or transported by barge through the western river system to New Orleans where it is loaded on board tank ships for transport overseas. All CSO loaded to barges at the Joliet refinery is completed through loading arm 61-M-75 at dock spot #1 (Figure 8-3).

Figure 8-3: CSO Loading Arm

At the culmination of the refinery process, the CSO is fed into one of two storage tanks located on the facility via the rundown line that originates at the Fluidized Catalytic

Figure 8-4: CSO Storage Tanks 515/516

Cracker (FCC). Each of these tanks has a capacity of approximately 40,000 barrels (Figure 8-4). The stored CSO is maintained in a heated condition of about 180° F to retain a low viscosity of the by-products thereby facilitating its transfer to the loading dock. The temperature variations are driven by the temperature of the CSO as it comes from the FCC and the steam suction heater. The pipeline that is used to supply the loading arm is insulated and heated its entire length by steam tracing (Figure 8-5).

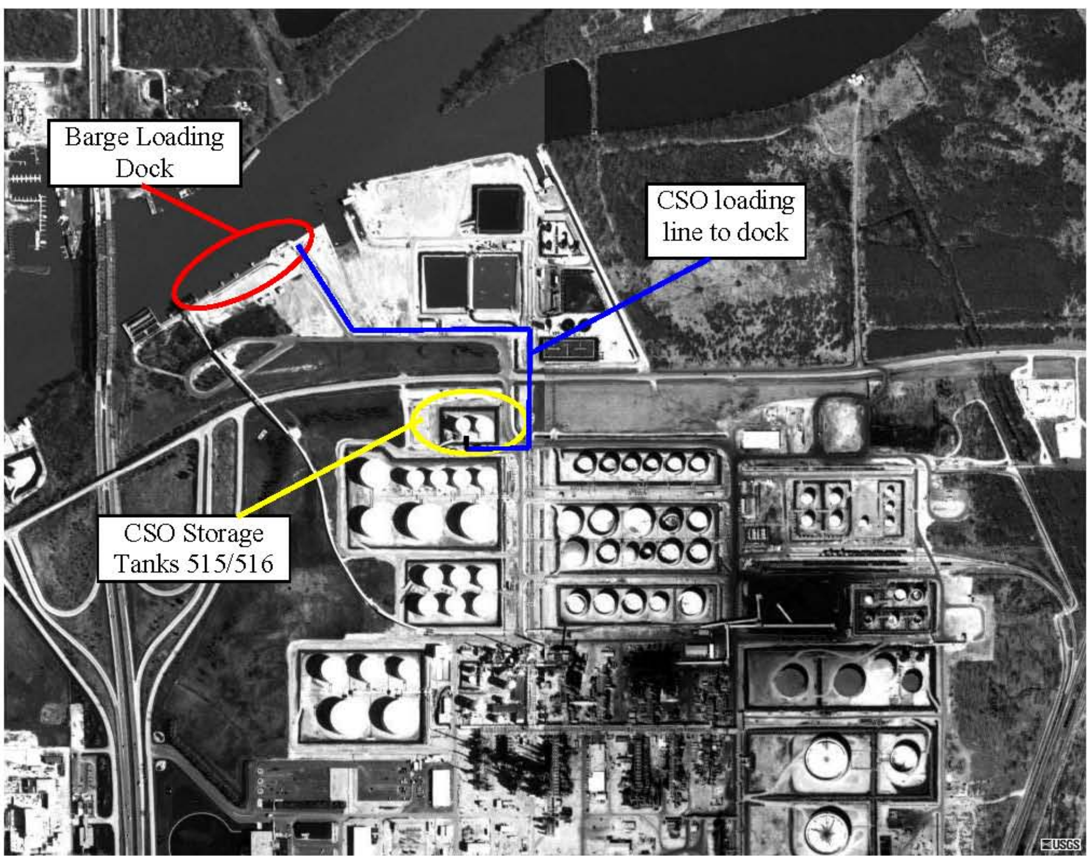


Figure 8-5: Aerial Photo of ExxonMobil - Joliet Refinery showing CSO storage tanks and loading dock

The transfer line also has two cross connects to other product pipelines (Exhibit 105 (SSI)). These cross connects are:

Product	Routing	Location	Block Valves
#2 Fuel	via Black Oil transfer line	Refinery	1 – Twin Seal Valve 2 – Gate Valves
#2 Fuel	Direct	Dock	2 – Gate Valves

The rundown line, leading from the FCC to the storage tanks, also has two cross connects to other product pipelines only for start up and shut down (Exhibit 109 (SSI)). These cross connects are:

Product	Routing	Location	Block Valves
Light Cycle Oil	Direct	Refinery	2 – Gate Valves
Light Cycle Oil	Direct	Refinery	2 – Gate Valves

Based on the testimony by [redacted] Supervisor – Oil Movements Area, these cross connects are not used except for pipeline repairs and start up/shut down and have a number of manual valves to ensure no cross contamination (Pgs. 2335-2336). Additionally, records and testimony indicated that pressure tests are performed regularly to ensure the soundness of the valves. Post casualty pressure tests were not conducted but [redacted] testified that he "had gauges put on the line, and verified that it (CSO loading lines) had positive pressure. At the time, I think it was, like, 45 pounds. And that was cold weather. So it didn't have much thermal pressure on the line." This pressure was verified against the valves (Pgs. 2333-2334).

Testimony also indicated that a number of repairs had been completed on the CSO line. In order to accomplish these repairs the CSO is pushed out of the line using approximately 300 barrels of number 2 fuel oil. In these cases a limited volume of the lighter oil is forced into the storage tank and becomes mixed with the CSO that is later loaded onto a barge (Pgs. 2324-2327, Exhibit CG-107 (SSI)).

According to ExxonMobil – Joliet's records, the last repair completed on the CSO line was in September 2004. From the time of the repair to 19 January 2005, approximately 53 barge loads of CSO, equal to 8 times the volume of both tanks 515 and 516, had been transferred through that line (Pg. 2327).

b. Changes in CSO flashpoint: In 2004 the ExxonMobil – Joliet refinery determined that the Light Cycle Oil piping circuit was operating at temperatures that would accelerate corrosion rates and reduce pipe life expectancy (Exhibit CG-97(confidential)). As a result, the facility took action to lower the Light Cycle Oil draw rate and temperature to ensure that they were within acceptable corrosion rate levels (Exhibit CG-97 (confidential)). This change in operation lowered the flashpoint of the CSO being produced. Historically, the flashpoint of the CSO produced at ExxonMobil was in the vicinity of 230° F, but between 2004 and 2005 the flashpoint trended downward into the

180° F range (Exhibit CG-97 (confidential)). However, these lower flashpoints were still within the range stated on the ExxonMobil – Joliet Refinery Material Safety Data Sheet for CSO, as >141° F (Exhibit EMC-01).

c. <u>Transfer procedures:</u> The ExxonMobil – Joliet refinery had established written cargo transfer procedures in accordance with federal regulations (Exhibit CG-72). These transfer procedures outlined protocols for all aspects of barge transfers including, but not limited to, a list of products transferred and their qualities, personnel requirements, training requirements, emergency procedures, communications, and loading and unloading procedures (Exhibit CG-72).

As a prerequisite for any vessel receiving product at the Joliet refinery, the vessel must undergo a vetting process. This process is designed to ensure that the vessel meets minimum standards as established by ExxonMobil. This process is limited to the material condition of the vessel. SeaRiver Marine, the maritime component of ExxonMobil, completes or contracts for the vetting process. In the case of the EMC 423, SeaRiver contracted an outside source for this vetting. SeaRiver contracted [redacted] to conduct the inspection on the EMC 423. He was also a contracted consultant for Egan Marine Corp and the 3rd party auditor who conducted the audit of Egan Marine Corp for American Waterways Operators.

d. <u>Training and qualification:</u> ExxonMobil had an established, documented training program for employees who were designated as persons in charge of barge transfers. The training program included supervised on-the-job training, classroom training, and knowledge and skill based testing (Exhibit CG-72).

Each perspective person in charge was required to complete a "skills and knowledge checklist", which consisted of successfully performing tasks and answering questions associated with barge transfers in the presence of a qualified person in charge. When completed, each task was "signed off" by a qualified individual. When the entire checklist was complete, the trainee was required to pass a written test, at which time he or she was deemed a qualified person in charge of barge transfer operations (Pg.1745, Exhibit CG-72). However, ExxonMobil did not update their training material to reflect the change in line clearing procedures. As of 1998 the correct answer to the person in charge qualification test question *"What was used to flush loading arms after loading"*, was still listed as *"distillates"* (Exhibit CG-79).

e. <u>Cargo line clearing procedures:</u> ExxonMobil's standard procedure is to use nitrogen to "blow down" the cargo line, loading arm, and the barge at the completion of a transfer of CSO (Pg. 1773). Nitrogen was used to clear the cargo line after the transfer to EMC 423 was completed on the morning of January 19, 2005 (Pgs. 1772-1773).

Until 1995, ExxonMobil's practice was to use distillates to clear CSO lines (Exhibit CG-99). The facility changed their line flushing procedures to use nitrogen instead of distillates when a barge over pressurized (Exhibit CG-99).

f. Set-up valve: Various portions of the CSO piping within the ExxonMobil facility are steam traced to prevent the CSO from setting up within the piping, especially during cold weather. However, during the loading of EMC 423 on January 18, 2005, ExxonMobil was unable to provide heat tracing to the cargo lines due to the failure of the steam control valve (Figure 8-6) (Pg. 1818 (SSI)). The inability to provide steam heat tracing resulted in CSO solidifying in the ExxonMobil tank 516 suction valve.

Figure 8-6: Steam supply control valve for tanks 515/516

The EMC 423 was initially supposed to be loaded from tank 516, but that became impossible when the tank's suction valve set up (Figure 8-7). ExxonMobil yard supervisors decided that rather than waiting to load EMC 423 until steam was restored and the valve thawed, they would load the barge from tank 515. However, tank 515 did not have the necessary volume of CSO to complete the transfer (Pg. 1819 (SSI)). To remedy this, plant workers gravitated cargo from tank 516 to tank 515 through the unit rundown line (Pg. 1820 (SSI)). This transfer took approximately 3-4 hours to complete (Pg. 1823 (SSI)). Once the gravitation of cargo was complete, the loading of EMC 423 began at 2310, at which time the ExxonMobil tank 516 suction valve was still frozen (Pg. 1822 (SSI)).

Figure 8-7: Main suction valve on storage tank 516

During the hearing, there was much discussion focused on the set up suction valve on tank 516, how the valve was thawed, and whether distillates were used to clear the blockage. This was a topic of importance in order to determine whether the CSO aboard the EMC 423 could have been contaminated with distillates as a result of their use in freeing the set up suction valve. [redacted] the ExxonMobil pumper the night of the EMC 423 loading, testified that steam was the only thing used to try to free the set-up valve and to his knowledge steam was the only thing ever used for that purpose (Pgs. 1826-1827 (SSI)). Additionally, the suction valve was still frozen at the time that the transfer of CSO to EMC 423 was completed, and there were no cargo lines connected to the run down line that would be capable of injecting distillates into the system (Pgs. 1822, 1846-1847 (SSI)).

g. Inspection History: As a regulated facility, the ExxonMobil – Joliet facility is required to be made available for inspection by the Coast Guard at the discretion of the Captain of the Port. In addition, transfer monitors are conducted randomly at the facility. The following outlines the facility inspection history from 1995 to the time of the explosion:

Date	Inspection type	Inspecting Unit	Comments
23 May 95	Facility Inspection	MSO Chicago	No Deficiencies.
25 Jun 96	Facility Inspection	MSO Chicago	No Deficiencies.
31 Aug 00	Facility Inspection	MSO Chicago	No Deficiencies.
23 Jan 00	Facility Inspection	MSO Chicago	(1) Deficiency. Maximum allowable working pressure not marked on transfer hose.
22 Feb 01	Facility Inspection	MSO Chicago	No Deficiencies.

