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United States Coast Guard

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October 2, 2000

From: Investigating Officer, Coast Guard Marine Safety Office, Milwaukee, WI
To: Commander Ninth Coast Guard District (m)
Via: Officer In Charge, Marine Inspection, Milwaukee, WI

Subj: SUPPLEMENTAL REPORT ON THE DISAPPEARANCE OF THE COMMERCIAL FISHING VESSEL LINDA E (O.N. 236906), WITH THREE CREWMEMBERS NEAR PORT WASHINGTON, WI ON LAKE MICHIGAN ON DECEMBER 11, 1998

Summary: This report supplements Marine Safety Office Milwaukee's November 22nd, 1999 Report of Investigation into the Disappearance of the Commercial Fishing Vessel LINDA E (O.N. 236906). Marine Safety Office Milwaukee reopened this investigation upon location of the wreck of the LINDA E by the USS DEFENDER on June 18th, 2000. Except as noted below, all facts, conclusions and recommendations from the November 22nd report remain valid.

Vessel Data: (In addition to description of the LINDA E in the November 22nd Report)

Name:	MICHIGAN	GREAT LAKES
O.N.:	650770	650771
Service:	Commercial Towing Vessel	Tank Barge
Gross Tons:	293	5024
Net Tons:	187	5024
Length:	112.6 ft.	414.1 ft.
Breadth:	27.1 ft.	60.1 ft.
Depth:	13.40 ft.	29.7 ft.
Propulsion:	Diesel	None
H.P.:	3900 HP	N/A
Built:	1982	1982
Homeport:	Whiting, Indiana	Whiting, Indiana
Owner/Manager: (on Dec 11, 1998)	Security Pacific Equipment Leasing, Inc.	Security Pacific Equipment Leasing, Inc.
Master:	Keith Grady	N/A
License:	Master, Great Lakes/Inland any Gross Ton, #722388	N/A
Junior Mate:	Scott Gorney	N/A
License:	Mate, Great Lakes/Inland any Gross Ton, #681746	N/A

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Vessel Description and Service
(In addition to description of the LINDA E provided in the November 22nd Report)

The tug and barge combination MICHIGAN/GREAT LAKES operates primarily in Lake Michigan, carrying fuel oil from Whiting, Indiana to Cheyboygan and Traverse City, Michigan. The barge GREAT LAKES is usually laden with cargo for its northern transit and returns to Whiting in ballast. These vessels generally operate as an Integrated Tug and Barge (ITB) with the tug MICHIGAN connected in the stern notch of the GREAT LAKES. The GREAT LAKES has an ice strengthened bow that allows this vessel to operate year round. The bow of the barge has a very heavy structure with very close stiffener spacing. Both the MICHIGAN and GREAT LAKES were built at Bay Shipbuilding in Sturgeon Bay, WI in 1982.

Record of Missing and Presumed Dead: (No modifications from the November 22nd report.)

Weather Data: (No modifications from the November 22nd report.)

Summary of Coast Guard and Volunteer Search Efforts:
(In addition to the November 22nd Report)

Marine Safety Office Milwaukee has continued to monitor the efforts of local commercial salvor's efforts to locate the LINDA E since the vessel disappeared. Despite hundreds of hours volunteered by these searchers, the location of the LINDA E remained unknown for 18 months. On June 18, 2000 the U.S. Navy Minesweeper USS DEFENDER, located the LINDA E while performing an underwater search at the request of Congressman Mark Green.

Summary of Investigation: (In Addition to the November 22nd Report)

Upon location of the LINDA E on June 18th, 2000, Marine Safety Office Milwaukee reopened the investigation into the vessel's disappearance. The Captain of the Port Milwaukee placed a safety zone around the current location of the LINDA E to protect physical evidence at the wreck site. On June 21st, the University of Michigan's Remotely Operated Vehicle (ROV) was deployed from the U.S. Coast Guard Cutter ACACIA to survey the wreck site. During this survey, investigators obtained video and still photographs of the LINDA E in its present condition. The ROV also collected paint samples from the LINDA E. These samples were later turned over to the Wisconsin State Crime Lab for comparison with samples collected previously taken from the barge GREAT LAKES. With the technical assistance of the Coast Guard Marine Safety Center (MSC), investigators analyzed the video and still photographs from the ROV to help determine the cause of the casualty. Investigators and MSC engineers refined previously obtained measurements from the MERCURY to validate the dimensional similarity of the MERCURY to the LINDA E. The MERCURY is a similar fishing vessel built by the same shipyard as the LINDA E. This information was used to develop dimensions for a profile of the

damage documented by the ROV. Investigators, again with the help of engineers from the MSC, compared the geometry of several vessels with the LINDA E's damage profile. Investigators analyzed photographs taken of the barge GREAT LAKES on December 22, 1998. Through this analysis, investigators determined the location of white and black marks, relative to the hull and to the vessel's December 11, 1998 waterline. Through interviews with persons having direct knowledge of the LINDA E, investigators gathered information on the operational practices of the crew. Investigators determined which vessels were in the area of where the LINDA E was found from interviews with people known to be on Lake Michigan on December 11, 1998. Investigators also reviewed vessel and facilities records related to vessel arrival and departures from Milwaukee and Port Washington, Wisconsin.

Findings of Facts: (In addition to the November 22nd Report)

1. The LINDA E was located on June 18th, 2000 at position 43^0 15.877' N, 087^0 45.940' W at the bottom of Lake Michigan. The vessel rests in approximately 260 feet of water, upright, partially imbedded into the lake bottom with an approximate 20^0 heel to port. The vessel is at rest on the bottom with a heading of approximately 040^0 T. See Enclosure (1A) and (1B)

2. The location where the vessel now rests is approximately 0.2 miles west of the northern gang of nets identified as being set by the crew of the LINDA E. See Enclosure (1). The closest point of land to this location is the Wisconsin shoreline, 7 statue miles (mi.) to the west.

3. The service door, located on the aft port side of the LINDA E, was found in the open position. A small tangle of fishing nets can be seen extending just outside this door. See Enclosures (2- A and F)

4. Two of the three stern doors on the LINDA E were found in the open position. The door that slides open to the port side of the vessel was fully open. One of the two doors that slide open to the starboard side of the boat was fully open; the other was partially open. See Figure (1). The spreader bar over which nets are normally set can be seen. A small amount of nets are visible through the stern door. No nets extend through the stern door.
   See Enclosures (2-B,C)

5. All other doors, including the two doors on the starboard forward side and the one door on the port forward side, were found in the closed position. See Enclosures (2-D,E)

