Liquid Cargo Movements and Incidents on the Minnesota Portion of the Upper Mississippi River

W. William Newstrand

The major spill from an onshore oil tank in Pennsylvania, which caused major pollution on the Ohio River system, generated considerable concern about a similar happening in Minnesota. This study was made in response to that concern. Records of liquid cargo movements on Minnesota's portion of the Upper Mississippi and of spills into the water were reviewed to determine historic patterns and the effectiveness of the commercial navigation system in handling liquid cargoes. Results of the study show that barges carry nearly a billion gallons of liquid cargo each year in Minnesota. Spills from navigation functions, that is, vessels and terminals, account for 0.00003 percent of the volume carried. The study also showed that the majority of spills into the river system came from nonnavigation activities. Over a 4-year period, 106,287 gal of contaminating liquids were spilled into the navigable portion of the Mississippi system in the state. Of that total, navigation activity contributed only 4,099 gal. Also reviewed in the study was the makeup of the tanker barger fleet that plies the upper river. Nearly 87 percent of the fleet is made up of double-hulled barges. Double-hulled barges are rapidly replacing the remaining 13 percent of the fleet.

Many individuals and organizations along the Upper Mississippi River have expressed concern about the possibility of a spill from tank barges. Their concern has prompted the preparation of this paper, which focuses on the navigable portion of the Mississippi River system within the St. Paul District of the Corps of Engineers. Concern about spills of waterborne liquid cargoes has prompted a number of studies on ways to reduce their numbers and impacts. Those same concerns have generated significant advances in the technology of containment and cleanup as well as dedicated response from both public and private organizations to such spills. Much of the activity has been directed toward the intercoastal and tidewater systems rather than the rivers because of the greater volumes of liquid cargo moved in the saltwater areas. However, a recent major spill from an on-land tank into the Ohio River has sparked new levels of concern in the interior.

BACKGROUND

Liquid cargoes make up as much as 10 percent of the nongrain freight volume handled each year by Minnesota's river transportation industry. Because many of the commodities included in the liquid cargo category are classified as hazardous material, there is serious concern about the potential for spills. Hazardous material spills in the water are more difficult to contain and clean up than similar on-land spills, and their environmental impacts are generally greater in both the amount of damage and areal coverage.

The most recent studies of river liquid cargo vessels and riverine spills were done by the Maritime Transportation Research Board (MTRB) and by the Corps of Engineers (COE). Both of these analyses covered areas significantly larger than the St. Paul District of the COE, which is the geographic extent of this analysis.

The MTRB study *Reducing Tankbarge Pollution* (*1*) resulted from controversy over a U.S. Coast Guard proposal that would have required double-hulled tank vessels for all waterborne oil transport. Study recommendations ranged from suggestions that the Coast Guard modify its proposal to force use of only double-hulled barges and find other ways to reduce spills, to such things as changing tankerman licensing requirements. The study addressed the national picture with divisions of analysis composed of entire rivers or major segments of rivers, such as the upper Mississippi. A major part of the study involved offshore and coastal waterway operations.

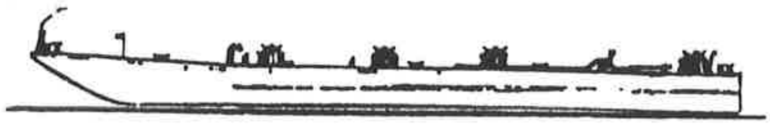
The COE's analysis for the supplement to the Environmental Impact Statement (EIS) for the second lock at Alton has a closer spatial relationship to this study in that it covers the Upper Mississippi on a pool-by-pool basis. The main difference is that it looked only at volumes of both cargo and spills and did not discuss vessel or facility types. The COE's effort also did not survey nonriver-related spills that entered the water.

VESSELS

There are several types and sizes of tank barges operating on the nation's shallow draft navigation system; most of them also operate in Minnesota. The basic design and range of sizes is shown in Figure 1. Differences in design and deck equipment respond to special cargo types. In Minnesota, all tank barges are fairly well standardized. The basic difference in tank barges that operate on this part of the river is in internal construction design; that is, there are single-hulled, single-sided barges, single-hulled, double-sided, and double-hulled barges. Figures 2, 3, and 4 are representations of barge construction plan drawings that show the three types of tank barges.