CHAPTER 9: SEQUENCE OF EVENTS

The primary purpose of this chapter is to present a timeline leading up to and after the casualty based upon the testimony of 35 separate witnesses during public hearings conducted in Chicago, Illinois from April 4-15 and June 27-July 13, 2005. Additional information has been drawn from various documents submitted as exhibits during and after these hearings and physical examination and evaluation by the Investigating Officer. All times are estimated as closely as possible and have been generated from the statements or testimony of witnesses and from evidence admitted during the course of the hearing. When there was conflicting testimony, the most probable times were estimated given the entirety of all testimony and evidence. This section documents the key actions and activities that led up to, during and immediately following the explosion that occurred aboard the EMC 423 on January 19, 2005.

September 20, 2004: EMC 423 underwent Coast Guard Inspection for Certification. One deficiency was noted – owners to provide 30 year section modulus gauging report prior to January 5, 2005. Requirement was never completed and was overdue at the time of the explosion (Exhibit CG-08, Pg. 2685).

January 12, 2005: M/V LISA E/EMC 423 moored at ExxonMobil – Joliet, to take on the first of three scheduled loads of Clarified Slurry Oil (CSO) to be transported to Chicago to be discharged at Ameropan Oil Company. Barge loaded with no reported difficulties (Exhibit CG-41).

January 15, 2005: M/V LISA E/EMC 423 discharged cargo at Ameropan Oil Company with no reported difficulties (Exhibit CG-41).

January 16, 2005: M/V LISA E/EMC 423 loaded CSO at ExxonMobil – Joliet with no reported difficulties (Exhibit CG-41).

January 16, 2005: [redacted] saw propane tank on the stern of the EMC 423 (Pgs. 769-770, 856-858, 882-883).

January 17, 2005: M/V LISA E/EMC 423 discharged cargo at Ameropan Oil Company with no reported difficulties (Exhibit CG-41).

The following entries occurred on January 18, 2005:

~1530: M/V LISA E/EMC 423 moored at ExxonMobil – Joliet Dock Spot #1, starboard side to in order to take on the last of the 3 contracted loads of CSO (Exhibit CG-41).

~1635: Tankerman [redacted] arrived and transfer Declaration of Inspection (DOI) was completed. (Exhibits CG-62, CG-70) The DOI was completed within the confines of ExxonMobil dock house (Pg.1667). The shoreside Person-in-Charge (PIC), [redacted], did not personally verify the majority of the items listed on the DOI, but stated that he discussed "most" of them with the tankerman (Pgs.1665-1667, 1773). The PIC did not issue the tankerman an air horn as back-up communication, despite the requirement to do so in the ExxonMobil – Joliet Refinery Wharf Operations Manual (Exhibit CG-72, Pg.1676). The PIC did not recognize the tankerman and did not check his identification or verify that he possessed a valid tankerman's card (Pg. 1674).

~1645: EMC 423 and ExxonMobil tank 516 were gauged by SGS North America, an independent gauging company (Exhibit CG-93). An upper, middle and lower sample was taken from tank 516 (Figure 9-1).

Figure 9-1: Storage tanks 515 and 516

~1700: EMC 423 connected to loading arm (Figure 9-2) for loading (Exhibits CG-61, CG-94).

~1710: EMC 423 disconnected due to leaky connection (Exhibit CG-61).

Figure 9-2: CSO Loading arm at ExxonMobil

~1720: EMC 423 reconnected. Connection failed pressure test 3 times (Exhibit CG-61, Pg. 1702).

~1730: PIC completed regular shift and was relieved of his duties by a new shore side PIC (Pg. 1703, Exhibit CG-62). Oncoming PIC, [redacted] testified that he did not inspect barge or discuss the majority of the items contained in the DOI with the off-going PIC or the tankerman (Pg.1754).

~1815: Transfer efforts suspended due to CSO being set-up in the main suction line valve (Figure 9-3), making loading from storage tank 516 impossible until the valve was cleared. Tankerman and shore side PIC departed (Exhibit CG-61, Pg.1221).

Figure 9-3: Main suction valve on storage tank 516

~2000: Facility personnel decided to load EMC 423 from storage tank 515 instead of waiting for tank 516 valve repairs. Tank 515 did not have sufficient volume of CSO to load the barge, so facility personnel began process of gravitating 3,300 to 3,500 barrels of CSO from tank 516 to tank 515 in order to have needed quantity to load the barge (Pgs. 1823, 2182). Additionally the rundown line continued to supply Tank 515 to make up volume.

~2250: Transfer of CSO between Tanks 516 and 515 was completed. SGS North America gauged Tank 515 and 516 (Exhibit CG-93, Pgs. 2125, 2194).

~2300: Transfer connection was made between EMC 423 and ExxonMobil dock (Exhibit CG-70, Pg. 1758).

~2310: Transfer started from Tank 515 to EMC 423 with Alexander Oliva acting as tankerman and [redacted] as the facility PIC (Pgs. 1758, 1760). Alexander Oliva was not a certificated tankerman. He did complete a new Declaration of Inspection, nor did he sign the existing one (Exhibits CG-70, CG-62, Pg. 1758).

~2355: [redacted] certificated tankerman, arrived and took over transfer operations as EMC 423 tankerman (Exhibit CG-61a).

The following entries all occurred on January 19, 2005:

~0010: [redacted] identified problems getting cargo into EMC 423 #4 cargo tank. He opened the upper cargo load valve a few more turns and experienced an "ammonia" smell as the CSO began flowing into the tank (Pgs. 1259-1262). He did not report the smell to the shore side PIC or the Master of the M/V LISA E (Pg. 1260).

~0515: Transfer completed (Exhibit CG-61a).

~0515: EMC 423 was gauged and a composite, running sample of barge tanks 1-4 was collected by SGS North America under the supervision of [redacted] as the facility PIC (Exhibit CG-93, Pg, 1507). Exxon Mobil tank 515 was gauged but no sample was taken (Pg. 2109, Exhibit CG-93). Total CSO loaded aboard EMC 423 was approximately 14,272 barrels (Pg. 2102, Exhibit CG-94).

~0530: Transfer line cleared with nitrogen and disconnected (Exhibit CG-61a, Pg. 1776).

~0545: [redacted] noticed propane tank with hose connected on EMC 423. Hose was reported to be partially buried in the ice and snow on the starboard side of the #4 cargo tank deck (Pgs. 1279-1281).

~0615: Barge was released (Exhibit CG-70).

~0700: M/V LISA E got underway, up-bound on the Illinois River pushing the EMC 423 loaded with CSO in route to Ameropan Oil Company, at California Avenue in Chicago, IL (Exhibit CG-41). The M/V LISA E had its single push knee spotted up to the center of the EMC 423 stern (Pg. 3080). The approximate outside temperature was 33° Fahrenheit (Exhibit CG-137).

~0850: M/V LISA E/EMC 423 locked up bound at Brandon Road and Dam (Exhibit CG-41).

~1030: M/V LISA E/EMC 423 locked up bound at Lockport Lock and Dam (Exhibit CG-41).

~1520: [redacted] boarded EMC 423 and started the generator and thermal fluid heater in preparation for offloading the cargo (Pg. 1128).

~1600: [redacted] returned to ballast the M/V LISA E, which was necessary in order to clear the Cicero and California Avenue Bridges. Ballasting was performed by pumping water into the forepeak, bow peak, and stern tanks using two two-inch electrical submersible pumps powered by the M/V LISA E (Pgs. 1133-1136).

~1600: [redacted] saw Alexander Oliva on the barge. Alexander Oliva was reported to have gone back and forth from the barge to the tug at least one time (Pg. 735).

~1615: [redacted] boarded the EMC 423 and started the cargo pump prime mover. Alexander Oliva was on the barge in the vicinity of the cargo pump when [redacted] arrived (Pgs. 1139-1141). Alexander Oliva may or may not have been wearing a life preserver, but testimony revealed that he will "generally lay it down out there on the barge" (Pg. 1141). The thermal fluid heater was operating normally, but the temperature was less than 200° F (Pgs. 1165, 1185). The normal operating temperature of the thermal fluid heater was 300-350° F (Pg. 1184).

~1625: [redacted] last saw Alexander Oliva on the barge between the starboard header and the cargo pump (Pg. 746).

~1630: [redacted] returned to the M/V LISA E. Alexander Oliva remained aboard EMC 423 preparing the barge to be discharged. [redacted] saw Alexander Oliva working between the EMC 423 cargo pump and the header line (Pg 1146).

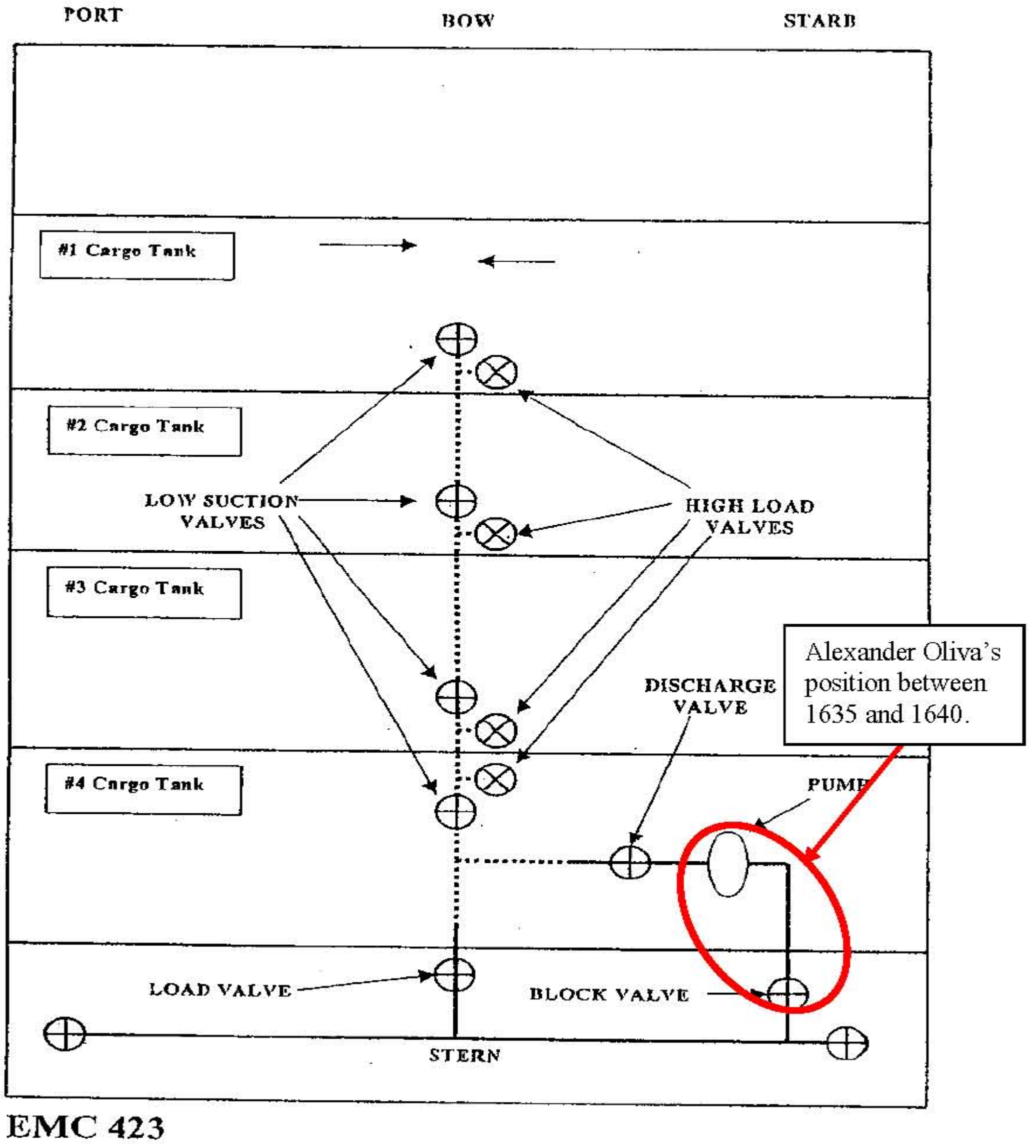


Figure 9-4: Area in which Alexander Oliva was last seen working prior to explosion

~1635: [redacted] lowered the M/V LISA E pilothouse and was setting up to pass Cicero Avenue Bridge (Pg. 859). [redacted] climbed to the top of the pilothouse to ensure that the M/V LISA E would clear the bridge (Pgs. 858-859). [redacted] last saw Alexander Oliva from the top of the pilothouse between 1635 and 1640 (Figure 9-4). He testified that Alexander Oliva was working on the barge between the cargo pump and the starboard header (Pgs. 1151-1152).