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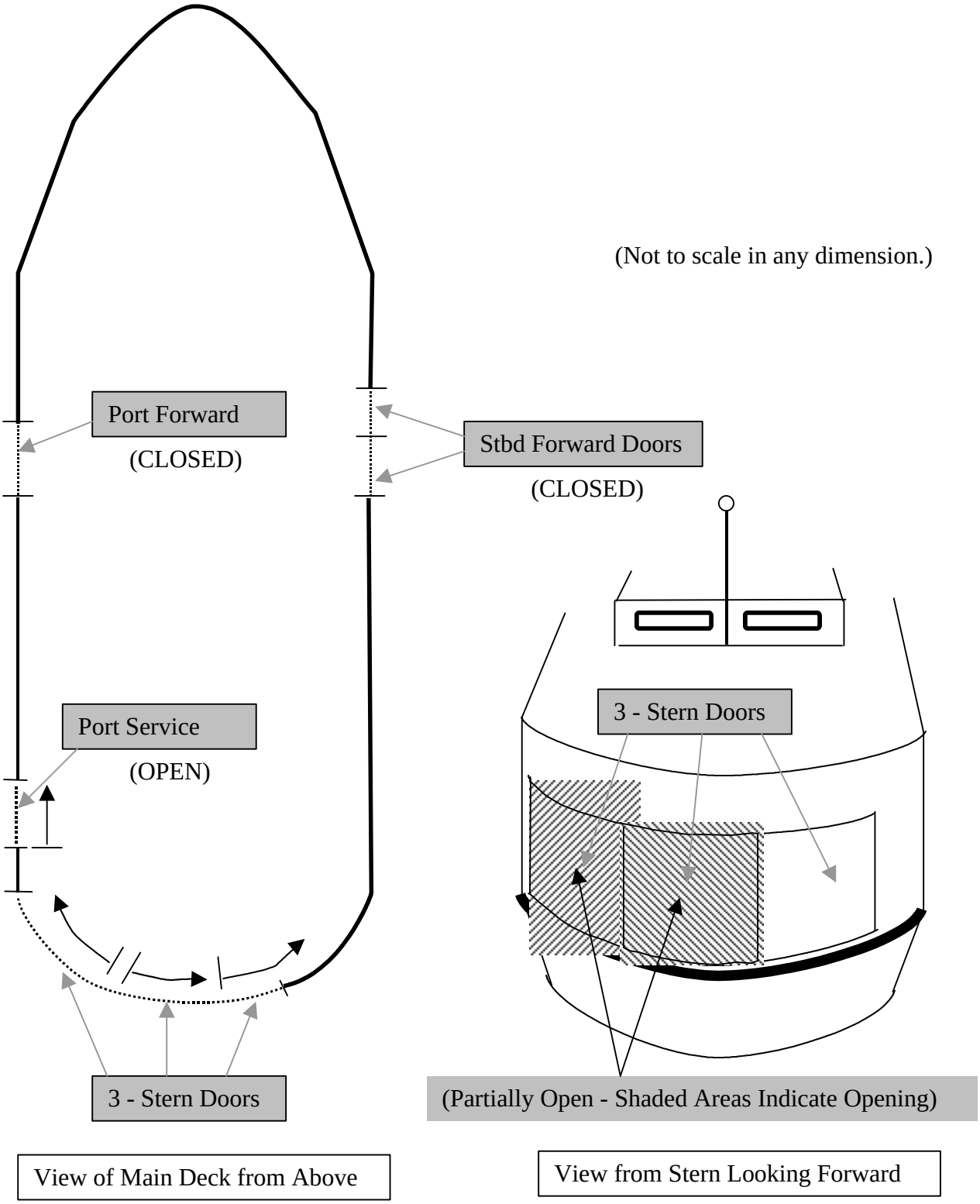
Figure (1): Door Locations on the LINDA E



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6. There are only a few objects visible immediately near the LINDA E:
   a. There are nets hanging out of the service door as described above.
   b. There are two tires lying on the bottom on the port side of the vessel. There are broken lines tied by slipknot to the upper deck railing near these tires. The LINDA E reportedly used tires as fenders. See Enclosure (2-F)
   c. There is a small, unidentified bar shaped object about 1 foot long just outside the stern door. See Enclosure (2-G)

7. A sonar and visual search by the University of Michigan ROV of an area approximately 50 meters around the LINDA E found no debris or loose gear from the vessel. The only object detected was an aluminum can located approximately 25 meters from the LINDA E.

8. There is significant damage evident on the starboard quarter of the LINDA E. This damage extends along the side of the vessel from the forward end of the deckhouse aft along the starboard quarter, almost exclusively above the rub rail. See Enclosure (3).

9. The most significant damage is a wedge shaped inset centered at a location approximately 14 inches forward of the aft, starboard portlight. This inset extends approximately 6 feet vertically down from the top of the lower deckhouse to just below the rub rail. This inset is several feet wide at its widest point near the upper deck and only a few inches wide near the rub rail. The upper deck of the vessel is crushed downward near the center of this inset. The deck is torn upward a few feet aft of the center of this inset. See Enclosures (2-H through T)

10. Extending forward of the center of the main inset, just above the rail, the sideshell is creased along a line running approximately 9 feet, to just forward of the deckhouse. See Enclosures (2-Q,R)

11. There is a semi-circular mark at the deck edge of the LINDA E, on the starboard side, centered just even with the forward end of the deckhouse. This mark is approximately 18.5 inches in diameter. The center of this mark is located approximately 8.0 feet from the center of the main inset described in paragraph 9. The forward most edge of this mark is therefore approximately 8.8' from the center of the main inset described in paragraph 9. See Enclosures (2-S,T)

12. The aft starboard portlight has several fractures but is not broken open. The portlights in the lower deckhouse on the starboard side are broken, their frames crushed. No other portlights on the vessel appeared to be damaged. See Enclosures (2-A,I,J,L,M,O,U)

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13. There are several appendages on the LINDA E that show different directions of deformation depending on their location. Generally, those that are forward of the main inset are bent forward and to port. Those appendages aft of the main inset are bent aft and to port.

    a. The vessel's LORAN (Long Range Navigation) antenna is located on and attached to the starboard side of the deckhouse, forward of the main inset. This antenna is bent forward and to the port side of the LINDA E. The exact angle that this antenna is bent to is not certain, but the antenna is bent more to port than forward. See Enclosures (2-U)

    b. The vessel's LORAN antenna support rod, located aft of the main inset, is bent aft and to port. The angle of bend to this support is approximately 45^0 aft and 35^0 to port. This rod is used to support the LORAN antenna when it is in the lowered or stowed position. See Enclosures (2-V,W,X)

    c. The mast supporting the radar and navigation lights is located forward of the main inset. This mast is bent forward and to port. The exact angle that this mast is bent to is not certain, but the mast is bent more forward than to port. The upper part of this mast, which holds the navigation lights, is bent more than the lower section. The radar dome located on the lower section is damaged. See Enclosure (2-Y)

14. There are a number of appendages near the damaged area on the LINDA E that show no visible signs of contact.

    a. The stern light support mast of the LINDA E does not appear to be disturbed. (See Enclosures (2-W,Z)

    b. Although the starboard navigation light fixture is hanging by its wire, the starboard navigation light screen (or shield) does not appear to be disturbed. See Enclosures (2-U, AA, AB)

    c. The port navigation light has also been removed from its navigation light screen and is hanging by its wire. The screen itself does not appear to be disturbed. See Enclosures (2-AC)

    d. The stove exhaust and diesel exhaust stacks, located forward of the deckhouse, do not appear to be disturbed. See Enclosures (2-AD, AE)

    e. The cellular telephone antenna located on the forward end of the top of the deckhouse does not appear to be disturbed. See Enclosures (2-AD)

    f. The horns located on the top of the deckhouse do not appear to be disturbed.

    g. The marine band antenna on the top of the deckhouse does not appear to be disturbed.