Regionally, there is considerable concern about the possibility of leaks from tanker barges, especially the single-hulled

Minnesota Department of Transportation, Transportation Building, St. Paul, Minnesota 55155.



Typical Sizes

Length (feet)	Width (feet)	Capacity (gallons)
175	25	302,000
195	35	454,000
290	50	907,000

FIGURE 1 Liquid cargo barges.

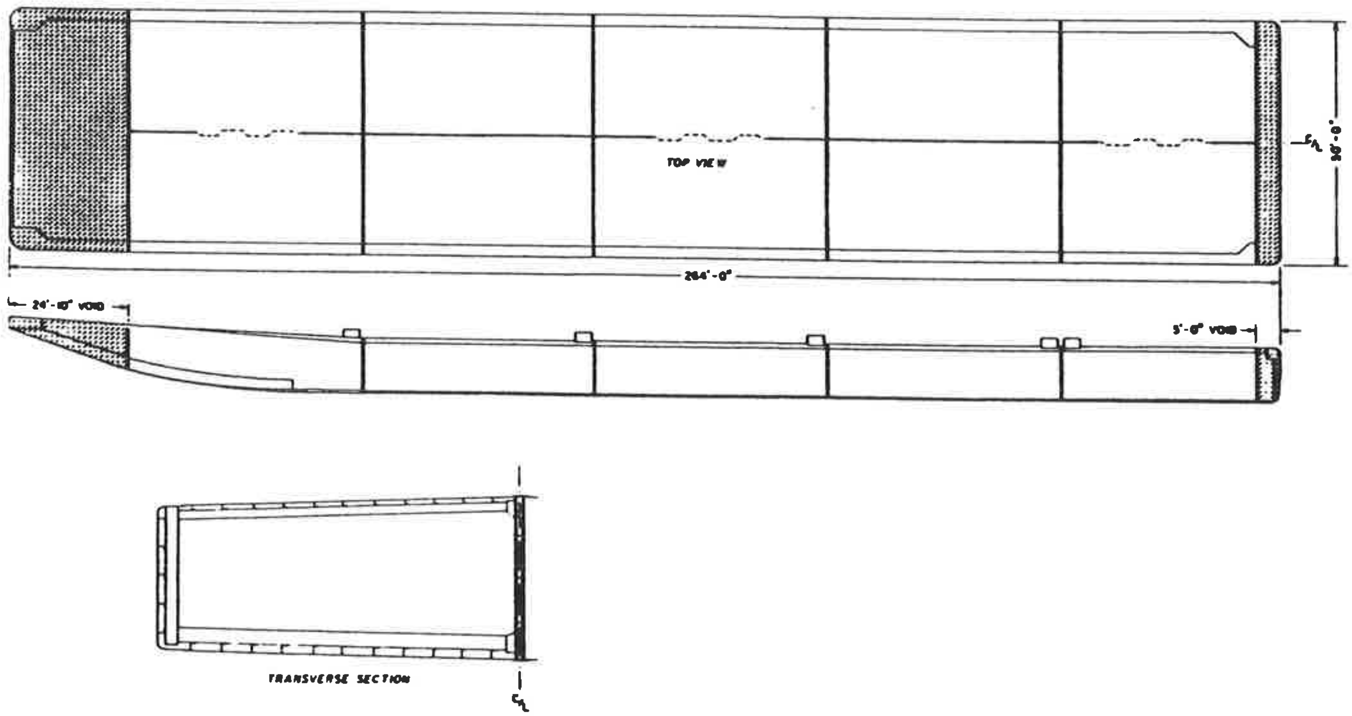


FIGURE 2 Liquid cargo: single-skin barge.

vessels that do not have side and bottom void compartments. As shown in Figures 2, 3, and 4, all tank rake barges, whether single or double hulled, have void compartments, collision bulkheads, and strengthened bracing in their bows and sterns to prevent cargo compartment damage in case of a collision. Rake barges, those with scow-type bows, are normally placed in the fronts of tows because their bow designs move more smoothly through the water and they have collision-protection void compartments of 25 ft or more. Box tank barges have smaller void compartments but they are usually placed in the center or rear of the tows and gain added protection from the other barges in the tow.