~1637 M/V LISA E and EMC 423 passed Olympic Oil, which is located 1500' downstream from the site of the explosion. M/V LISA E was traveling at a speed of 5-8 knots (Pg. 3101). Surveillance video from Olympic Oil revealed what appears to be Alexander Oliva (Figure 9-5)

Figure 9-5: Alexander Oliva on board EMC423 (Photo from Olympic Oil)

and a propane tank (Figure 9-6) aft of the cargo pump, on the inboard side of the discharge line (Exhibit CG-86).

Figure 9-6: Propane tank on board EMC423 (Photo from Olympic Oil)

~1639: [redacted] was satisfied that M/V LISA E would clear the Cicero Avenue Bridge when the vessel's pilot house was approximately 10 feet from the bridge. He climbed down the port ladder in route to the engine room (Pg. 1154).

~1640: [redacted] an eyewitness, was on the north bank of the Chicago Sanitary and Ship Canal, approximately 60' east of the Cicero Avenue Bridge (Exhibit

CG-03). He was shoveling dirt out of the back of his dump truck, which was backed up facing the canal. He stood up to take a break and looked over a fence directly across the canal (Pg. 2840). He noticed the M/V LISA E and the EMC 423 passing at a distance of about 150' and noted an orange glow on the barge as it cleared the Cicero Avenue Bridge (Exhibit CG-03, Pgs.2836, 2838). He determined that the orange glow was a "fire" on the EMC 423 just before the barge exploded (Pg. 2838). Figure (9-7) is a photograph taken by a news helicopter a few minutes after the explosion that illustrates the location of the eyewitness and his truck in relation to the canal and the Cicero Avenue Bridge, and his line of site "directly across the canal" (Exhibit CG-86).

Figure 9-7: Eyewitness ([redacted]) location at truck yard

NOTE: Figure (9-8) is provided to illustrate that the area of the flash that is found in (Figure 9-9) is not an attribute of the background or of the gantry in the foreground.

Figure 9-8: Photo of EMC 423 passing under Cicero Ave Bridge, before flash (Citgo Petroleum surveillance camera)

~1640: A white flash (Figure 9-9) was emitted from the EMC 423 just before the barge exploded (Exhibit CG-86).

Figure 9-9: White flash aboard EMC 423 just before the explosion (Citgo Petroleum surveillance camera)

~1640: [redacted] from the port side, main deck of the EMC 423, sees the white flash and describes it as a "bright light". [redacted] stated that the flash appeared on the opposite side of the thermal fluid heater and from where he was standing the flash was in line with the push-knee of the M/V LISA E (Pgs. 1156, 3079). [redacted]

[redacted] approximate location aboard the M/V LISA E when he saw the white flash just before the explosion (Figure 9-10).

Figure 9-10: [redacted]ocation at time of explosion

~1640: EMC 423 exploded at approximately mile 317.5 of the Chicago Sanitary and Ship Canal (Figure 9-11) (Exhibit CG-41). The tug and barge was just clearing the Cicero Avenue Bridge when the explosion occurred (Pgs. 754, 1152).

Figure 9-11: Explosion aboard EMC 423 (Citgo Petroleum surveillance camera)

[redacted] was at the wheel of the M/V LISA E when the explosion occurred. He heard a "popping" noise, followed by a loud concussion and orange glow. He initially reported the explosion coming from the area of the thermal fluid heater. He ducked below the pilot house console upon seeing the explosion (Pgs. 755-756).

[redacted] reported hearing a "popping" noise, followed by a metallic rumbling sound, similar to a barge running aground on the rocks. A sense or feeling of rumbling has been encountered prior to an explosion in previous casualties such as the ATC 3060 on 17 March 1975. When he turned around he saw a white flash followed by a red fireball (Pg. 1157).

[redacted] was sleeping in his cabin aboard the M/V LISA E when the explosion occurred. He reported that the explosion awoke him and he thought that the vessel had struck the Cicero Avenue Bridge. He immediately exited the stern door on the M/V LISA E and reported seeing black smoke behind the vessel. He then ran forward through the galley toward EMC 423 (Pg. 1390).

[redacted] reported seeing the explosion from the back of his dump truck in the truck yard. He saw a large fireball and ducked. He reported hearing what he believed to be at least one explosion following the first as debris rained down all around him (Pg. 2836-2841).

The EMC 423 sustained damage below the waterline to the #4 port wing void, stern void, #1 and #2 starboard wing voids, and in the cargo tank bottom of the #1, #2, #3, #4 cargo tanks (Pgs. 2941-2943). The cargo tank top was blown off the forward portion of the #4 cargo tank and the entire #3 and #2 cargo tanks (Figure 9-12), and portions of the exposed cargo were burning (Exhibit CG-86).

Figure 9-12: Overhead of EMC 423 showing blown off cargo tank top

~1642: [redacted] used his cell phone to contact the owner of Egan Marine, [redacted] to tell him that the barge exploded (Pg. 757). [redacted] tried contacting the Coast Guard via VHF channel 16, but had difficulty due to explosion damage to M/V LISA E antennas (Pg. 759).

[redacted] met at the bow of the M/V LISA E and released the face and hold down wires, which attached the tug to the burning barge. The port face wire was parted (Pg. 758). The M/V LISA E then pushed the bow of the EMC 423 into the north bank of the canal, where it was tied off just to the east of the Citgo Petroleum Corporation Dock at approximately mile 317.4 (Pgs. 1158, 1390).

~1648: USCG Station Calumet Harbor received a distress call from M/V LISA E via VHF channel 16, reporting that there had been a large explosion on the EMC 423

(Exhibit CG-43). Communications between the Coast Guard and the M/V LISA E were broken due to the vessel's damaged antennas, but the M/V WINDY CITY was near the scene of the explosion and passed information between the Coast Guard to the M/V LISA E (Exhibit CG-50, Pg. 1036). The Coast Guard also obtained some information from the M/V LISA E via cellular phone (Pg. 1037).

~1650: Chicago Fire Department helicopter was dispatched (Exhibit CG-43).

~1650: Chicago Fire Department arrived on scene at the explosion site with a "full complement", which included two engines, two trucks and a battalion chief (Pgs. 2747, 2749).

~1658: USCG Station Calumet Harbor dispatched a search and rescue boat crew. The small boat was trailored to the closest boat ramp to the explosion site due to severe ice conditions on the lake and canal (Exhibit CG-43). The boat ramp was approximately 30-40 minutes from the station by vehicle, depending on the volume of traffic (Pg. 1060). The site of the explosion was approximately 15-20 minutes by boat from the boat ramp, based on ice conditions (Pg. 1061).

~1703: Chicago Fire Department pumper truck began application of water to EMC 423 from Citgo Petroleum Corporation dock on the east bank of the Chicago Sanitary and Ship Canal (Exhibit CG-86). The water was being applied from a single line at 500-600 gallons per minute (Figure 9-13) (Pg. 2751).

Figure 9-13: Chicago Fire Department fighting fire on EMC 423

~1719: Chicago Fire Department foam truck from Midway Airport began application of foam to EMC 423 from Citgo Petroleum Corporation dock on the East bank of the Chicago Sanitary and Ship Canal (Exhibit CG-86).

~1721: EMC 423 sunk. Fire extinguished (Exhibit CG-86 and CG-43).

~1735: Chicago Fire Department vessel, VICTOR SLAGER, arrived on scene at the explosion site (Exhibit CG-43).

~1749: USCG Station Calumet Harbor small boat, CG-255057 underway on Chicago Sanitary and Ship Canal in route to explosion site (Exhibit CG-43).

~1819: CG-255057 on scene conducting search for missing crewman, Alexander Oliva (Exhibit CG-43). Probability of detecting floating victim determined to be greater than 98% with one pass up the center of the canal (Exhibit CG-47). Chicago Marine Police Unit M2, Chicago Fire Department vessel VICTOR SLAGER, Chicago Fire Department Helicopter, M/V LISA E and M/V WINDY CITY on scene searching (Pg. 1064).

~1835: Chicago Sanitary and Ship Canal was closed to all vessel traffic between mile 314 to 318.5 (Exhibit CG-139).

~1852: CG-255057 escorted M/V LISA E to shore at the request of Chicago Fire Department to conduct witness interviews with the vessel crew (Exhibit CG-43).

~1855: CG-255057 underway to resume search for Alexander Oliva (Pg. 1072).

~1900: Chicago Fire Department Chief and several other law enforcement officials conducted on site witness interviews with M/V LISA E crew. During the course of the interviews, [redacted] stated that there was a propane tank and torch aboard the EMC 423 calling it a "rosebud". [redacted] stated the torch's purpose was to warm the cargo pump before offloading. He also indicated that it was possible that Alexander Oliva was using the torch at the time of the explosion (Pgs. 1935-1936, Exhibit CG-85).

~1946: CG-255057 found burnt metal binder 300-500 yards west of the Cicero Avenue Bridge near the north bank of the canal (Exhibits CG-43, CG-57, Pg. 1088). Binder to contain the MSDS sheets and was determined have been aboard the EMC 423.

~2018: CG-255057 recovered severely burnt and torn work boot 300-500 yards west of Cicero Avenue Bridge, close to the south bank of the canal (Exhibits CG-43, CG-56, Pg. 1087). Boot was later determined to be a complementary match to the boot that was found on Alexander Oliva.

~2130: Coast Guard directed [redacted] to undergo post casualty drug test.

~2140: CG-255057 moored along side M/V LISA E to locate Alexander Oliva's brother, [redacted] to notify him of Coast Guard's intent to suspend the search, but [redacted] had departed the scene (Exhibit CG-43, Pgs. 1077-1078).

~2200: ATF and Coast Guard conducted on site interviews with M/V LISA E crew. During course of the interviews, [redacted] both acknowledged the presence of a propane tank and torch (rosebud) aboard the EMC 423, and that its purpose was to "thaw out" or "free up" the cargo pump. They also stated that Alexander Oliva was known to smoke on the barge and that he was known to smoke marijuana (Exhibit CG-84, Pgs. 1896, 1899).

~2215: Coast Guard Group Milwaukee Communication Center notified Alexander Oliva's next of kin that the Coast Guard's search was to be suspended (Exhibit CG-47).

~2240: Search suspended (Exhibit CG-43).

~2245: CG-255057 departed scene in route to boat ramp (Exhibit CG-43).

~2315: The gauger, SGS North America, returned to ExxonMobil – Joliet to sample shore tank 515 after hearing about the EMC 423 explosion (Pg. 2167, Exhibit CG-145).

January 24, 2005: The Chicago Sanitary and Ship Canal was opened to vessel traffic with the exception of miles 317.4 to 317.6 (Exhibit CG-139).

January 26, 2005: The Chicago Sanitary and Ship Canal was open to restricted vessel traffic between miles 317.4 to 317.6 (Exhibit CG-139).