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15. There is no significant damage to the port side of the LINDA E. The only damage observed on the port side of the vessel was:

    a. A bend in the deck rail on the lower deckhouse. This bend is reportedly an existing condition that occurred in port from tying up during severe weather. See Enclosures (2-AF)

    b. A very minor crease in the port quarter sideshell, between the service and stern doors. This damage is located near the after end of the lower deckhouse. At this location the upper deck structure becomes continuous across the beam of the vessel. See Enclosures (2-AG)

    c. A discontinuity in the deck line near the port forward door. This appears to be a pre-existing condition that can be observed in photographs taken before the vessel disappeared. See Enclosures (2-D)

16. Although the lake bottom obscures much of the bottom of the LINDA E, the visible portion of the hull beneath the rub rail shows little damage beyond a few superficial scratches. There is no evidence of significant damage to any other location on the vessel.

17. There is no visible indication of fire (no burn marks, soot, etc.) on any part of the vessel. Except for small, localized areas of damage, the paint on the vessel appears relatively intact.

18. No fishing day shape was observed on the LINDA E during the June 21, 2000 ROV dive.

19. No physical remains of the three missing crewmembers were observed during the June 21, 2000 ROV dive.

20. The following areas of the exterior of the LINDA E are painted black:

    a. upper deck,

    b. rails on the upper deck,

    c. tops of the upper and lower deckhouse,

    d. and the rub rail

21. The following areas of the exterior of the LINDA E are all painted white:

    a. sides above and below the rub rail,

    b. sides of the upper and lower deckhouse

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22. The mostly likely load condition of the LINDA E at the time of its sinking places the upper deck edge at a height approximately 5.7 feet above the water. The top of the lower deckhouse is approximately 12", and thus would extend approximately 6.7 feet above the water. See Enclosure (9)

23. The only vessels known to be operating in the waters within 20 nautical miles of Milwaukee and Port Washington on December 11th, 1998 between 0946 and 2000 were as follows:

    Commercial fishing vessels:

    LINDA E (O.N. 236906),
    D&S (O.N. 234508),
    JOLENE (O.N. 248708)

    Oceanographic Research Vessel:

    NEESKAY (O.N. 512553)

    Towing Vessel/Barge Combinations:

    JACKLYN M (O.N. 571493) /INTEGRITY (O.N. 1044267) (in push mode)
    MICHIGAN (O.N. 650770)/GREAT LAKES (O.N. 650771) (in push mode)
    HOLLY ANN (O.N. 225913)/L1010 (O.N. 916314) (in push mode)
    SUPERIOR (O.N. 210354)

24. The following vessels were investigated and found to be outside of 20 nautical miles of Milwaukee and Port Washington on December 11th, 1998 between 0946 and 2000:

ALGORAIL (O.N. L6805531)	ALGOWAY (O.N. L7221251)
ARTHUR M. ANDERSON (O.N. 264207)	CHALOTHORN NAREE (O.N. L7530614)
FEDERAL MCKENZIE (O.N. L8119273)	HERBERT C. JACKSON (O.N. 278780)
WINONA ISLAND PRINCESS (O.N.1025503)	JAMES R. BARKER (O.N. 573682)
JOSEPH L. BLOCK (O.N. 574870)	LESOVODSK (O.N. L9008110)
KAYE E. BARKER (O.N. 263980)	MARK HANNAH (O.N. 519204)
MYRON C. TAYLOR (O.N. 228960)	PRESQUE ISLE (O.N. 553416)
RECOVERY (O.N. 228149)	RUFFY KADINGER (O.N. 634653)
SHERRY LYNN (O.N. 234497)	SOUTHDOWN CHALLENGER (O.N. 202859)
STOLT ASPIRATION (O.N. L8610019)	

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25. Of the vessels listed in paragraphs 23 and 24, the Integrated Tug and Barge (ITB) combination MICHIGAN/GREAT LAKES is the only vessel known to have transited the immediate area where the LINDA E was found.

26. Operators on the towing vessel MICHIGAN recorded the following positions in the vessel's weather log on December 11, 1998: See Enclosure (1)

Time	**Latitude**	**Longitude**	**Gyro Heading**
1030	"Spire WP #40" (43^0 29.00')	(087^0 43.750')	189^0
1120	43^0 20'	87^0 44.'	189^0
1200	43^0 12.2'	87^0 46.7'	189^0

27. Mr. Keith Grady, master of the MICHIGAN, was on watch from 0730 until 1130 on December 11, 1998. Scott Gorney, junior mate of the MICHIGAN, relieved Mr. Grady of the navigation watch at 1130.

28. During his watch Mr. Gorney performed chart corrections on the pilothouse chart table.

29. The pilothouse chart table is located at the rear of the pilothouse, oriented such that the person working there must face aft. See Enclosure (11)

30. The radar system installed on the tug MICHIGAN on December 11, 1998 did not have a collision avoidance alarm system.

31. Both Mr. Gorney and Mr. Grady have Radar Observer (Unlimited) endorsements on their U.S. Coast Guard issued licenses. Mr. Grady and Mr. Gorney stated that the radar is normally on during their watches. As part of their watch keeping, both stated that they make regular checks of the radar.

32. Both Mr. Grady and Mr. Gorney stated that if there had been a discrepancy with the vessel's radar, that it would have been logged. There are no entries in the vessel's log to indicate that there were any discrepancies with the vessel's radar between November 1st and December 16, 1998.

33. Mr. Gorney recalled that shortly after relieving Mr. Grady and while making chart corrections, he saw an unusual number of seagulls pass aft of the vessel.

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34. On December 11, 1998, there were three crewmen working on the deck of the barge GREAT LAKES throughout the day: Roger Herod, John Prcklik, and Mike Frampton.

    a. Able Body Seaman (AB) Roger Herod was on watch from 0800 -1200. During this time he stripped tanks in preparation for taking on cargo in Whiting, IN. He was moving about the vessel, sounding the tanks frequently. He neither saw nor heard any other vessels; he noticed nothing unusual.

    b. AB John Prcklik was on watch from 1200 -1600. He worked on the deck of the barge from 1130 to 1300. He relieved the mate of the navigation watch for a bathroom break around 1330. The only vessel he recalls seeing was a tug and barge (later identified as the ITB JACKLYN M/INTEGRITY) coming out of Milwaukee around 1345. He noticed nothing unusual.

    c. Ordinary Seaman (OS) Mike Frampton, a day worker, worked on both the barge and the towing vessel throughout the day. He spent some of this time inside the generator space of the barge. He neither saw nor heard any other vessel; he noticed nothing unusual.

