1. Drafts rules and regulations for the transportation, handling, loading, discharging, stowage, storage, and use of explosives or other dangerous cargoes;
2. Determines the kind and degree of hazard inherent in the water shipment of dangerous substances;
3. Reviews regulations, international standards, and proposals that relate to (a) protection of the environment in water transportation of hazardous materials and (b) vessels and waterfront facilities from the standpoint of environmental pollution hazards;
4. Makes studies of the behavior and effects of pollutants released to the environment under normal and accident conditions; and
5. Predicts trends in the transportation of hazardous materials and their evaluation in terms of future environmental hazards.

SUMMARY

Federal interest in effective transportation use of major river navigation systems has manifested itself in actions to facilitate safe commerce. Today's need for the conservation of energy will unquestionably attract greater federal interest because of the recognized energy efficiency of waterway transportation. Reasonable people also recognize that a balanced capability among all modes of transportation (water, air, rail, and truck) is essential to meet the nation's needs. Industry as well as the federal government will be challenged to identify national transportation needs and to promote a homogeneous interface among the modes. It is conceivable that such efforts will work changes in the predominant bulk shipment of coal, grain, fertilizers, petroleum products, and chemicals on U.S. inland waterways. It is reasonable to assume that container and roll-on/roll-off cargo-handling facilities will begin to emerge on the riverbanks much as they were introduced to ocean ports as the result of transportation technology.

Whatever the future holds, energy efficiency as well as the need for safe commerce will be an important factor in shaping federal interest in effective transportation use of major river navigation systems.

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Analysis of Towboat and Barge Use on Inland Waterways

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In 1975, the U.S. Army Corps of Engineers instituted the Performance Monitoring System (PMS) at locks on inland waterways. PMS data, collected at each lock, allow the Corps to monitor the use of navigation locks and traffic movements and to analyze tow operating characteristics. Based on data derived from PMS, the Corps developed a computer program called VESUSE to analyze inland-waterways use of towboats, barges, and flotillas by simulating their movements. The elements of the VESUSE program are described and are found to be reliable. The information on the characteristics of vessel utilization is useful for studies related to inland-waterways operations and planning.

The VESUSE computer program, developed by the Navigation Analysis Center of the U.S. Army Corps of Engineers, makes it possible for the first time to assess and analyze the characteristics of tow-equipment use on inland waterways. These characteristics are significant for various studies of operations and planning for inland waterways. Input to VESUSE are Performance Monitoring System (PMS) data on the movements of tows and barges through navigation locks. The program infers the movements that have taken place between the locks and from them estimates how many operational vessels of various types are present on a given section of inland waterway during a given time period. An operational vessel is defined as one that moves through a lock during the time period. The program also estimates the fraction of the time an average vessel of each type is in use or idle.

This paper presents a description of the various elements of the program.

PERFORMANCE MONITORING SYSTEM

PMS is a system of data collection at navigation locks whose purpose it is to monitor lock operations and the passage of commercial vessels through the locks (1). From a PMS data record, VESUSE extracts the lock code, direction of the lockage (upstream or downstream), identification number of the towboat, times and dates when the flotilla arrived in the lockage queue and completed the lockage, whether or not the flotilla had stopped since its last lockage, and the horsepower of the towboat. It also obtains the number of light boats in the lockage (commercial towboats that are not carrying cargo or pushing barges and that passed through the lock at the same time as the main flotilla). Finally, VESUSE obtains a table describing barges from the record. For each group of barges, the table gives the type of the barges, what commodity and how many tons they were carrying, and how many barges constituted the group. The data that PMS supplies on vessel movements between locks are very sketchy. Moreover, PMS data are not entirely reliable. These facts may limit the accuracy of the program's results.

CLASSES OF VESSELS

The classifications of the vessels used are the 9 barge categories used in PMS, 11 categories of towboats (distinguished by horsepower range), and the

Figure 1. Extract from transit-time report.

From Lock	To Lock	Transit Time (days)	Distance (miles)	Direction (upstream, downstream)
IL08	MI26		95.0	D
IL08	MI25		104.0	D
MI24	MI25		32.0	D
MI25	MI24	Variable	32.0	U
MI25	IL08		104.0	U
MI25	MI26		41.0	D
MI26	IL08		95.0	U
MI26	MI25		41.0	U
.	.		.	.
.	.		.	.
.	.		.	.

category of "light boats", which are any towboats whose horsepower was not reported in the data. The table below gives the barge categories used:

Barge Category	Symbol
Seabee or LASH	B
Bulk cargo vessel (self-propelling)	C
Integrated (made up as a unit to operate integrally)	I
Regular or long jumbo barge	J
Motorized	M
Small regular barge	R
Super jumbo barge	S
Bulk tanker vessel (self-propelling)	T
Other	Z

The following towboat categories are used (in horsepower): 0-600, 601-1200, 1201-1600, 1601-2000, 2001-3400, 3401-4400, 4401-6000, 6001-7000, 7001-8000, 8001-9000, ≥9001, and light boats.