February 4, 2005: Alexander Oliva's body was recovered by the Chicago Police Department. The deceased was floating near the south bank of the Chicago Sanitary and Ship Canal at approximately mile 316.7 (Exhibit CG-115). He was not wearing a lifejacket or work vest.

CHAPTER 10: CASUALTY ANALYSIS

The purpose of this chapter of the investigative report is to ascertain the most probable sequence of events and causal factor(s) by summarizing key evidence and testimony as resolved by the investigator. The process that was utilized in this analysis was to first identify the conditions that must be present for the casualty followed by ascertaining any alternative theories that could reasonably fulfill each of those conditions.

In order for an explosion to occur the following conditions must be present: 1) flammable vapor and air (mixture) within a confined space, 2) path for vapor to travel and 3) a competent source of ignition. Alternative theories were identified, explored, examined and determined to be viable or improbable for each condition.

This process proved particularly difficult to piece together due to many witnesses altering their statements as the investigation progressed. Not limited to but most notably, on the night of the explosion [redacted] told Chicago Fire Department and Bureau of Alcohol Tobacco, Firearms and Explosives (ATF) investigators that there "was" a torch onboard the barge at the time of the explosion, and when he testified at the hearing he stated that it was "possible" that there was a torch on the barge (Pgs. 784, 1896, 1936, 3128). As such, substantial emphasis was placed on the physical and electronic (photographic, video and digitalization) evidence that was amassed, reconstructed and examined during the course of this investigation. The physical and electronic evidence could not be refuted or be in conflict, as was prevalent in the statements and testimony of those associated with the casualty. In more than one instance, statements and/or testimony was modified or inconsistent with information gathered at a different stage of the investigation or hearing.

a. <u>Most probable sequence of events</u>: The M/V LISA E and EMC 423 spotted starboard to at ExxonMobil – Joliet refinery dock spot #1 located in Channahon, Illinois, mile 278.0 of the Des Plains River at 1545, January 18, 2005. The EMC 423 originally attempted to start loading at 1815 on January 18, 2005 but ExxonMobil experienced a problem with the suction valve located on Clarified Slurry Oil (CSO) Storage Tank 516. The suction valve could not be opened because CSO had set up in the valve. The CSO set up when the steam controller for steam supply to the CSO tank yard failed; thereby, stopping the flow of steam to the suction valve on Storage Tank 516. The air temperature that evening was approximately 14° F. (Reference 6) CSO is a highly viscous liquid that has a pour point of approximately 50° F (Exhibit EMC-01).

ExxonMobil, using the rundown line, gravity fed 3,300 to 3,500 barrels of CSO from Storage Tank 516 to Storage Tank 515 in order to have sufficient CSO to load the EMC 423 from a single static storage tank. Barges must be loaded from a static tank so that an accurate accounting of the volume of cargo that was transferred can be calculated. This resulted in about a 5 hour delay in loading the EMC 423 but once resolved the loading of EMC 423 was completed without a reported issue. The EMC 423 loaded approximately 14,272 barrels (599,424 gallons) of CSO at the ExxonMobil – Joliet refinery through loading arm 61-M-75.

The M/V LISA E got underway, pushing the EMC 423, at approximately 0700 on January 19, 2005 for what would start out as a typical transit; much like the two previous transits that took place on January 12 - 15 and 16 - 17, 2005. The weather at 0700 was approximately 33° F with West winds at 8 mph. The tug and barge completed locking through at Brandon Road Lock and Dam at 0850 and Lockport Lock and Dam at 1030, without delay. According to the Master of the M/V LISA E, [redacted] transit time from ExxonMobil – Joliet to Ameropan – California Ave, the receiving facility, is between 8 and 10 hours, without delays. Ameropan – California Ave facility is located at mile marker 320.2 of the Chicago Sanitary and Ship Canal in Chicago, IL.

Per standard practice, [redacted] the engineer and a crew member, Alexander Oliva, from the LISA E crossed over to the EMC 423, while underway, approximately 60 to 90 minutes before arriving at the discharge location. [redacted] and Alexander Oliva went to start the diesel engine prime mover for the Delco 60 Kw generator and the Hopkins Volcanic 5.0 million BTU thermal fluid heater. After completing these tasks, [redacted] and Alexander Oliva returned to the M/V LISA E. Sometime later, [redacted] observed Alexander Oliva returning to the EMC 423 to prepare the barge for spotting at Ameropan – California Ave starboard side to. Alexander Oliva was also preparing the barge to discharge by moving mooring lines to the proper side, removing the header blind on the starboard side of the barge and installing an 8" to 6" reducer, as required at Ameropan – California Ave. At approximately 1615, [redacted] returned to the EMC 423 to check on the thermal fluid heater and start the diesel engine prime mover for the cargo pump. At that time, Bill Rogers noted that the thermal fluid heater's heating medium was at approximately 200° F.

Within the EMC 423 cargo tanks, the CSO had generated vapors that consisted of hydrocarbons ranging from C_2 to C_{12}. These light ends created a vapor because residual oils, such as CSO, have trace amounts of light hydrocarbons. These hydrocarbons are generated by cracking as a result of localized heating (hot spots) in a tank and by vapor bubbles being released from occlusions in the oil. This vapor release occurs during oil transfer, stirring or heating. (Reference 2)

The vapors released by the CSO did not generate sufficient pressure within the tank to lift the one pound pressure/vacuum valves; therefore, trapping the vapors in the tank without displacing the air that already filled the two-foot headspace. This fuel/air mixture created an atmosphere within the explosive range. These now flammable vapors in the cargo tanks were emitted from any unsecured tank opening, which included the standpipe located adjacent to the cargo pump discharge outlet.

Alexander Oliva was also tasked with getting the cargo pump ready for the offload. Alexander Oliva "bumped the clutch" to see if the cargo pump was going to turn and found that it would not due to the cold temperatures solidifying CSO within the pump. One of the heat tracing lines attached to the cargo pump head was not connected so the heating system medium was not circulating through the pump casing to heat the congealed CSO. Alexander Oliva used a propane torch (rosebud) instead to heat the pump casing with the intention of heating the solidified cargo inside enough to allow the pump to turn freely.

[redacted] an eyewitness, was located in the truck yard located on the North bank of the Chicago Sanitary and Ship Canal, approximately 60' east of the Cicero Avenue Bridge. He was shoveling dirt out of the back of his dump truck, which was backed up to the truck yard's perimeter fence that ran along the canal. He stood up to take a break and looked over a fence directly across the canal. He observed the M/V LISA E and EMC 423 as the tow was clearing the Cicero Avenue Bridge noting an orange glow on the barge. He determined the orange glow was a "fire" on the EMC 423 just before the barge exploded.

During the course of heating up the cargo pump with the rosebud, Alexander Oliva accidentally ignited the unrestricted flammable vapors escaping through the standpipe. The flame traveled down the standpipe into cargo tank #4, causing the flammable vapors contained within the cargo tank's headspace to ignite and over pressurize the tank.

At approximately 1640, the EMC 423 suffered a violent explosion just as the stern of the M/V LISA E was clearing the Cicero Ave Bridge. At the time of the explosion, [redacted] was in the pilot house steering the tow. [redacted] had just climbed down the pilothouse's port ladder after confirming the M/V LISA E would clear the Cicero Avenue Bridge and was adjacent to the galley door on the port side of the main deck in route to the engine room. [redacted] was asleep in the bunk room located on the upper deck aft of the pilot house. Alexander Oliva ([redacted] brother) was on the EMC 423 in the vicinity of the cargo pump.

The explosive over pressurization of cargo tank #4 caused the tank top to lift rapidly resulting in Alexander Oliva receiving numerous blunt force trauma injuries to the head, torso, lower extremities and internal organs resulting in death. The explosion also caused him to be thrown off the barge and into the Chicago Sanitary and Ship Canal from where he was recovered approximately 16 days later.

The explosion, which originated in cargo tank #4, caused the forward half of the deck over cargo tank #4 on the starboard side to fold over its respective side of the barge. The explosion propagated forward into the next cargo tank pushing the cargo tank #3/#4 bulkhead forward into cargo tank #3. This propagation continued causing the deck plate from cargo tanks #3 and #2 to separate along the midline lap seam sequentially. The deck plate of both cargo tanks #3 and #2 become wrapped against the sides of the barge to port and starboard, respectively. Deck plate covering the port side of cargo tank #4 was folded forward and remained attached to the plate covering the port side of cargo tank #3. Simultaneous with the deck plate on cargo tank #4 being blown off and folded forward, the deck plate on cargo tank #3 was displaced outboard allowing the plate from cargo tank #4 to come to rest on the exposed frames of cargo tank #3.

After approximately 41 minutes, the barge sank due to the vessel taking on water from tears formed in the bottom plate at the buck frame fillet weld fore/aft of the #3/#4 cargo tank bulkhead. Additionally, the #3 P/S, #4 P/S and aft voids were compromised allowing both CSO and water to enter them. The loss of the cargo tank top exacerbated the down flooding.

b. Alternative theories (vapor source): During the course of the investigation there was speculation raised on how flammable vapors could be produced from/associated with this cargo.

Contamination –The CSO loaded on to the EMC 423 may have been contaminated with a lighter, more volatile product during the loading process. The theory put forth was that ExxonMobil employees used an unknown product or light distillate as a "line wash" to help clear the CSO set-up in the suction valve. After the line was cleared, the lighter substance would have been loaded onboard the EMC 423 with the CSO. The "line wash" was claimed to have been the source of the explosive vapors within the EMC 423's cargo tanks.

As reflected in the Coast Guard Research and Development Report, a limited volume of a lighter hydrocarbon contaminate on a higher flashpoint cargo can yield a reduction of the flashpoint. (Reference 2) In comparison, the flashpoint of the load taken on January 19 was 192° F while the flashpoint of the previous two loads was 198° F and 189° F (Reference 7 and 8). These flashpoint values indicate that the suction valve problem, present only during the January 19 load, did not have any impact on the flammable vapors generated by the CSO. In each of these loads, the flashpoint tests were consistently preformed using ASTM D-93 Pensky-Martens Closed Cup Test, on the multi-tank composite samples taken immediately after the loading was completed.

Numerous ExxonMobil employees testified that it was no longer company practice to use a line wash to clear obstructed cargo lines or valves. Several witnesses who took part in the transfer and the clearing of the valve the night that the EMC 423 was loaded with CSO testified that they used steam to "thaw" the CSO set up in the tank valve. Additionally, no CSO moved through the valve on storage tank 516 as a part of the gravity feed process to storage tank 515 or the loading of EMC 423. The gravity feed was completed from storage tank 516 to using the rundown line, a separate line from the suction line. Lastly, the suction valve on storage tank 516 was not cleared until after the transfer to EMC 423 was completed.

Another possibility which could tend to raise the flammability vapor concentration inside cargo tanks exist is the presence of a cargo residue from previous, more flammable cargoes. Witness testimony, records provided by Egan Marine and SGS gaugers records reflect that CSO from the ExxonMobil – Joliet refinery was the last three cargoes carried onboard the EMC 423. Additionally, the flashpoint test on the cargo sample taken from the EMC 423 cargo tank #1 after the casualty (post-fire) was 209° F. (Reference 9)

Extensive chemical analysis using gas chromatograph/mass spectrometry was undertaken to compare the volatile fractions of the cargo from ExxonMobil storage tank 515 and cargo taken from cargo tank #1 after the casualty. Similar testing was also completed on a sample of the multi-tank composite sample taken from the EMC 423 after the load was complete and was compared to the sample taken from cargo tank #1 after the casualty. The analysis of the test results revealed that "there is no evidence that the post-fire barge samples are different than the ExxonMobil tank samples or the pre-fire barge samples," (Exhibit CG-147).