35. The generators used for stripping operations are located at the after end of the barge, just forward of where the tug MICHIGAN sits in the notch. The noise from the generators makes it more difficult to hear any sounds from outside the pilothouse.

36. Stripping operations require the generators on the barge to be running. The crew of the MICHIGAN was stripping the cargo tanks on December 11, 1998.

37. Closing the windows of the MICHIGAN pilothouse greatly reduces the noise from the generators.

38. Mr. Grady stated confidently that the pilothouse windows were closed during his watch on December 11, 1998. He further stated that he doesn't operate during the winter months with the windows opened. Mr.Gorney could not recall for certain if the windows were opened or closed during his watch.

39. Mr. Grady and Mr. Gorney stated that they can normally hear sound signals from other vessels in close quarters, even with the pilothouse windows closed. Mr. Grady further stated that, in the past, whenever the vessel has struck ice while in a ballast condition, the resulting sound is clearly audible throughout the vessel. He was not sure how large a piece of ice the vessel had hit when he made this observation.

40. The ITB MICHIGAN/GREAT LAKES has an overall length of 454’ and breadth of 60’. On December 11th, 1998, the barge was in a ballast condition with drafts of 13 feet forward, 14 feet aft.

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41. The pilothouse on the MICHIGAN is enclosed, and sits approximately 400' aft of the bow of the barge. Enclosure (4 J,K)

42. The master and crew of the ITB MICHIGAN/GREAT LAKES reported no equipment problems in the vessel's logbook or during any of the interviews with Coast Guard investigators.

43. Coast Guard investigators photographed white and black marks found on the stem of the GREAT LAKES at Cheyboygan, MI on December 22, 1998. Using the December 11th draft waterline as a reference, these white marks would have been located on the stem extending intermittently from a point 5.5 feet above the waterline to a point 6.3 feet above the waterline. The very faint black marks at the top of the white marks would have been 6.3 feet above the waterline. See Enclosures (4), (5), (6)

44. Coast Guard investigators photographed white and black marks on the starboard side of the GREAT LAKES at Cheyboygan, MI on December 22, 1998. Among these marks is a white and black scrape mark that begins at the lower chine approximately 5.4 feet above the waterline (Reference Point N in Enclosure 4, figure D). This mark begins approximately 8 feet from the stem, as measured horizontally from a point on the stem 5.4 feet above the waterline. This mark is approximately 9 feet from the marks found on the stem, as measured horizontally, at a point on the stem 6.3 feet above the waterline.

45. The white and black scrape marks described in paragraph 41 include two white scrapes with curved leading edges. The leading edges are separated by approximately 18 inches. See Enclosures (4, figure F)

46. On May 17, 2000, Coast Guard Marine Inspectors examined the hull of the GREAT LAKES during the vessel's required dry dock examination. Inspectors found minor damage in way of the number 1 port and starboard wing tanks at the turn of the bilge. The damage found was consistent with normal Great Lakes service. Inspectors found no unusual markings on the barge.

47. An analysis by the Coast Guard Marine Safety Center (MSC) found that the bow geometry of the barge GREAT LAKES is consistent with the geometry of the hull deformation found on the LINDA E. This bow geometry is also consistent with the direction and extent of deflection of the radar mast, LORAN antenna and antenna support rod. Further, this bow geometry is also consistent with a lack of deformation to appendages such as the stern light mast, upper deckhouse deck, navigation light shield and stove exhaust. See Enclosure (9)

48. An analysis by the MSC found that the deformation observed on the LINDA E is not consistent with the geometry of any of the other vessels listed in paragraph 23 above. See Enclosure (9)

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49. A comparison of several hull forms in addition to the hulls forms of the vessels listed in paragraphs 23 indicates that the deformation found on the LINDA E is not consistent with many of the most common hull forms found on the Great Lakes. In general, this damage profile is not consistent with that which would be expected from most barges with raked or flat bows, towing vessels, or the traditional "Laker" hull forms. See Enclosure (9)

50. According to representatives of Bay Shipbuilding, that yard has built no other vessel with a bow geometry similar to that of the GREAT LAKES.

51. The MSC's geometric analysis determined that, if the GREAT LAKES and LINDA E had collided, the vessels would most likely have intersected at an angle of approximately 90^0 (+/- 15^0). The most likely initial point of contact on the LINDA E would have been at the upper deck edge, starboard side, approximately 14" forward of the aft most portlight. See Enclosure (9)

52. The center of gravity for the LINDA E at the time of the casualty was most likely located approximately 5' from the keel, 14' from the stern, and on the centerline. See Enclosure (9)

53. An impulse/momentum analysis modeling the collision of the ITB MICHIGAN/GREAT LAKES with a vessel the mass of the LINDA E results in the following: See Enclosure (10)

    a. The maximum possible reduction in speed for the ITB would be on the order of 0.03 knots.

    b. The angular velocity of the ITB would change by approximately 0.03 degrees/per second.

    c. The largest possible deceleration of the ITB would be approximately 1 foot/second^2.

    d. The minimum threshold for a person to detect a linear deceleration is 2.6 feet/second^2

54. The technical analyses in enclosures (9) and (10) indicate that the forces generated from a collision with the bow of the ITB MICHIGAN/GREAT LAKES would have acted to heel the LINDA E to port.

55. MSC's geometric comparison of the LINDA E's damage profile and the bow geometry of the barge GREAT LAKES determined that the most likely angle of heel that the LINDA E would have experienced, had the GREAT LAKES and LINDA E collided, to be approximately 51^0 to port. See Enclosure (9)

56. The MSC analysis indicates that at a 51^0 angle of heel, the entire port side (including the port service door and part of the stern door) of the LINDA E would be submerged. Assuming that both these doors were open, the MSC estimates that it would take approximately 2 seconds for downflooding to exceed the LINDA E's reserve buoyancy. See Enclosure (9)

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57. Wisconsin State Crime Lab's Analysis of the paint samples taken from the barge, GREAT LAKES and LINDA E indicate the following: See Enclosure (12)

    a. The black particles taken from the GREAT LAKES were not consistent with the black paint taken from the LINDA E.

    b. The white scrapings from the GREAT LAKES and white paint from the LINDA E could be of the same type. See Enclosure (12).

58. Mr. Leif Weborg was known to work the two sets of nets recovered at the location described in the November 22nd Report of Investigation. Each gang of nets ran nearly exactly east-west. These sets or "gangs" were each made up of eight boxes of nets. Each box is an open container, usually made of plastic. Each box holds one section of nets. Each of these net sections is about 1200 feet long.

59. Extra nets in open boxes were usually carried on board the LINDA E. These net boxes were usually stored in the after part of the vessel.