The total U.S. tanker barge fleet, according to towing industry records, consists of 3,563 vessels, 870 of which are single hulled, 1,306 are double sided, single hulled, and 1,387 are double hulled. The Minnesota Department of Transportation (Mn/DOT) surveyed all tank barge owners and operators listed in *Inland River Guide* (2) to determine the numbers of each kind of tank barge used on the Upper Mississippi and the total capacities of each type. Thirty-five of the 147 tanker barge owners who work on the inland river system operated on the Upper Mississippi and 30 of them in Minnesota waters at the time of the survey. That number was confirmed through industry contacts. Table 1 represents a summary of the data collected in the 35 responses to the Mn/DOT survey. Only 8.4 percent of the tank barges used in the COE's St. Paul District are single skinned, only 4.7 percent are double sided, and nearly 87 percent are double hulled. Of the total fleet capacity operating in Minnesota, single-hulled barges account for 10 percent, double-sided barges for less than 5 percent, and double-hulled barges for 85 percent.

Although there is not federal law requiring double-hulled construction on new tank barges, all that are currently being built for the inland system are double hulled. This has been true since the 1970s.

U.S. Coast Guard regulations have helped cause this change to double-hulled construction. Their inspection requirements for double-hulled vessels cost considerably less than do those

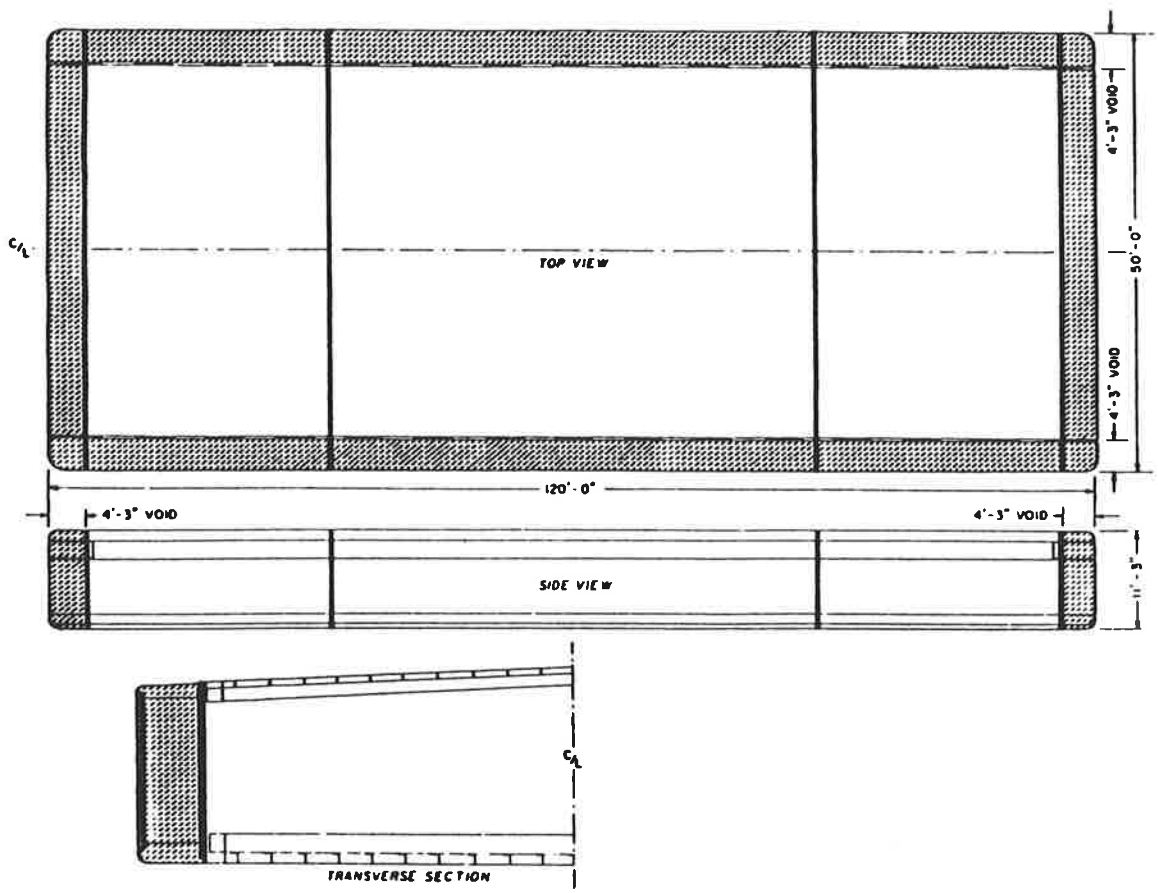


FIGURE 3 Liquid cargo: single-skin barge with double sides.