The same chemical testing was used on laboratory generated vapors using samples of cargo from the ExxonMobil storage tank 515, cargo tank #1 after the casualty and the multi-tank composite sample taken from the EMC 423 after the load. The analysis of the test results indicated that these cargo "samples generate essentially the same headspace" (Exhibit CG-148). Therefore, the possibility of contamination is deemed improbable as the source of flammable vapors.

Hydrogen Sulfide – Hydrogen sulfide is a highly toxic and flammable gas. During the course of all vapor analysis testing, both laboratory and field, no indication of hydrogen sulfide presence was detected. A marine chemist that tested other barges loads of CSO from ExxonMobil – Joliet refinery found no measurable levels of hydrogen sulfide in the headspace (Exhibit CG-147). Therefore, it was deemed improbable as the source of flammable vapors.

Change in Refinery Process – The possibility that the ExxonMobil cargo had a lower flashpoint than indicated on the ExxonMobil – Joliet refinery MSDS or historically loaded on barges must also be considered. Based on the records of flashpoint testing completed by SGS gaugers on a composite tank sample for every load of CSO for Clark Oil Trading the flashpoint of the January 19 load of CSO is not below that stated in the MSDS or inconsistent with the flashpoint of the previous two loads.

The history of flashpoint test results before and after the change in the operational controls of the Light Cycle Oil product draw (Chapter 8, pg 4) to increase run life of the Light Cycle Oil piping circuit (Exhibit CG-97), indicate that the composition of CSO had been relatively consistent. All things remaining stable, the key influence into the final composition of CSO is determined by the make up of the feed stock crude oil. As a result of the change in operational controls, the volume of light hydrocarbon increased causing a change in the flashpoint of CSO generated by the ExxonMobil – Joliet refinery. Regardless, the resultant cargo property characteristics maintained its classification criteria as a Grade E cargo. Therefore, it was deemed improbable that this change in process was the precursor to the generation of the flammable vapors.

c. <u>Alternative theories (vapor path)</u>: There were a number of openings to the EMC 423 cargo tanks that could have constituted the vapor path that initiated the explosion. Any path of vapor emanating from an unrestricted opening in a cargo tank would need to be in close proximity to a source of competent ignition. This premise is based on the testimony of [redacted] (ATF) as it relates to the effect of the barge's forward speed (approx. 5 to 8 knots), in combination with the 10 knot wind from the North, on the ability of the vapor maintaining its explosive/flammable sustaining/initiating characteristics.

Cargo Hatches/Ullage Openings – All cargo hatches/ullage openings are on the top of the cargo expansion trunks located along the centerline of the EMC 423. The closest hatches/ullages are those associated with cargo tanks #3 and #4. While these hatches constitute a viable vapor path, both cargo hatches appeared to have been closed and cargo tank #3's hatch was dogged with at least one dog. The exact condition of the ullage openings cannot be fully ascertained nor the specific number of dogs engaged on cargo hatch #4 as the bronze dog bolts on cargo tank #4's hatch/ullage opening were melted as a result of the fire. However, based on the condition of cargo tanks #1 and #2 closure mechanisms, it is reasonable to conclude that the ullage openings were closed and dogged. Having considered these uncertainties, the hatches/openings are not in proximity of any fixed competent source of ignition. Therefore, the hatches and ullage openings were deemed improbable as the vapor path that initiated the explosion.

Pressure Vacuum Valves – Pressure Vacuum (PV) valves were installed aboard The EMC 423 as original equipment and remain a requirement as the certificate of inspection provides for the carriage of Grade B and lower cargoes. Title 46 CFR 32.55-25 (2) allows for venting of cargo tanks of tank barges constructed on or after July 1, 1951 via use of a venting system permitted for a higher grade of liquid instead.

Pressure Vacuum valves are designed to limit the maximum pressure and vacuum that can exist in a tank. When a tank is being filled, the gas (air, vapor, etc.) that filled the space above the liquid is compressed and if this pressure was allowed to exceed the design pressure of the tank then it would burst. Also, if the temperature of the tank increases then the effect of vaporization and expansion would cause pressure in the tank to increase whereas a reduction in temperature causes a vacuum to be created. When the relief valve does lift due to pressure, air will predominantly be discharged rather than cargo vapor. (Reference 10)

All PV valves are attached to the cargo expansion trunks that are located along the centerline of the EMC 423. The closest PV valves are those associated with cargo tanks #3 and #4. At least three of the four PV valves aboard the EMC 423 were not bolted down properly and could have been a source of flammable vapor whether the flame screens were intact or not. Additionally, in order for these PV valves to be a viable vapor path, the CSO in the cargo tanks would have to be capable of generating sufficient pressure to lift the pressure weight; thereby, venting flammable vapors. A condition consistent with carrying low volatile cargoes with PVs installed as was found to be a contributing factor in the M/T FIONA casualty on 31 August 1988. (Reference 11)

According to the data included on the MSDS, the CSO was not volatile enough to generate sufficient pressure to lift the PV valves and the PV valves are not in proximity of any fixed competent source of ignition. Therefore, they were deemed improbable as the vapor path that initiated the explosion.

Butterworth/Cleanout Ports – Each cargo tank was equipped with 4 deck mounted butterworth/cleanout ports. Only two of the ports, located port and starboard on the aft deck of cargo tank #4, were in proximity of a competent source of ignition (within 10 feet of the thermal fluid heater). Examination of each of these ports indicated they were properly bolted and sealed; therefore, they were deemed improbable as the vapor path that initiated the explosion.

d. Alternative theories (ignition sources): There were a number of competent sources of ignition present on the EMC 423 that could have ignited a vapor with a path to a confined space resulting in the explosion. [redacted] (ATF) testified that a competent source of ignition would have to be within a couple of inches of the vapor path to ignite it (Pg. 3338) as a result of the barge's forward speed (approx. 5 to 8 knots) in combination with the 10 knot wind from the North.

Thermal fluid heater – The thermal fluid heater aboard the EMC 423 was a competent source of ignition. The burner was essentially a large flame aboard the barge, and although contained within the thermal fluid heater, it was a possible source of ignition. The thermal fluid heater also had three motors associated with it that were not designed to be used in hazardous locations and could have been a source of ignition.

The thermal fluid heater was installed in a hazardous location - within 3 meters of a cargo tank clean out port. In accordance with Title 46 CFR 111.105-29 (c), "where the cargo is heated to within 15° C of its flashpoint … the weather locations must meet Title 46 CFR 111.105-31(l)." However, the port was blanked off with a vapor tight closure device, eliminating the possibility that flammable vapors could have escaped. Since there were no probable paths for the vapor within a couple of inches of the thermal fluid heater, it was deemed an improbable source of ignition.

Smoking – There was testimony provided during the hearing and in witness statements made to investigators that Alexander Oliva had been known to smoke aboard the barges. An ATF explosion expert testified that a lit cigarette in itself is not a competent source of ignition and that a spark from a lighter would have to be within a couple of inches of a flammable vapor to ignite it. This was deemed to be an improbable source of ignition.

Pyrophoric iron sulfide – Pyrophoric iron sulfide is an auto-ignition condition that can occur in barge cargo tanks. This possibility was explored, but quickly discounted because the trade that the EMC 423 was engaged in was not conducive to creating the conditions necessary within the cargo tanks to cause pyrophoric iron sulfide. Specifically, pyrophoric iron sulfide is formed by the conversion of iron oxide (rust) into iron sulfide in an oxygen-free atmosphere where hydrogen sulfide gas is present (or where the concentration of hydrogen sulfide (H_2S) exceeds that of oxygen). When the iron sulfide crystal is subsequently exposed to air, it is oxidized back to iron oxide and either free sulfur or sulfur dioxide gas is formed. (Reference 12) The EMC 423 transports CSO nearly exclusively (specifically the last three loads), which does not subject the cargo tanks to low oxygen/high sulfur condition for extended periods. According to "The International Oil Tanker and Terminal Safety Guide", iron sulfide should not form when there is a significant oxygen concentration in the tank because iron oxide (rust) will form instead. (Reference 4) Additionally, after the explosion, the EMC 423's cargo tank #1, which was intact, was examined for any signs of iron sulfide build-up. No signs were noted.

Static electricity – The possibility that a static electric charge emitted by Alexander Oliva ignited the vapors, thereby causing the explosion was explored and was determined to be unlikely. Alexander Oliva was wearing leather gloves, rubber soled leather boots and a non-conductive Nomex suit, which would all significantly reduce, if not eliminate, the possibility of him discharging a static electric charge. Additionally, hazards presented by clothing and footwear are not significant as surfaces become contaminated by dirt and moisture that reduce electrical resistance (Reference 4) both of which are prevalent on inland tank barges.

Generator/Electrical System – The EMC 423 generator and 4V-71 diesel prime mover were recovered from the canal and examined by investigators and representatives from Detroit Diesel Corporation. No abnormalities were noted and all testimony supports that the EMC 423 generator was operating normally at the time of the explosion. As indicated in Chapter 5, the generator provided power only to the thermal fluid heater. All power was transmitted to the Thermal Fluid Heater via cabling run through a conduit located on deck and was not routed in the vicinity of a source of vapor. In addition, the generator/prime mover was not located within a couple of inches of any identified vapor path. For these reasons, the EMC 423 generator/electrical system was deemed to be an improbable ignition source.

Cargo Pump Prime Mover – The EMC 423 cargo pump was driven by a 6V-71 diesel engine located approximately 12' forward of cargo pump (Figure 5-2). The engine was never recovered from the canal but the engine cradle and foundation was examined by Detroit Diesel. From the examination they were "able to conclude that no thermo event occurred at this location due to the lack of scorch marks, soot residue, burned paint or melted plastic, aluminum or rubber components located on the cradle." Prior to and at the time of the casualty, the crew reported that the engine was operating normally. Since there were no probable paths for the vapor within a couple of inches of the cargo pump prime mover and all indications are that it was working normally, it was deemed an improbable source of ignition.

The possibility of a transient source of ignition relative to each of the alternatives theories (vapor path) was deemed improbable given that Alexander Oliva was the only person on the EMC 423 and his last known location was in the vicinity of the cargo pump in support of his job to prepare the barge for discharge.

e. Casualty Recreation: In order to make optimal use of the video information garnered from the CITGO facility security camera and the testimony provided by [redacted] and [redacted] the length of the Chicago Sanitary and Ship Canal between the CITGO facility and the Cicero Ave Bridge was digitalized. The EMC 423 and M/V LISA E were individually laser scanned using a Leica HDS3000 with Leica Cyclone Software - version 5.5 (Figure 10-1).

Figure 10-1: Individual digital scans of canal and tug/barge

A laser scanner works on the principle of emitting a laser to be bounced off an object, and returned to the scanner from which the point's three dimensional coordinates relative to the scanner are derived. The scanner used has two mirrors, one horizontal and one vertical inside the instrument to manipulate the horizontal and tilt angle of the laser beam which is emitted. These mirrors are tilted repeatedly creating a grid over the object being observed with the emitted laser, thus producing a three dimensional model of the object. The laser scanner determines the distance between a large number of object points and the scanner by emitting laser pulses in different directions and detecting the echoes from the objects. The laser scanner used, Leica HDS3000, has a modeled accuracy of 2mm. The laser has a width of 6mm at 50 meters. This makes any individual point node have an absolute accuracy of 6mm in 3D space within one scanworld.

Six scanworlds were combined by registration in pairs of two. The three combined scanworlds were then merged to make the final model space to include the tug, barge and canal in a scene only seconds before the explosion (Figure 10-2). The vessels were positioned relative to one another based on the testimony provided during the hearings and during the course of field investigative work. The M/V LISA E and EMC 423 together were then positioned in the canal by comparing the digital image (Figure 10-2) with the photo data (Figure 10-3).