60. Mr. Dan Anderson, a commercial fisherman and acquaintance of Mr. Weborg recovered the LINDA E's nets on December 14, 1998. He previously stated that he believed the south gang of nets appeared to have been the more recently checked of the two. However, he also recalls seeing Mr. Weborg working the southern gang of nets on December 10th, 1998.

61. As a general practice, commercial fishermen do not usually work the same gang of nets two days in a row.

62. As reported in the November 22, 1999 report, Mr. Steven Anderson, operator of the commercial fishing vessel D&S, stated that he saw the LINDA E early in the morning on December 11, 1998. On that date, Mr. Anderson recalls that he "ran in and set out", meaning that he lifted nets while headed west and set nets while headed east.

63. The distance from the markers of these two gangs of nets to the location where the LINDA E was found varies from 0.2 (Nautical Miles) NM from the western end of the northern gang to 2.5 NM from the eastern end of the southern gang of nets. See Enclosure (1)

64. The most direct course from the net markers to Port Washington varies from approximately 319^0T to 335^0T

65. The normal cruising speed of the LINDA E was approximately 8.5 Knots.

66. Based upon statements of persons who worked on board the LINDA E, the general operating practices for the vessel were as follows:

a. The crew would take turns keeping watch in deckhouse while outbound. The boat would take one to three hours to get to the nets, depending on where the nets were located.

b. Once on location, the crew would raise the nets, usually with the boat travelling into the current. The crew would usually only lift one gang of nets in a day, alternating between different gangs each day. Three persons usually performed the raising operation. It takes approximately 12 to 40 minutes to raise one box of nets. The time required varies based upon number of crew on board, their skill, the weather and the amount of fish in the nets. The goal for the crew was to raise one box at least every 15 minutes. The two doors on the forward starboard side of the LINDA E must be open for this operation. These doors are usually closed afterwards.

c. After raising a gang of nets, the crew sometimes adjusts the position of the vessel.

d. Once at the desired location, the crew would immediately begin setting nets. Only two persons were required for setting. Usually, the autopilot was set for this operation and the boat would travel in a direction with the current. To set one gang with eight boxes of nets would take between 30 and 90 minutes. The port-most sliding stern door must be open during this operation. The other two sliding stern doors were usually open. The service door on the aft port side would frequently be open during this operation.

e. While the other two crew members began to set nets, Mr. Leif Weborg would typically sit in the deckhouse and eat his lunch. Once done with his lunch, he would go forward and dress (clean) fish.

f. One of the crew would periodically check the vessel's course and position. Because of where the LORAN position display was located, it could be read from the main deck without climbing up into the deckhouse. However, occasionally someone would go up to the deckhouse seat to look out.

g. Some time after the nets were set someone would set a course for home. The other two crewmembers would then eat their lunch. This would last the first 10-20 minutes of the voyage home.

h. Once finished with their lunch, one person would go forward and help dress fish. The other crewmember would begin washing down the boat. The stern doors and port service door would typically remain open until this was completed. Depending on weather and seas, setting course and speed for the homeward voyage might be delayed until these doors could be closed.

i. The person dressing fish forward would periodically look out of the small window in the door on the starboard side.

j. While returning, the vessel's course and speed might be adjusted to allow the crew time to clean fish and properly dispose of fish entrails before entering port.

67. The steering controls for the LINDA E were located in the deckhouse.

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68. The throttle controls for the LINDA E were located in both the deckhouse and near the starboard forward door.

69. Some commercial fishermen on the Great Lakes use a periodic alarm to remind the crew to check the course and look outside the vessel. The crew of the LINDA E did not use an alarm of this type.

70. The LINDA E's autopilot used the boat's magnetic compass to maintain course.

71. Mr. Leif Weborg reportedly possessed a fishing day shape, but there is no evidence to indicate whether or not a day shape was being shown on December 11, 1998. It is also not known whether or not Mr. Weborg displayed a fishing day shape at all times or only while engaged in fishing.

72. Some Lake Michigan fishermen claim that inclement weather or icing on top of the fish tug make raising and lowering a day shape hazardous. These fishermen opt to display their fishing day shape at all times, whether or not they are currently engaged fishing.

73. The same boat builder who built the LINDA E built the fishing vessel MERCURY one year earlier. From comparison of contractual design records and photographs, we have determined that the hull and deckhouse outer structures on the two vessels are dimensionally similar. The most significant difference between the two is the location of doors and portlights. See Enclosure (7)

74. As determined by comparison with the deckhouse of the fishing vessel MERCURY, the visibility from the deckhouse of the LINDA E was very restricted, particularly in the direction of the starboard quarter. Visibility from the main deck inside the LINDA E would have been even more restricted as the portlights are more widely spaced. Visibility from the "fish table", where fish cleaning takes place, to the starboard side of the vessel would have been particularly restricted because of the relatively small window located in the starboard forward door. See Enclosure (8)

75. There is no evidence available to determine the physical capabilities of the crew of the LINDA E immediately preceding this incident.

76. Some radar systems used by commercial fishermen on the Great Lakes are installed with collision avoidance alarms to warn when another vessel may be approaching too closely.

77. The LINDA E was equipped with radar of unknown type. It is unknown whether the LINDA E's radar was equipped with a collision avoidance alarm.

78. There is no evidence to indicate whether or not the crew of the LINDA E was using the installed radar immediately preceding this incident.

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79. The doors of the LINDA E slide on a metal track and occasionally required significant force to open.

80. There is no evidence available to determine the condition of the LINDA E's equipment immediately preceding the incident.

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Analysis:

Part I: Determination of Casualty Type

The conclusion as to what type of casualty occurred is based upon the following:

1. As described in the analysis provided by the MSC, the structural damage observed on LINDA E is indicative of an external force, applied in a consistent direction, to a localized area of the vessel. The markings and deformation geometry indicate this force was in the form of a wedge shape, much like of the bow of a vessel. This damage is therefore consistent with damage that would be expected from a collision with the bow of another vessel.

2. The damage observed on the LINDA E is not consistent with an explosion. In addition to being indicative of an external force applied in a consistent direction to a localized area, there is virtually no debris scattered around the vessel. Further, none of the larger portlights are broken.

3. The damage observed on the LINDA E is not consistent with a fire. Except for small, localized areas of damage, the paint on the vessel is relatively intact. There are no burn or soot marks and the structural damage is concentrated in extremely small areas.

4. The LINDA E was located in approximately 260 feet of water, about 7 statute miles from the shore or any fixed objects. The damage observed is almost exclusively above the vessel's waterline. The damage observed on the LINDA E is therefore not consistent with a grounding or an allision.

5. The damage observed on the LINDA E is inconsistent with failure of the vessel's hull due to overloading. There is a lack of longitudinal hull deformation and the damage is restricted to one side of the vessel, well aft of amidships.

6. The damage observed on the LINDA E is not consistent with localized hull failure, such as would be expected due to materiel defect or workmanship. Although the lake bottom obscures a view of the hull below the waterline, the visible portion of the hull below the rub rail shows only superficial damage. Apart from those in highly deformed areas, there are no visible fractures, broken welds, torn seams or plate separations.