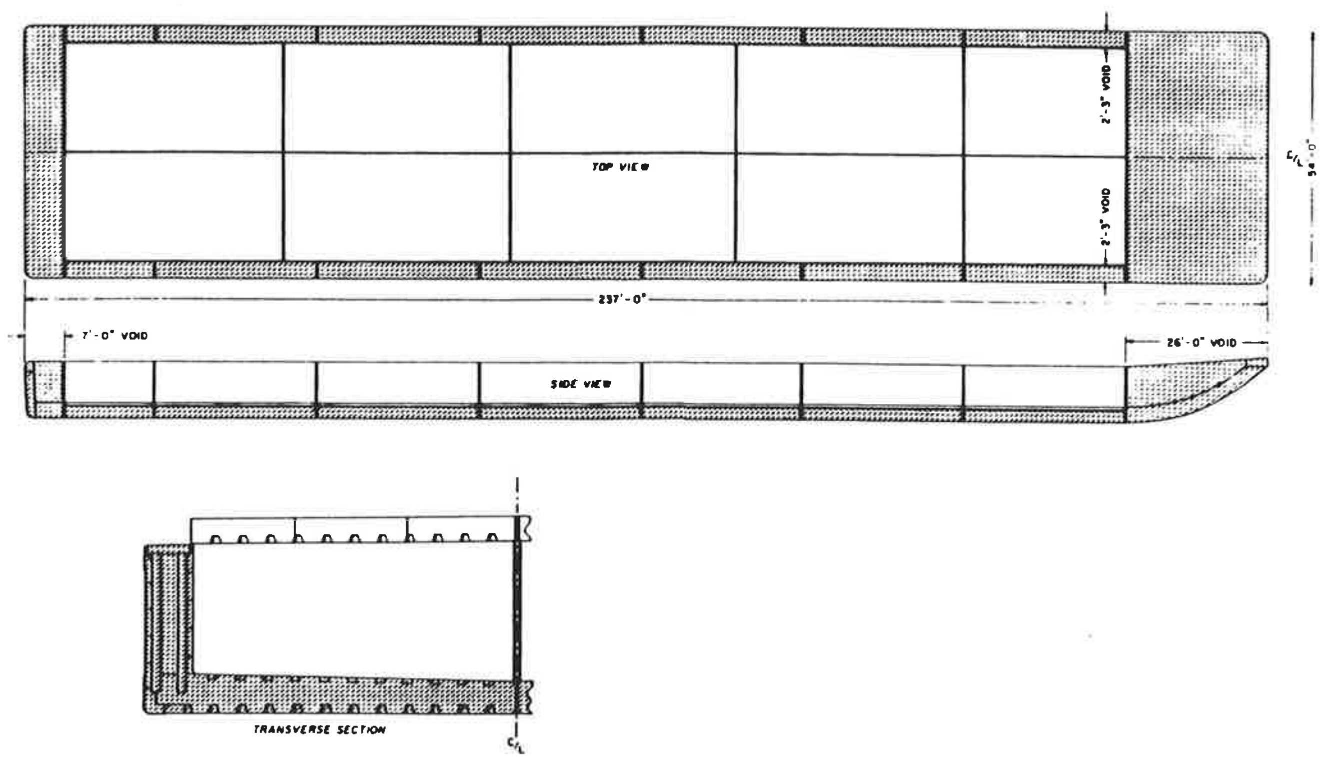


FIGURE 4 Liquid cargo: double-skin barge with double sides.