The photo graph line errors allow the tug to move plus or minus less than 9 feet in the canal. There is a 4 foot error moving up and down the canal. The error distributed to the barge would be less than 5 feet side to side and less than 2 feet up and down the canal. In conclusion, the overall accuracy of the tug and barge in relationship to the canal is placement within 1 foot of absolute position.

Figure 10-2: Digital recreation of M/V LISA E and EMC 423 coming under Cicero Ave Bridge seconds before the explosion

Figure 10-3: CITGO security photo of M/V LISA E and EMC 423 coming under Cicero Ave Bridge seconds before the explosion

Using the still photos from the security camera located at CITGO a sight line was projected through the gantry (Figure 10-5) in the foreground to a white flash (Figure 10-3 - circled) that appears in the distance.

Figure 10-4: Eyewitness ([redacted] location at truck yard

[redacted] during his testimony indicated that he was in the back of his truck resting after shoveling dirt out. While resting he stated he was looking "directly across the canal" when he observed an "orange glow" on the barge. At approximately the same time [redacted] concluded it was a "fire" on the barge, which was immediately followed by the explosion. Using the live news film footage, a still image of the truck yard was created that showed the location and orientation of [redacted] truck allowing an assessment of his direction of view across the canal and the area of the barge he was observing (Figure 10-4). This piece of information was then applied, as a sight line, to the digitalized recreation (Figure 10-5).

According to [redacted] testimony, he was on the port side of the M/V LISA E looking forward over the single push knee when he observed the "white flash" followed immediately by a red fire ball/explosion in the same general area. By using this information, sight lines were projected from his approximate location over the push knee on the M/V LISA E and across the EMC 423 (Figure 10-5).

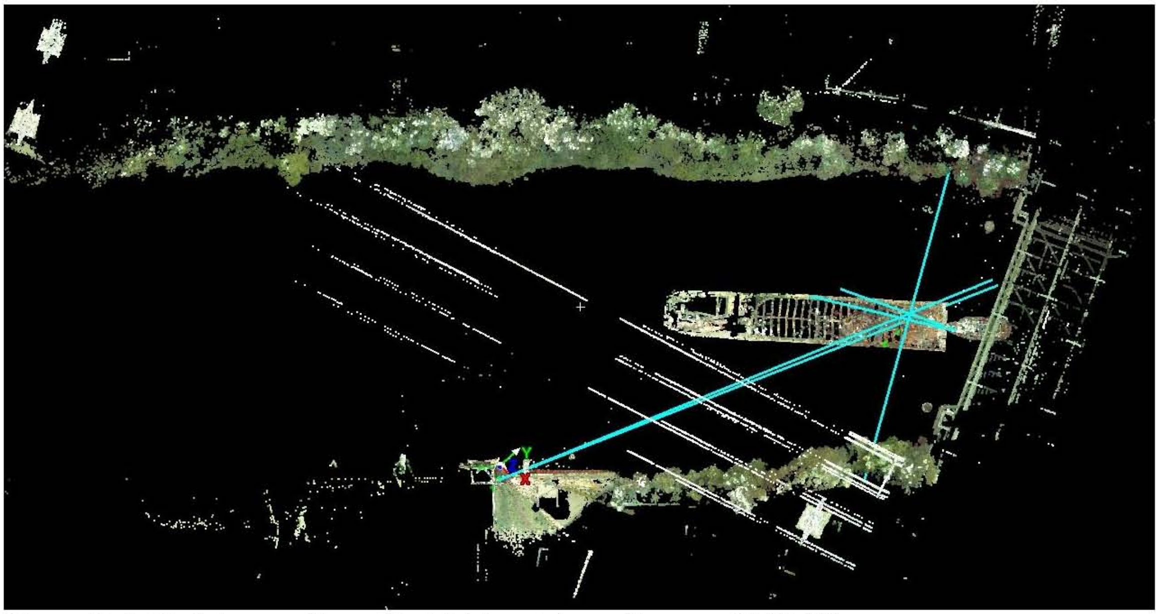


Figure 10-5: Digital recreation with sight lines intersecting over EMC 423

As indicated in Figures 10-5 and 10-6, the sight lines generated from two witnesses and the CITGO surveillance camera all cross in the immediate vicinity of the EMC 423 cargo pump. In combination with the testimony and physical findings, the crossing of these sight lines within the same immediate area serve to provide conclusive evidence that all the conditions necessary for the casualty to occur were present in the vicinity of the cargo pump. Present were a flammable vapor/air mixture confined within the number 4 cargo tank, a path for the vapor to travel from the confined space via the standpipe, and a competent source of ignition in the form of the propane torch on board the EMC 423 for the purpose of heating the cargo pump.

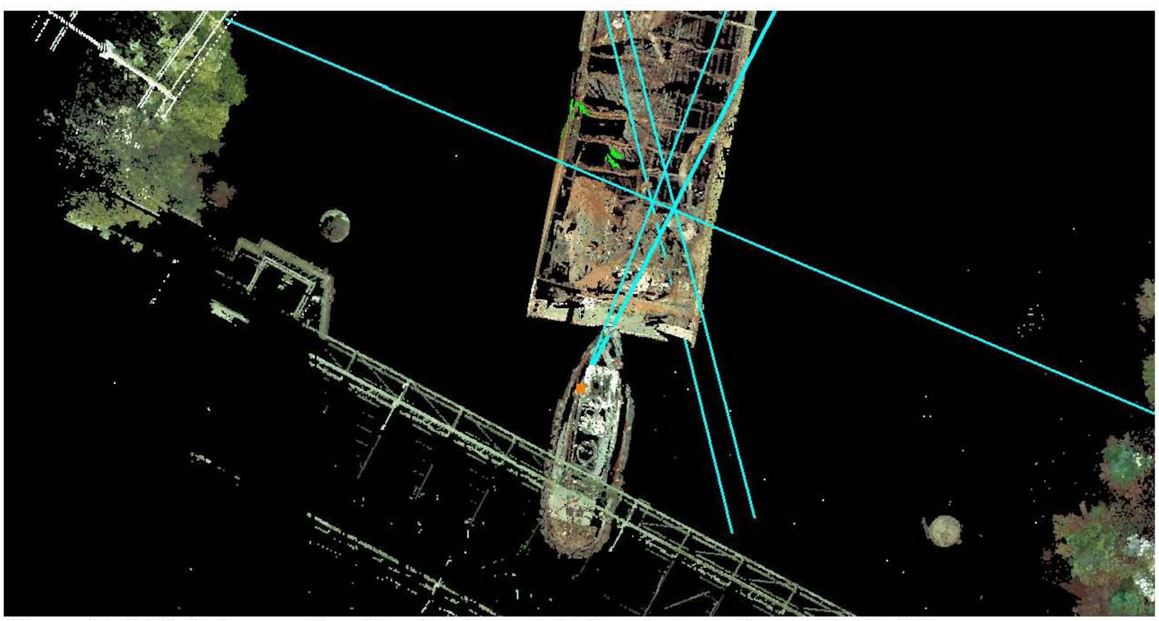


Figure 10-6: Digital recreation directly above sight lines intersection on EMC 423

f. <u>Cause of Death:</u> The Cook County Assistant Medical Examiner, [redacted] determined the cause of Alexander Oliva's death to be drowning (Exhibit CG-113). The basis for this finding, as testified by [redacted] was that Alexander Oliva drowned because "he was found in the water" despite there being "no specific findings in the lungs indicating he was drowned" (Pgs. 2485-2487). [redacted] also testified that he did not have any previous experience with victims that had been exposed to an explosion or with marine related deaths. Based on this investigating officer's experience with physical injuries sustained during barge explosions and the result of [redacted] finding based on his experience, a consultation was sought. This consultation was received from [redacted] Deputy Medical Examiner at the Department of Defense, Armed Forces Institute of Pathology (Exhibit CG-142).

[redacted] was able to render expert consultation regarding blast, blunt force, and submersion injuries as a result of his experience with causes of death prevalent in the military, e.g., drowning, gunshots and blast injuries. Based on the write-up, photos and toxicology provided from Office of the Medical Examiner, Cook County, Illinois, [redacted] concluded that "the cause of death was multiple blunt force injuries due to an explosion, rather than drowning due to an explosion." He also stated that "severe injuries of the head and torso…would have caused rapid death" (Exhibit CG-142).

FINDINGS OF FACT:

EGAN MARINE CORPORATION

1. [redacted] is the sole owner of Egan Marine Corporation and Service Welding and Shipbuilding.
2. Egan Marine Corporation had several different versions of safety manuals and guides.
3. Egan Marine Corporation employees were unclear about which safety manual was most applicable and most up to date.

AMERICAN WATERWAYS ORGANIZATION

4. Egan Marine Corporation was a member "in good standing" of the American Waterways Organization's (AWO) Responsible Carrier Program (RCP) at the time of the EMC 423 explosion.
5. Egan Marine Corporation's most recent AWO audit was conducted in 2002 by [redacted].
6. [redacted] was a certified AWO auditor.
7. [redacted] was a contract employee for Egan Marine Corporation.
8. [redacted] stated that [redacted] administered Egan Marine Corporation's training program.
9. [redacted] denied administering Egan Marine Corporation's training program.
10. Most recent AWO audit conducted by [redacted] indicated that Egan Marine Corporation had an extensive training program with record keeping.
11. AWO RCP requires member companies to document written procedures and policies with regard to maintenance including retention of maintenance records and preventative maintenance program.
12. Egan Marine Corporation 2002 RCP audit stated that Egan Marine had a written maintenance program that included procedures for the performance of scheduled maintenance, procedures for correcting deficiencies identified during maintenance, and a policy regarding the retention of maintenance records.
13. No maintenance records for EMC 423 were produced pursuant to a January 25, 2006 subpoena to Egan Marine Corporation.
14. Egan Marine Corporation employees testified that the company did not track or document preventative maintenance.
15. [redacted] had no established duties as Egan Marine Corporation's Vice President of Operations.
16. [redacted] made nearly all decisions on behalf of Egan Marine Corporation.

INSPECTION

17. The EMC 423 had one outstanding inspection deficiency at the time of the explosion - to complete required section modulus prior to January 5, 2005.
18. The EMC 423 COI was revoked on September 8, 1999 for overdue cargo tank internal and drydock inspections.
19. The EMC 423 received a new COI on September 9, 2000 without undergoing cargo tank internal and drydock inspections.
20. Significant portions of EMC 423 sideshell and bow sections were replaced while the vessel was out of service between 1999 and 2000.
21. The hull alterations/repairs were not approved or inspected by the Coast Guard at the time of their undertaking.
22. Numerous other modifications were made to the EMC 423 without Coast Guard notification, approval or inspection, i.e. addition of fuel tank, fuel heater, tank-top repairs.
23. The EMC 423 missed its required annual inspections in 2002 and 2003.
24. Coast Guard MISLE inspection records for EMC 423 were inconsistent and included varying levels of inspection details.
25. The Coast Guard has outdated guidance to address what information should be included in a MISLE inspection narrative.