7. The port service door and stern doors of the LINDA E were found in the open position. Assuming these doors were open when the vessel sank, they would allow the pressure inside and outside the LINDA E to equalize, thus preventing hydrostatic implosion of the vessel. Even if these doors had been closed when the vessel sank, the damage observed is localized to one area of the vessel and caused appendages to move in directions opposite of the structure. Therefore, this damage is not consistent with that which could be expected from hydrostatic crushing.

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8. While there may be some damage to the LINDA E that occurred after the vessel struck the lake bottom, the observed wedge shaped damage is not consistent with this type of force:

    a. Significant damage was observed only on the vessel's starboard side. This is not consistent with a longitudinal hull failure that could be expected from striking the bottom with the vessel's bow or stern first.

    b. The relatively minor crease observed on the port side between the service door and stern door may have been caused by the vessel striking the bottom. However, this crease is located very near where the upper deck becomes continuous at the after end of the deckhouse. Therefore, it is also possible that transfer of the collision impact load from the starboard side caused this damage.

    c. This damage is also not consistent with damage that could be expected in the case of the vessel's side striking the bottom. The lake bottom in the area where the LINDA E now rests is relatively flat and soft. There are no objects on the lake bottom within at least 50 meters of this location that are capable of creating the observed damage geometry. In any case, had the vessel rolled on its side when hitting the bottom there would likely have been some damage to other appendages such as the stove exhaust stack or stern light mast.

    d. As described in Conclusion (f) of Enclosure (14), it is unlikely that the LINDA E suffered from inadequate intact stability. However, if significant flooding had occurred for any reason, the vessel might quickly founder. There is no evidence to indicate that downflooding occurred for any reason other than extreme heel after a collision. Regardless, there are no plausible explanations for how the observed damage profile might have occurred after the vessel sank.

<u>Part II: Identification of Other Vessel Involved in Collision</u>

The conclusion as to which vessel was involved in a collision with the LINDA E is based upon the following:

1. The ITB MICHIGAN/GREAT LAKES was, on December 11, 1998, the only vessel known to be in the area where the LINDA E disappeared.

2. The ITB MICHIGAN/GREAT LAKES on December 11, 1998, passed very close to the area where the LINDA E wreckage was found.

    a. Based upon the 10:30, 11:20 and 12:00 positions logged by the operators of the ITB MICHIGAN/GREAT LAKES, these vessels passed within 1/2 mile of the location of the where the LINDA E currently rests. The closest point of approach to this location occurred at approximately 11:43.

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b. Although the recorded trackline of the ITB MICHIGAN/GREAT LAKES does not pass directly over the final position of the LINDA E, the distance between the two is small enough (approximately 2000 yards) to be explained by the combined effects of the following:

   i. The positions used to develop this trackline were only intended to be accurate to within the nearest minute of latitude or longitude.

   ii. A lack of precision in recording the positions from the Differential Global Positioning System (DGPS). For example, the 1120 position was recorded in whole minutes of latitude and longitude.

   iii. The effects of set and drift on the ITB between the 1120 and 1200 DGPS fixes.

   iv. The lateral distance the LINDA E could have moved from the collision position while sinking through 260 feet of water.

c. A trackline connecting only the 1030 position and the 1200 position passes almost directly over the final position of the LINDA E.

d. The damage to the LINDA E indicates that the vessel would have rotated as a result of the collision. The heading of the LINDA E as it rests on the bottom is consistent with collision with a vessel on a course of 189^0T and the expected rotation.

3. The bow of the barge GREAT LAKES was found to have markings consistent with those that could have come from contact with the LINDA E.

a. The bow of the barge GREAT LAKES has an extreme rake. As a result, the marks observed on the stem were found in a location that places them significantly forward of the bow wake affected area. Because of this, the LINDA E would not have been affected by the barge's bow wake at the moment of impact. Therefore, comparisons can be made between the height of the forward-most markings on the stem of the barge and point of the initial contact on the LINDA E.

b. The height of the white marks on the stem of the GREAT LAKES was at the approximate same height as the upper deck edge of the LINDA E. This is consistent with the expected initial point of contact of the two vessels.

c. The lack of white marks higher on the stem of the GREAT LAKES is consistent with the downward damage on the top of the lower deckhouse. As nearly all the force in this area appears to be downward, the bow above the white marks would have primarily made contact with the black paint on the top of the deckhouse.

d. The beginning of the black and white scrape marks on the GREAT LAKES (described in Finding of Fact No. 41) is approximately the same distance from the stem of the barge as the semi circular mark (described in Finding of Fact No. 11) is from the main inset on the LINDA E . This is consistent with the LINDA E rotating around the barge's bow after the initial impact.

e. The distance separating the leading edges of the white scrape marks on the GREAT LAKES (described in Finding of Fact No. 42) is approximately the same as the diameter of the semi circular mark (described in Finding of Fact No. 11). This is consistent with the LINDA E sliding against the barge's side after rotation.

4. The barge GREAT LAKES has a bow geometry that is consistent with the damage found on the LINDA E.

5. None of the other vessels known to be off Port Washington and Milwaukee on December 11, 1998 have a bow geometry that is consistent with the damage found on the LINDA E.

6. The bow geometry of the ITB MICHIGAN/GREAT LAKES is relatively unique amongst vessels found in the Great Lakes.

7. The most common vessels found on the Great Lakes have bow geometries inconsistent with the damage found on the LINDA E.

8. The white material sampled from the barge GREAT LAKES was determined to be consistent with the color, texture, microchemical and physical properties of the paint found on the LINDA E. The Wisconsin State Crime Lab determined that they could be of the same type.

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Part III: Considerations for Contributing Causes of the Casualty

1. **Factors affecting visibility from the ITB GREAT LAKES**:

   a. On the morning of December 11th, 1998 the sun was just off the port bow of the ITB MICHIGAN/GREAT LAKES, shining directly into the pilothouse. While we do not know where the LINDA E was before the collision, it is most likely that she was off the port bow of the ITB. It is therefore likely that the sun made it difficult for the operator in the pilothouse of the MICHIGAN to see the LINDA E. The severity and duration of this difficulty depends on the location, course and speed of the LINDA E immediately before the incident, all of which are unknown.

   b. Due to the size and length of the ITB MICHIGAN/GREAT LAKES, once a small vessel such as the LINDA E is close off the bow, the tug operator's view of that vessel may be completely obscured. The damage profile suggests that the LINDA E would have been in this area immediately before collision. It is therefore likely that, for the last few seconds preceding this collision, the operator of the ITB MICHIGAN/GREAT LAKES could not see the LINDA E.