TABLE 1 MINNESOTA PORTION, UPPER MISSISSIPPI TANKER BARGE FLEET, FALL 1987

	Number of Companies	Number of Barges	Capacity Range 1,000 gallons	Total Capacity 1,000 gallons
Single Hull	5	45	343.2-1,041.0	31,495.4
Double Sided	5	25	328.9-1,001.0	14,700.4
Double Hull	23	463	328.9-1,086.8	262,197.7

for single-skin barges. The savings in inspection costs justify the added construction costs for double hulls over the long term.

All 30 companies who operate on the Upper Mississippi reported that as their single hulled barges are scrapped they will be replaced by double-hulled vessels.

LIQUID CARGO MOVEMENTS

Liquids carried by barges in Minnesota include a wide variety of commodities. Major movements include such commodities as crude oil, refined petroleum products, fertilizers, and industrial molasses, along with lesser quantities of vegetable oils, caustic soda, paints, fish emulsions, asphalt, and assorted chemicals.

There are 22 active river terminals that handle liquid cargoes in Minnesota. Three other, currently inactive, terminals have capacities for handling and storing a variety of liquid cargoes, mostly petroleum products.

The history of liquid cargo movements in the St. Paul COE District for the period 1978 through 1987 is shown in Table 2. Total liquid cargo movement for the period was 32 million tons, or approximately 9.2 billion gallons. Average annual quantities are 3.2 million tons (with a range of 2.6 million tons to 3.8 million tons) or 923 million gal (with a range of 783 million to 1.1 billion gal). All data are recorded by the Corps and the towing/terminal industry by tons; conversion to gallons was based on 7 lb/gal, or 286 gal/ton for all liquids except asphalt, which was computed at 235 gal/ton.

SPILLS

There are two basic categories of spills that have an impact on the river: those that involve activity on the water or on the shore and those that occur on dry land but drain to the water. In the first category, the spills are caused by commercial vessel, terminal, small boat, and marina accidents. Land spills include a wide variety of operations including railroads, trucks, pipelines, and off-river terminal or factory operations.

The St. Paul Office of the Coast Guard and the Minnesota Pollution Control Agency (PCA) have records of all such spills in the Minnesota portion of the study area for the period 1984 through 1987. Although PCA spill records predate 1984, that year's change in record keeping made it possible to determine spills that were definitely river related. Their records show

TABLE 2 BULK LIQUID CARGO MOVEMENT, ST. PAUL DISTRICT CORPS OF ENGINEERS (thousands of gallons)

YEAR	POOL 2 INTERPOOL	POOL 2 INTRAPOOL	NON-METRO COE DISTRICT	TOTAL
1978	816,077	183,004	81,338	1,008,419
1979	703,351	177,648	92,928	973,927
1980	697,610	183,250	154,555	1,035,415
1981	774,645	179,000	104,448	1,058,093
1982	556,885	182,750	90,262	829,897
1983	585,437	185,475	114,657	885,569
1984	539,771	177,250	186,329	903,350
1985	520,239	180,785	82,482	783,506
1986	522,451	185,650	128,013	836,114
1987	536,393	182,347	129,730	848,470
TOTAL	6,252,859	1,817,159	1,164,742	9,162,760

TABLE 3 LIQUID CARGO SPILLS 1984–1987, MINNESOTA PORTION OF MISSISSIPPI RIVER

Source	Occurrences	Volume (Gallons)
Commercial Navigation	32	4,399
Recreational Boating	3	260
Railroads	12	40,810
Other Transportation	15	7,900
Non River Industry	34	52,918
Totals	96	106,287

the location of each spill, the source, the commodity, and the amount of liquid involved.

Data from the U.S. Coast Guard and PCA reports are summarized in Table 3. PCA data is limited to those spills that occurred in Minnesota. These data were supplemented by Coast Guard information on vessel cargo losses on the Wisconsin portions of the river. Records of non-vessel spills from the Wisconsin side were unavailable. There is no liquid cargo generation in the Iowa portion of the COE St. Paul District.

Data in Table 3 show that in the 1984 to 1987 period a total of 96 river-contaminating spills occurred in the Minnesota/Wisconsin portion of the Corps' St. Paul District. The volume of liquid lost was unknown for 17 of those spills. Of the 79 incidents with measured cargo losses, the total volume was 106,287 gal. Of the total 96 incidents, 21 with 4,038 gallons can be charged to commercial river vessels and 9 with 361 gallons are the responsibility of river terminal facilities. The remaining 66 spills of 101,888 gal occurred in non-commercial navigation-related operations. Data on recreational boating cover only reported incidents at marinas involving equipment failures.