DRUG AND ALOCHOL PROGRAM INSPECTORS

26. Egan Marine Corporation administered their own drug and alcohol testing program.
27. Egan Marine hired [redacted] as the drug and alcohol testing program special agent.
28. [redacted] was directed by his employer and the Coast Guard to submit himself to post casualty drug testing the night of the EMC 423 explosion.
29. [redacted] did not undergo post casualty drug testing after the EMC 423 explosion.
30. [redacted] a pre-employment drug test on March 28, 2005, testing [redacted]
31. [redacted] Merchant Mariners Document (MMD) was revoked for testing [redacted] for marijuana in 1999.
32. [redacted] did not complete the necessary rehabilitation program to return to work in a safety sensitive position aboard commercial vessels.
33. [redacted] was working aboard the M/V LISA E and EMC 423 in a safety sensitive position at the time of the barge explosion.
34. Alex Oliva's post-mortem toxicology test screened [redacted] for traces of benzoylecgonine (cocaine) and cannabinoids (marijuana).
35. [redacted]
36. [redacted]

BARGE

37. The EMC 423 was owned and operated by Egan Marine Corporation.
38. The EMC 423 was a double side, single bottom, subchapter D tank barge, certificated to transport Grade B and lower petroleum products.
39. The EMC 423 was one piece of a three barge tow, with all 3 barges configured similarly.
40. The EMC 472 was the middle section of the three barge tow and is configured almost identically to the EMC 423.
41. The EMC 423 was regulated under Title 46 CFR subchapter D (tank vessels).
42. Portions of the EMC 423 cargo piping ran on deck and through the cargo tanks.
43. The EMC 423 cargo piping that was on deck was insulated.
44. The EMC 423 cargo pump was a positive displacement 10" Viking pump with a Faulk reduction gear, powered by a 671 Detroit Diesel engine, all mounted on a steel frame on the starboard side of the #4 cargo tank-top.
45. With the exception of the Detroit Diesel 671 engine, the entire EMC 423 cargo pump assembly was recovered in the canal after the explosion.
46. The piping on the discharge side of the cargo pump was made of 8" x ½" mild steel pipe.
47. The EMC 423 cargo pump was modified from the original design specifications to include the addition of a bleed valve on the discharge side of the pump.
48. There was only one cargo pump onboard the EMC 423 at the time of the explosion.
49. There was a 37 7/8" tall, 2 1/2" diameter standpipe protruding through the EMC 423 #4 cargo tank-top inside the cargo pump frame.
50. The standpipe was equipped with a ball valve.
51. The valve was open and there was no handle on the valve operating mechanism when the standpipe was recovered.
52. There was no closure device in place and it presented an open path between the #4 cargo tank and the atmosphere.
53. There was no damage to the threads on the end of the standpipe.
54. The internal surface of the standpipe and the standpipe threads were coated with a thick, black petroleum product.
55. There was conflicting testimony with regard to the closure devices and/or fittings on the standpipe.
56. The EMC 423 cargo tanks were equipped with a 1 pound pressure, ½ pound vacuum relief valve.
57. The cargo tank #1 P/V valve was not properly assembled.
58. Two of the remaining three EMC 423 PV valves were not properly assembled.
59. The EMC 423 cargo tank #1 P/V valve flame screen was partially clogged.
60. The EMC 423 was original equipped with a Vapor thermal fluid heater located on the port side of the barge, forward of the cargo manifold.
61. A refurbished Volcanic thermal fluid heater was installed aboard EMC 423 when the vessel was out of service between 1999 and 2000.
62. The Volcanic thermal fluid heater was located athwartship, slightly port of center on the stern of the barge aft of the transfer header.

63. The thermal fluid heater installation was not approved or inspected by the Coast Guard at the time of installation.
64. The thermal fluid heater was installed in a weather location.
65. The two aft barge "clean out ports" were located within 10' of the Volcanic thermal fluid heater.
66. The EMC 423 thermal fluid heater blower motor, fuel pump motor, and circulation pump motor were not rated to be installed in a hazardous location.
67. The thermal fluid heater circulation pump was circulating heated Therminol through the EMC 423 cargo tank heating system piping at the time of the explosion.
68. The EMC 423 cargo heat trace tubing was located inside the insulation along all above deck cargo piping.
69. The EMC 423 heat trace line was constructed of a variety of steel piping and stainless steel tubing.
70. The stainless steel cargo heat trace lines were connected with compression fittings.
71. The EMC 423 cargo pump was equipped with a chamber through which a heating medium could be circulated.
72. The EMC 423 and EMC 472 pumping systems and heat tracing systems were configured nearly identically.
73. The EMC 423 cargo pump was thrown from the barge during the explosion with sufficient force to tear the 8" x ½" cargo piping on the discharge side of the pump.
74. The EMC 423 stainless steel heat trace tubing attached to the cargo pump was undamaged in the explosion.
75. The compression fitting attached to the heat trace tubing that remained on the cargo pump was undamaged.
76. The compression fitting attached to the heat trace piping at the pump's discharge piping connection to the athwart ship cargo header was undamaged.

M/V LISA E

77. The M/V LISA E was owned and operated by Egan Marine Corporation at the time of the EMC 423 explosion.
78. The M/V LISA E was a 62', 75 gross ton, single tow knee uninspected towing vessel built in 1963 and powered by two 400 horsepower diesel engines.

CREW

79. [redacted] was the Master of the M/V LISA E at the time of the EMC 423 explosion.
80. [redacted] held a valid Master of Towing Vessels license, for vessels less than 100 gross tons, on Great Lakes, Inland Waters and Western Rivers.
81. Alexander Oliva did not hold an MMD or Mariner's license at the time of the EMC 423 explosion.
82. [redacted] did not hold an MMD or Mariner's license at the time of the EMC 423 explosion.

83. [redacted] did not hold an MMD, but did hold a Master of Motor Vessels under 100 Gross Tons (does not include towing vessels) at the time of the EMC 423 explosion.
84. [redacted] was the only certificated tankerman aboard the M/V LISA E / EMC 423 at the time of the explosion.

EVENT

85. The EMC 423 transported CSO for the two loads prior to explosion.
86. The EMC 423 arrived at ExxonMobil to load CSO on January 18, 2005.
87. The EMC 423 tankerman, [redacted] and the facility person in charge completed a Declaration of Inspection.
88. The EMC 423 tankerman and facility person in charge did not verify one another's tankerman/PIC credentials.
89. The transfer of CSO to the EMC 423 was delayed prior to loading any product due to a frozen valve at the ExxonMobil facility.
90. Tankerman [redacted] departed ExxonMobil at approximately 1815.
91. The transfer was restarted with Alexander Oliva acting as the EMC 423 tankerman at approximately 2310.
92. [redacted] returned to resume his duties as tankerman at approximately 2355.
93. Egan Marine Corporation conducted at least 16 transfers between January, 2004 and January 2005 without a certified tankerman.
94. [redacted] saw a propane tank and an attached hose buried in the ice on the deck of EMC 423 while he was loading the barge.
95. SGS North America was contracted by ExxonMobil and Clark Oil Trading to perform all necessary gauging and sampling of the product during the cargo loading/offloading process.
96. SGS North America sampled ExxonMobil storage tank 516 prior to beginning the loading of EMC 423.
97. SGS North America took a composite sample of one quart from each of EMC 423's four cargo tanks upon the completion of the barge loading.
98. SGS North America sampled ExxonMobil storage tank 515 a few hours after the EMC 423 explosion.
99. The EMC 423 loading was completed and the M/V LISA E departed ExxonMobil pushing the EMC 423 in route to Ameropan, Inc. at California Avenue, Chicago, IL via the Chicago Sanitary and Ship Canal on the morning of January 19, 2005.
100. The transit speed of the M/V LISA E/EMC 423 was between 5-8 knots.
101. The outside temperature at the time of the casualty was approximately 33° F.
102. It is common practice aboard Egan Marine vessels for the crew to board barges while underway prior to reaching their destination to prepare for discharge, i.e. start generator, start thermal fluid heater, start and free cargo pump.
103. [redacted] started the EMC 423 generator and thermal fluid heater in preparation of the offload at approximately 1520.
104. [redacted] started the EMC 423 pump engine at approximately 1615.
105. The thermal fluid heater temperature was less than 200° F at approximately 1615.

106. [redacted] last saw Alexander Oliva aboard the EMC 423 between the cargo pump and the starboard cargo header at approximately 1625.
107. [redacted] returned to M/V LISA E at approximately 1630.
108. [redacted] last saw Alexander Oliva between the cargo pump and the cargo header aboard the EMC 423 at approximately 1635.
109. The M/V LISA E and EMC 423 passed Olympic Oil, where surveillance video captured what appears to be Alexander Oliva in the immediate vicinity of the EMC 423 cargo pump at approximately 1637.
110. The M/V LISA E and EMC 423 passed Olympic Oil, where surveillance video captured what appears to be a propane tank in the immediate vicinity of the cargo pump at approximately 1637.
111. An eyewitness was looking directly across the Chicago Sanitary and Ship Canal from the north bank and saw an orange glow aboard the EMC 423 at approximately 1640.
112. A white flash was emitted from the vicinity of the EMC 423 cargo pump at approximately 1640.
113. The EMC 423 exploded at approximately 1640.
114. A Bureau of Alcohol Tobacco, Firearms and Explosives (ATF) expert stated that the EMC 423 explosion initiated in the #4 cargo tank.
115. The EMC 423 sustained significant explosion damage below the waterline, resulting in progressive flooding.
116. The EMC 423 cargo tank top was blown off the forward portion of the #4 cargo tank, the # 3 cargo tank, and the #2 cargo tank.
117. [redacted] was located on the port side main deck of the M/V LISA E at the time of the explosion.
118. [redacted] was piloting the M/V LISA E at the time of the EMC 423 explosion.
119. [redacted] was sleeping aboard the M/V LISA E at the time of the EMC 423 explosion.
120. Alexander Oliva was aboard the EMC 423 near the cargo pump when the barge exploded.
121. Coast Guard Station Calumet Harbor received distress call from [redacted] reporting explosion at approximately 1648.
122. Coast Guard Station Calumet Harbor dispatched a search and rescue boat crew to the nearest boat launch at approximately 1658.
123. Coast Guard Station Calumet Harbor small boat was underway in the Chicago Sanitary and Ship Canal in route to the EMC 423 explosion site at approximately 1749.
124. Coast Guard Station Calumet Harbor boat crew was on scene at the EMC 423 explosion site conducting search for Alexander Oliva, along with Chicago Marine Police vessel M2, Chicago Fire boat VICTOR SLAGER, Chicago Fire Department helicopter, M/V LISA E, and M/V WINDY CITY at approximately 1819.
125. The Coast Guard boat crew completed search pattern with a greater than 98% probability of detecting a person in the water without a life jacket.

126. Alexander Oliva's next of kin was notified that the search would be suspended at approximately 2215.
127. The Coast Guard suspended the search for Alexander Oliva at approximately 2240.
128. Coast Guard boat crew departed the scene at approximately 2245.
129. The Chicago Fire Department initiated EMC 423 firefighting from the north bank of the Chicago and Sanitary Ship Canal with a single water line at 500-600 gallons per minute at approximately 1703.
130. The Chicago Fire Department foam truck began foam application on EMC 423 from the north bank of the Chicago Sanitary and Ship Canal at approximately 1719.
131. The EMC 423 sank and the fire was extinguished at approximately 1721.
132. [redacted] was interviewed by Chicago Fire Department and law enforcement investigators.
133. [redacted] stated to investigators that there was a propane tank and torch on board EMC 423 at the time of the explosion.
134. [redacted] stated to investigators that the purpose of the torch was to warm up the cargo pump.
135. [redacted] stated to investigators that Alexander Oliva was operating the EMC 423 cargo pump at the time of the explosion.
136. [redacted] was interviewed by ATF and Coast Guard investigators.
137. [redacted] stated to ATF and Coast Guard investigators that there was a propane tank and torch (rosebud) aboard EMC 423 at the time of the explosion.
138. [redacted] stated to ATF and Coast Guard investigators that the purpose of propane torch was to heat up the EMC 423 cargo pump.
139. [redacted] stated to ATF and Coast Guard investigators that Alexander Oliva had been known to smoke on the barge.
140. [redacted] stated to ATF and Coast Guard investigators that Alexander Oliva had been known to smoke marijuana.
141. During the formal hearing [redacted] stated to investigators that he was unaware of whether there was a propane torch aboard the EMC 423 at the time of the explosion, but it was a possibility
142. [redacted] was interviewed by ATF and Coast Guard investigators.
143. [redacted] stated to ATF and Coast Guard investigators that Alexander Oliva may have been using a propane torch to free up the cargo pump at the time of the explosion.
144. Alexander Oliva was recovered deceased at mile 316.7 of the Chicago and Sanitary Ship Canal on February 4, 2005.
145. Alexander Oliva was not wearing a life preserver or work vest when he was recovered.
146. A Post-mortem examination of Alexander Oliva revealed multiple broken bones, lacerations, and ruptured and lacerated organs.
147. The Cook County Coroner determined the cause of Alexander Oliva's death to be drowning because he was found in the river.