2. **Factors affecting visibility from the LINDA E**:

   a. The window arrangement of the LINDA E does not provide a wide and unobstructed view of the surrounding waters. Its widely spaced portlights are the only means for viewing outside the vessel. Crewmembers would have had to look out multiple, small portlights from various angles and locations within the deckhouse to obtain a full appraisal of the situation in the surrounding waters.

   b. Environmental conditions at the time of collision were favorable for those onboard the LINDA E to see the ITB MICHIGAN/GREAT LAKES. The ITB was on a relatively steady, predictable course and speed. Visibility was good (7NM) and the large ITB would have been to the north of the LINDA E, away from the sun. The computed geographic visibility, based on height of eye, from the LINDA E to the ITB was approximately 8 NM. Based upon environmental conditions alone, the ITB should have been readily visible to someone in the deckhouse of the LINDA E for at least 20 to 30 minutes before the collision.

3. **Operational status of LINDA E at time of collision:**

   a. Based upon the two gangs of nets being found to be properly set, and a lack of nets visible through the stern door, the LINDA E was most likely not immediately engaged in fishing when the collision occurred. However, the position of the vessel's doors and the proximity of the LINDA E's final position to the nets indicate that the crew may have completed fishing within minutes of the collision. The duration of this time gap varies

from 2 to 30 minutes and is dependent upon which gang of nets the LINDA E crew worked that day and at which end of the nets they finished. There is insufficient evidence to determine with certainty which nets were being worked that day or at which end the LINDA E would have finished.

b. There is insufficient evidence to determine whether or not the LINDA E was moving immediately before the collision occurred. The damage observed is possible whether the LINDA E was drifting or moving at its maximum speed of 8.5 Knots (14.3 ft/sec).

i. Moving: The initial contact between the stem of the barge and side of the LINDA E was most likely very brief, less than 1/4 second. At most, the LINDA E could have moved 3.6 feet in this time. There are creases in the starboard quarter and scrapes at the deck edge of the LINDA E consistent with contact with the barge's stem. These extend several feet aft of the main inset. If the LINDA E began rolling away from the stem of the barge in the first few milliseconds, as expected, the deformation of the appendages would have been as found.

ii. Drifting: The damage discussed above is also consistent with contact that would have occurred as the LINDA E rotated around the stem and scraped down the starboard side of the barge. This rotation would have occurred even if the LINDA E were drifting.

iii. Either: Areas where sliding contact is evident are forward of the main inset. These marks most likely occurred after the LINDA E rotated around the stem and slid down the starboard slide of the barge. They are consistent with either scenario.

4. **Operational status of ITB MICHIGAN/GREAT LAKES at time of collision:**

a. Based on the fixes taken from the logbook of the ITB MICHIGAN/GREAT LAKES, the speed over ground of the vessel was approximately 12 Knots. At a speed of 12 knots, the ITB MICHIGAN/GREAT LAKES would travel roughly 40 feet in 2 seconds and 400 feet in 20 seconds.

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Conclusions (These conclusions are based upon the facts from this report and the November 22, 1999 report and supercede all conclusions in the previous report.)

1. This casualty was a collision between the ITB MICHIGAN/GREAT LAKES and commercial fishing vessel LINDA E.

2. The apparent cause of this casualty is a failure of the operators of the ITB MICHIGAN/ GREAT LAKES to detect the LINDA E and a failure of the operators of the LINDA E to detect the ITB MICHIGAN/GREAT LAKES or take sufficient action to avoid collision with the ITB.

3. Based upon the evidence available, we cannot conclusively determine why the operators of the LINDA E were unable to avoid collision with the ITB. We have found no direct evidence to indicate that the propulsion and communications system of the LINDA E failed. We cannot be certain that the crew of the LINDA E did or did not see the ITB prior to the collision. We also cannot be certain that the crew of the LINDA E was or was not standing a proper lookout.

4. The contributing causes of this casualty are as follows:

   a. Obscured visibility from the tug MICHIGAN: The sun may have obscured the MICHIGAN operators' view in the direction of the LINDA E. During the last few seconds before the collision, the operators' view of the LINDA E would most likely have been obscured by the bow of the barge. It is unlikely however, that the tug operator's view of the LINDA E would have been completely obscured at all times prior to the collision.

   b. Use of Radar: Beyond visual detection, there were other means available to the operators of the MICHIGAN and LINDA E to reduce the risk of collision, including the proper use of radar. Based upon the following, we conclude that the radar on the MICHIGAN was not monitored adequately or that it was not used properly. The role that the use of radar on the LINDA E played in this casualty cannot be determined.

      i. The radar on board the MICHIGAN was reportedly working properly. The condition of the radar on the LINDA E is unknown.

      ii. The metal structure of both the LINDA E and the ITB are conducive to painting a clear radar target.

      iii. Weather and sea conditions around the time of the collision were favorable for the operators of both vessels to detect the other vessel by radar.

iv. Both vessels were well within radar range of each other for a significant time before the collision.

c. Diverted Attention of the ITB Operator: The location and orientation of the chart table on this vessel is not uncommon. The chart tables on many vessels require the operator to face aft to perform routine navigation duties: plot fixes, identify navigation hazards, locate aids to navigation, etc. However, in this case, the mate was performing a non-navigation activity that distracted his attention from activities essential to navigation, such as looking out for other vessels. That he was doing these corrections at the beginning of his watch, near the estimated time of collision, indicates that this likely contributed to the casualty.

d. Rapid downflooding of the LINDA E: Rapid downflooding occurred as an immediate result of this collision. The force from the resulting collision easily overwhelmed the LINDA E's righting moment, causing the vessel to heel severely, thus submerging the large door openings. The resultant flooding overcame the vessel's reserve buoyancy, sinking the LINDA E within seconds.

e. Lack of watertight subdivision of the LINDA E: Like many fishing vessels on the Great Lakes, the LINDA E lacks watertight subdivision or compartmentation. Once significant downflooding occurs, particularly of the magnitude in this case, the vessel will sink rapidly. If the LINDA E had sufficient buoyancy to remain afloat for even a short period of time, the likelihood that the crew would have been able to escape and survive would have increased appreciably.

f. Difficulty of egress from the LINDA E: In the first few seconds after the collision, the LINDA E experienced rapid downflooding as the vessel heeled and yawed violently. The vessel likely sank by its stern with nets and other gear loose inside. With the forward doors closed, egress from the vessel under these conditions would be extremely difficult. Had there been an accessible egress route, the likelihood that the crew would have been able to escape and survive would have increased appreciably.

g. Restricted visibility due to LINDA E's window arrangement: While we do not know if the crew of the LINDA E saw the ITB, environmental conditions were favorable for them to do so in adequate time to avoid a collision. However, the LINDA E's window arrangement made it difficult for the crew to obtain a full appraisal of surrounding waters and likely contributed to the risk of collision.

5. It is unclear from the evidence available as to what the LINDA E's operational status was prior to the collision. The LINDA E could have been making way, drifting, not under command (disabled), or fishing. We therefore cannot determine which vessel would have had right of way immediately prior to the collision.