Individual PCA spill records generally indicate the success of cleanup efforts, that is, the amount of spilled liquid that was recovered. Because water spills were often recorded as "sheens," or the amount of spill was unknown, this analysis did not attempt to determine the percent of recovery.

Petroleum distillates account for the majority of spills into the river, with gasoline being the commodity with the highest volume of spills. Some detail on such spills and commercial navigation's (vessels and facilities) share of the total is given in Table 4.

SPILL PREVENTION, CONTAINMENT, AND CLEANUP

This study did not attempt to determine levels of recovery of spilled material. Records on many in-water spills are sketchy because of the rapid dispersal of liquids in the river. An accurate count of the percentage of spills recovered is difficult.

All tank barge operations require at least one licensed tankerman as part of the crew. When an under-way vessel starts to leak, the tankerman will stop the leak before major cargo loss occurs. Only on the rare occasion of a major collision or a sinking is the tankerman unable to stop cargo loss quickly. Tankermen are also on duty during vessel-to-shore facility transfer operations. Federal law requires each liquid handling river terminal to have ready access to a spill-containment system such as floating booms, which are placed around the

TABLE 4 PETROLEUM SPILL STATISTICS 1984–1987, MINNESOTA PORTION OF MISSISSIPPI RIVER

	Total Occurrences		Commercial Navigation Share			
Commodity	Number	Volume (gallons)	Number	Pct of Total Occurrences	Volume	Pct of Total Volume
Gasoline	10	8,505	5	50.0	68	0.8
Heating Oil	15	7,529	11	73.3	3,977	52.8
Diesel Oil	8	4,525	2	25.0	100	2.2
Other Oils	32	542	16	50.0	89	16.5

vessel in the water. If there is a spill, the booms keep the floating material from dispersing into the river, making it easier to clean up. Many of the terminals that handle liquid cargoes only have their own containment and cleanup systems. Others, which only occasionally handle liquids, rely on contract spill recovery teams or enter into cooperative agreements for the purchase and use of the costly systems.

The individual terminals are responsible for cleanup of any spill caused by their operations. If they fail to respond, the Coast Guard, the EPA, or the Minnesota PCA will contract for the cleanup with one of the private contractors and then charge the cost to the responsible party. In addition to the cost of cleanup, an operator of a boat or terminal facility can be fined according to procedures in the Clean Water Act.

CONCLUSIONS

This review of cargo and spill data, vessel and fleet characteristics, and spill response techniques indicates that water transportation of liquid cargoes poses little threat to the riverine environment in Minnesota. During the 1984 to 1987 period, the waterborne freight industry lost only about 4,399 gal of liquid cargo out of the nearly 3.4 billion gal it carried in Minnesota.

There are 288 mi of commercially navigable river in this report's study area. Assigning an average yearly liquid cargo loss of 1,100 gal to those miles, there was about 3.8 gallons/mi of liquid cargo spilled in the river by the towing and terminal industry each year. That would probably generate a less significant sheen than the one produced by the thousands of outboard motors that ply the same portions of the river.

There is no intention here to minimize the potential impact on the environment from a spill into the river. The intent is to stress the excellent safety record owned by the towing and river terminal industry. In fact, the record of all of the liquid cargo handlers in the river valley is impressive. For example, Mn/DOT freight records for 1985 show that the railroads moved 57,600 cars with 1.3 billion gal of liquid cargo in the river valley. With liquid cargo levels of that magnitude, the recorded 12,000 or so gal that are spilled each year into the river is a very small portion representing a five decimal percentage of the total. The nonriver facilities included in the data also have exemplary spill safety records when the volumes of liquids handled are considered.

REFERENCES

1. *Reducing Tankbarge Pollution*. Maritime Transportation Research Board. Commission on Sociotechnical Systems. National Academy Press, Washington, D.C., June 1981.
2. *Inland River Guide*. Waterways Journal, St. Louis, Mo., 1990.

Publication of this paper sponsored by Committee on Inland Water Transportation.