148. A Department of Defense Armed Forces Institute of Pathology Medical Examiner determined the cause of Alexander Oliva's death to be blunt force trauma due to the explosion.
149. The Chicago Sanitary and Ship Canal was closed to vessel traffic from miles 314-318.5 after the casualty on January 19, 2005.
150. The Chicago Sanitary and Ship Canal was opened with the exception of miles 317.4 to 317.6 on January 24, 2005.
151. The Chicago Sanitary and Ship Canal was open to restricted traffic between miles 317.4-317.6 on January 26, 2005.

CARGO

152. The EMC 423 was loaded from the ExxonMobil tank 515.
153. A CSO sample was taken from the EMC 423 cargo tank #1 after the explosion.
154. The pour point of CSO is approximately 50° F.
155. The flashpoint of the CSO aboard EMC 423 at the time of the explosion was 192° F.
156. The CSO was loaded aboard EMC 423 at approximately 185 ° F.
157. The CSO aboard EMC 423 was approximately 175° F at the time of the casualty.
158. CSO produces flammable vapors at temperatures below its flashpoint.
159. CSO is a mixture.
160. CSO vapor contains C-2 and larger petroleum hydrocarbons.
161. CSO is a byproduct of the refinery process.
162. Title 46 CFR 30.10-15 defines grade E cargoes as any combustible liquid having a flashpoint of 150° F or above as determined by an open cup test.
163. The MSDS for CSO stated that the flashpoint was greater than 141° F, as determined by closed cup test.
164. Title 46 CFR 30.10-27 states that 150° F flashpoint as determined by an open cup test on a liquid petroleum cargo is the equivalent of a 140° F flashpoint as determined by a closed cup test.
165. The CSO loaded onboard the EMC 423 was a Grade E cargo.
166. The flashpoint of CSO produced at ExxonMobil – Joliet decreased from an average of approximately 230° F to an average of approximately 200° F between December 2004 and January 2005.
167. Flashpoint changed as a result of ExxonMobil changing the refinery production process.
168. ExxonMobil used nitrogen to clear the transfer line at the completion of the EMC 423 loading.
169. MSDS's are not intended for bulk marine transportation.
170. CSO samples from ExxonMobil tank 515 and pre-explosion multi-tank composite from the EMC 423 were comparatively analyzed and there was no evidence that the two samples were different.
171. Title 33 CFR 155.815 (b) states that no person may open a cargo tank closure device aboard an underway tank barge unless authorized and supervised by a licensed officer or tankerman.

172. Title 46 CFR 35.30-10 states that no tank barge cargo tank openings shall be opened or remain open without flame screens except under the supervision of a senior member of the crew.

173. Title 46 CFR 36.20-1 states that tank barges and tank ships carrying Grade E liquids in molten form at elevated temperatures may omit flame screens on cargo tank vent lines.

174. The volatility of the CSO aboard the EMC 423 was insufficient to generate adequate vapor pressure to lift the PV valves.

175. The Coast Guard Research and Development Center initiated a study in response to several explosion incidents involving high flash point liquids at temperatures below their flashpoint.

176. The Coast Guard Research and Development Center study determined that flash point is not a reliable measure of the flammability of vapor space within a cargo tank containing a petroleum based Grade E cargo.

CONCLUSIONS:

1. The heat tracing line was not connected to either the heat trace tubing that remained on the cargo pump or the heat trace piping at the pump's discharge piping connection to the athwart ship cargo header.
2. Alexander Oliva was using a propane torch (rosebud) to heat the EMC 423 cargo pump at the time of the explosion.
3. The propane torch that Alexander Oliva was using was the source of ignition for the EMC 423 explosion.
4. The standpipe located at the EMC 423 cargo pump was the path of flammable vapor for the explosion.
5. The CSO in the cargo tanks of EMC 423 was the source of vapor for the explosion.
6. The CSO that was loaded onto the EMC 423 was not contaminated.
7. The most recent AWO audit conducted on Egan Marine Corporation did not reflect the company's operation.
8. The veracity of Egan Marine's last AWO audit is questionable due to its inaccuracy and the auditor's relationship with Egan Marine as a contracted employee.
9. Egan Marine did not have a preventative maintenance system in place for its vessels and marine equipment.
10. Egan Marine did not have a structured, organized employee training program in place.
11. Egan Marine employees were unfamiliar with and, generally, did not follow company safety guidance.
12. Egan Marine's drug testing program was not conducted in accordance with the Federal regulations.
13. Egan Marine conducted barge transfers without qualified tankerman.
14. Alexander Oliva was alleged to have used drugs.
15. Use of drugs cannot be ruled out as a contributing factor in this casualty.
16. Egan Marine did not have a system in place to consistently advise the Coast Guard about repairs and alterations to their barges.
17. Marine Safety Office Chicago inspection administrative record keeping was not accurate or effective.
18. Coast Guard SAR response met all applicable standards.
19. Alexander Oliva's cause of death was blunt force trauma due to injuries received as a result of the explosion.
20. The EMC 423 sank due to the loss of integrity in the watertight envelope as a result of damage received from the explosion.
21. The MSDS for the CSO being carried aboard the EMC 423 met all of the federal regulatory requirements.
22. The ExxonMobil – Joliet Refinery MSDS for CSO did not accurately reflect the precise chemical properties of the cargo being carried by EMC 423.
23. There is no regulatory requirement for an MSDS to reflect the precise chemical properties of a cargo.

24. There is a conflict in the regulations between Title 33 CFR 155.815 (b), which states that tank barge cargo tank openings must be authorized/supervised by a licensed officer or tankerman, and Title 46 CFR 35.30-10, which states that tank barge cargo tank openings must be under the supervision of a senior member of the crew.
25. The EMC 423 explosion initiated in cargo tank #4.
26. The thermal fluid heater was installed in a hazardous location per Title 46 CFR 111.105-31(l).
27. Part one of the Coast Guard Research and Development Center study determined that flashpoint is not a reliable measure of the flammability of vapor space within a Grade E cargo tank.
28. Flashpoint is not indicative of the fire or explosion hazard of a petroleum based heated Grade E cargo.
29. The PV valves aboard the EMC 423 prevented the cargo tanks from venting thereby not allowing the air/oxygen in the tanks to be displaced.
30. The EMC 423 was certificated and equipped to safely carry cargoes of much higher flammability and volatility, up to and including Grade B.
31. There is evidence of violation of 46 CFR 30.01-10 on the part of the operator Egan Marine Corporation.
32. There is evidence of violation of 33 CFR 156.160 on the part of the operator Egan Marine Corporation.
33. There is evidence of violation of 33 USC 1321 (b)(3) on the part of the operator Egan Marine Corporation.
34. There is evidence of misconduct and/or negligence as defined in 46 CFR 5.27 and 5.29 on the part of the Master of the M/V LISA E.
35. There is no evidence that any member of the Coast Guard or any other Government agency caused or contributed to the cause of this casualty.

The apparent primary cause of the casualty was the ignition of flammable vapors emitted from cargo tank #4 through the unobstructed standpipe located adjacent to the cargo pump. The propane torch was being used by Alexander Oliva to heat the CSO in the cargo pump.

The principal contributing cause of the casualty was the inoperative cargo pump heat trace system due to the disconnected portion. This resulted in the use of the propane torch to heat the cargo pump.

RECOMMENDATIONS:

RECOMMENDATIONS FOR MARINE SAFETY UNIT CHICAGO

1. Marine Safety Unit Chicago should institute a policy to identify changes to vessels while out of service and that are returning to service.
2. Marine Safety Unit Chicago should institute a policy to establish standards for MISLE entry.
3. Marine Safety Unit Chicago should ensure that [redacted] does not return to work aboard vessels in a safety sensitive position without receiving approval from a Substance Abuse Professional (SAP).

RECOMMENDATIONS FOR NINTH COAST GUARD DISTRICT

4. The Ninth Coast Guard District DAPI inspector should conduct a comprehensive DAPI audit of Egan Marine Corporation.
5. It is recommended that further investigation under the civil and/or criminal penalty procedures be initiated in the case of Egan Marine Corporation concerning their part in the casualty.
6. It is recommended that further investigation under the suspension and revocation procedures be initiated in the case of [redacted] Master of the M/V LISA E concerning his part in the casualty.

RECOMMENDATIONS FOR COAST GUARD HEADQUARTERS

7. The U.S. Coast Guard should amend the regulations to require all crew members employed aboard Uninspected Towing Vessels that are towing barges regulated under 33 CFR 104 (Maritime Security: Vessels) to obtain a Merchant Mariner's Document in order to ensure higher qualification/personal standards and track individual drug testing history.
8. The U.S. Coast Guard should develop regulations to require hazardous location plans for all inspected tank barges certificated to carry flammable or combustible cargos.
9. The U.S. Coast Guard should amend Title 46 CFR 2.01-1 (Application for Inspections) to require individuals submitting an Application for Inspection to include a list of all vessel repairs and alterations conducted since last inspection for certification.
10. The U.S. Coast Guard should remove or amend Title 46 CFR 36.20-1 to require tank barges and tank ships carrying grade E petroleum based liquids in molten form at elevated temperatures to install flame screens on cargo tank openings.
11. The U.S. Coast Guard should amend Title 46 CFR 32.55-25(a) (2) to prohibit the use of PV valves aboard tank vessels carrying Grade E petroleum based liquids in molten form at elevated temperatures.
12. The U.S. Coast Guard should amend Title 33 CFR 156 to include the definition of grades of cargoes as defined in Title 46 CFR 30.10.

13. The U.S. Coast Guard should amend Title 33 CFR 156.150 (Declaration of Inspection) to include the requirement for tankerman and facility persons in charge to verify one-another's tankerman card/person in charge qualification prior to beginning cargo transfers.
14. The U.S. Coast Guard should amend Title 33 CFR 156.150 (Declaration of Inspection) to include the requirement for facility persons in charge to provide cargo grade (as defined in Title 46 CFR 30-10) to the vessel tankerman.
15. The U.S. Coast Guard should amend regulations to resolve the conflict between Title 33 CFR 155.815 and Title 46 CFR 35.30-10, requiring all personnel conducting activities associated with either cite to hold a Merchant Mariner Document with the appropriate tankerman endorsement.
16. The U.S. Coast Guard should amend Title 46 CFR 35.30-15(b) to add the requirement for unmanned tank barges authorized to carry Grade A, B, C, D liquids at any temperature, or grade E liquids at elevated temperature to be equipped with a combustible gas indicator suitable for determining the presence of explosive concentrations of the cargo carried.
17. The U.S. Coast Guard should draft guidance to specify minimum information that a Marine Inspector is required to enter into a MISLE inspection activity narrative.
18. The U.S. Coast Guard Research and Development Center should initiate a study into general fire and explosion hazards of Grade E petroleum based cargoes, with particular attention focused on flashpoint and how it relates the flammable vapor generation hazards.
19. The U.S. Coast Guard should contact American Waterways Organization representatives and recommend that they restrict Responsible Carrier Program auditors from conducting audits on companies for which they provide other services, or that may otherwise create a conflict of interest.
20. The U.S. Coast Guard should work with the Occupational Safety and Health Administration to amend MSDS requirements to address shipment of cargo in bulk by water, i.e. grade of cargo, regulatory and transportation information.
21. The U.S. Coast Guard should work with the Occupational Safety and Health Administration to add requirement for MSDSs to more precisely reflect chemical and physical properties of cargos.
22. Recommend that this casualty investigation be closed.

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