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6. While there is insufficient evidence to determine which vessel might have had right of way immediately preceding the collision, the operators of either vessel could have taken action that would have prevented the collision. Even a minor course or speed change by either vessel taken in adequate time would likely have averted this collision.

7. It is possible that the crew onboard the ITB neither felt, heard, nor observed the collision with the LINDA E.

    a. The barge marks and damage profile suggest this was not a fully plastic collision but rather the two vessels collided briefly and relatively lightly. Therefore, the reaction upon the barge would have been relatively small.

    b. As estimated by the impulse/momentum analysis of enclosure (10), the velocity change and deceleration of the ITB was extremely small, even if it were a fully plastic collision. Because of the conservative assumptions made in this analysis, it is likely that the actual velocity change and deceleration of the ITB were even less. Regardless, even the highest estimated deceleration is well below the minimum threshold for detection by a person.

    c. The sound of the generators on the aft end of the barge and closed pilothouse windows would have made it more difficult to hear the noise of the LINDA E striking the bow of the GREAT LAKES. The relatively small impact force on the extremely rigid bow structure of the GREAT LAKES might not be heard in the tug's enclosed pilothouse located 400' aft of the impact point.

    d. The bow of the GREAT LAKES easily obscured the view of the LINDA E from the pilothouse, particularly when the LINDA E was close to the bow.

    e. The LINDA E most likely sank very quickly, possibly before it passed far enough aft to be seen by anyone on deck of the GREAT LAKES or in the pilothouse of the MICHIGAN. The analysis by the MSC indicates that downflooding of the LINDA E would have overcome the vessels reserve buoyancy in 2 seconds. Making the conservative assumption that the LINDA E did not move transversely after the collision, the vessel would only have moved 41 feet aft of the stem of the GREAT LAKES. Even if it took an additional few seconds, it is possible that LINDA E would have sunk completely before moving far enough aft to be seen from the pilothouse of the MICHIGAN.

    f. It is common knowledge that seagulls frequently follow fishing vessels. Thus, the observation by the mate of a large number of seagulls is consistent with what might be expected after a collision with a fishing vessel. However, as there are many possible reasons that seagulls might be seen in large numbers, it is not valid to assume that the presence of seagulls indicates that a fishing vessel is nearby or that a collision with any vessel has occurred. The presence of seagulls alone, which may or may not coincide with

this incident, would not cause most prudent mariners to assume that a collision had occurred.

8. There is evidence of failure on the part of the operators of the ITB MICHIGAN/GREAT LAKES to maintain a proper lookout so as to make a full appraisal of the situation and risk of collision as required by Inland Navigation Rule 5.

9. While the evidence available is not sufficient to conclusively determine whether the LINDA E crew was maintaining a lookout, our investigation has revealed numerous practices, such as use of autopilot while cleaning fish, that indicate the crew may not have been standing a proper lookout prior to the collision.

10. There is evidence of failure on the part of the operators of the ITB MICHIGAN/GREAT LAKES to make proper use of the radar equipment to obtain early warning of risk of collision as required by Inland Navigation Rule 7.

11. While it is not known if the crew of the LINDA E was using the installed radar, the proper use of radar, particularly radar with an installed collision avoidance alarm, would likely have reduced the risk of collision.

12. There is evidence of negligence on the part of licensed mariners for failure to obtain or properly use information available, such as radar, to determine the presence, courses and speeds of other vessels.

13. The permanent display of fishing day shapes is an unsafe practice. During this investigation we learned that this is a common practice among fishing vessels in Lake Michigan. The potential exists for this practice to confuse mariners and increases the risk for future casualties. The justification for this practice is the risk involved with working on top of an ice covered fishing vessel in bad weather or seas. Nevertheless, we believe it is possible to reduce both the risk of collision and risk to the operator with a well-designed installation. There is no evidence to suggest that the LINDA E displayed their fishing day shape permanently and it does not appear that this practice played a role in this casualty.

14. The LINDA E crewmen Leif Weborg, Scott Matta, and Warren Olson sank with the vessel and are presumed dead.

15. While there is no evidence to indicate that an EPIRB would have saved the lives of the crew, had the LINDA E carried an EPIRB the Coast Guard might have been able to begin its search earlier. In addition, an EPIRB might have condensed the search area.

16. There is no evidence that fatigue contributed to this casualty.

17. Weather and sea state do not appear to be factors in this casualty.

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18. There is no evidence that drugs or alcohol contributed to this casualty.

19. Except as noted above, there is no evidence of actionable misconduct, negligence, inattention to duty, or willful violation of law or regulation on the part of any licensed or certificated persons.

20. There is no evidence that any personnel of the Coast Guard, or any other government agency, or any other person contributed to this casualty.

16700/MC98016578
October 2, 2000

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Recommendations

1. It is recommended that through existing maritime safety programs, the Commander, Ninth Coast Guard District re-emphasize to all mariners using the Great Lakes the importance of maintaining a proper lookout at all times when underway. Distractions from normal watchstanding responsibilities, such as updating charts or cleaning fish, should be considered in addition to prevailing weather conditions when determining what constitutes a proper lookout.
2. It is recommended that as part of the Ninth District commercial fishing vessel safety program the Commander, Ninth Coast Guard District, develop lessons learned from this casualty to
   a. re-emphasize the importance of maintaining a proper lookout, particularly in consideration of the limited visibility from many Great Lakes fishing vessels,
   b. promote the voluntary use of radars with anti-collision alarm features,
   c. reiterate to commercial fishermen the inherent risks associated with operating a boat that has no watertight subdivision, including the difficulty of egress from a fast sinking fishing vessel, and
   d. re-emphasize to all Great Lakes fishing vessel operators the importance of properly displaying a fishing day shape.
3. It is recommended that MSO Milwaukee publish the contents of this supplemental report as a safety advisory to all commercial vessels operating in Lake Michigan. That a copy of this investigation report be provided to the State of Wisconsin and local agencies responsible for investigating boating accidents.
4. It is recommended that proceedings be initiated to determine whether suspension and revocation action is warranted against the license of mariners involved in this incident.
5. It is recommended that this investigation be closed.

B. R. EMOND
Investigating Officer

Enclosures: (1) Excerpt from Chart 14904
(2) Photographs of LINDA E from June 21, 2000 ROV Dive
(3) Diagrams of Intact and Damage Profile, with Dimensions
(4) Photographs of barge GREAT LAKES taken December 22, 1998
(5) Dimensional Analysis of Marks on GREAT LAKES
(6) Diagram of Barge Bow Marks relative to LINDA E
(7) Photographs of the Deckhouse of the Commercial Fishing Vessel MERCURY

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Enclosures: (Continued)

(8) Dimensional Comparison of Mercury and LINDA E
(9) MSC Technical Analysis
(10) Impulse/Momentum Analysis
(11): Visibility from pilothouse of MICHIGAN
(12): Paint Sample Analysis
(13): Video of June 21, 2000 ROV Dive
(14): November 22, 1999 Report of Investigation