TRACKING OF VESSEL ACTIVITIES

The VESUSE program tracks the travel of a particular tow complex, or flotilla, by grouping together the lockage records pertaining to the prime vessel (towboat) and sorting these records according to the time and date of the lockage. However, rather than tracking a flotilla's travel throughout the system during the given study period, it tracks its travel through one pool at a time, from entry to exit. Stated another way, the program looks at one pool at a time and studies all the flotillas that passed through (or just into or out of) that pool during the study period.

TRANSIT TIME

When the program has records of a flotilla's entering and subsequently leaving a pool, and when there was no stop in between, the program subtracts the time of the flotilla's entering the pool from the time of its leaving to obtain its transit time. The program computes averages of the transit times from each lock to each adjacent lock in the study area and records these averages in the transit-time report (see Figure 1).

In a future version of VESUSE, sophisticated statistical methods may provide more accurate predictions of transit time by using such predictors as season of the year, upstream versus downstream travel, distance between locks, towboat horsepower rating, tonnage of freight pushed, and number of barges pushed.

SIZE OF OPERATIONAL BARGE FLEET

Next, the program looks at one pool at a time and again studies the travel of flotillas through the pool, accounting for each barge. To be precise, if a flotilla takes barges out of the pool that it did not bring in and that were not brought in by a previous flotilla during the study period, then the program deduces that those barges were already present in the pool at the beginning of the study period. Since every barge must have been present in some pool at the beginning of the study period, this leads to an estimate of the size of the operational fleet. The program assumes that an operational barge is one that moves through a lock during the period of study. The same logic applies to light boats.

ACTIVITY OF BARGES

While applying this accounting type of approach to computing the number of barges in the system, the program also develops a composite figure for the amount of use each type of barge received during the study period. This figure is in the form of barge-use days.

The assumptions underlying the barge-use-day statistic are the following:

1. If a barge traveled through a pool as part of a flotilla that did not stop in the pool, then it was "in use" for the entire time the flotilla was in the pool.
2. If the flotilla did stop for partial refleeting and then went on, still pushing one of the same barges it came in with, then the barge was "in use" for the amount of time that the flotilla would have required for nonstop travel between its point of entering the pool and its point of leaving. This time requirement is estimated from the transit-time report (Figure 1). The barge was "idle" the rest of the time it spent in the pool (during which time refleeting was presumably taking place).
3. If a barge entered the pool with a flotilla and remained there, then it traveled with the flotilla half of the distance between the flotilla's point of entering the pool and its point of leaving and was deposited midway at a hypothetical dock. It was in use for as much time as the flotilla would have required to travel from its point of entering the pool to this hypothetical dock and thereupon became idle (again, the time requirement is estimated from the transit-time report). In the VESUSE program, this idleness is different from the idleness discussed in the second assumption above, since the program cannot individually identify or track the barge any further. At this point, the accounting type of study discussed earlier enters in.
4. If a barge joins a flotilla in the pool and leaves with it, the case is the converse of assumption 3 above and is treated accordingly.
5. Time spent in loading or unloading is idle time.
6. Time spent waiting in lockage queues is in-use time.

The results of this portion of the study are recorded in the barge-use report (see Figure 2).

BOUNDARY CONDITIONS

A flotilla may enter a pool and remain there until the study period is over or enter a pool before the study period begins and then leave. In such a case, the VESUSE program makes an educated guess about where the flotilla was going to or coming from. For pools bounded by two locks, this guess is simple to make. Lacking concrete information, the program assumes that a flotilla that entered the pool but did

Figure 2. Extract from barge-use report.

Barge Type / Pool	B	C	I	J	M	R	S	T	Z	Total
MI25	#	#	#							#
	%	%	%							%
MI26	#	#	#							#
	%	%	%							%
.										
.										
.										
	#	#	#							#
	%	%	%							%

Note: # = average number of operational barges;
% = percentage use of operational barges.

Figure 3. Extract from tow-use report.

Horsepower Range / Pool	1-600	601-1200	1201-1600	. . .	9000-*****	Total
MI25	#	#	#			#
	%	%	%	. . .		%
MI26	#	#				#
	%	%		. . .		%
.				. . .		
.				. . .		
.				. . .		
Total	#	#				#
	%	%		. . .		%

Note: # = average number of operational towboats;
% = percentage use of active towboats.

not leave during the study period traveled to the midpoint of the pool and then became idle. Conversely, it assumes that a flotilla that left the pool was formerly sitting idle at the midpoint of the pool and traveled the distance from the midpoint to the lock by which it exited. (In a pool at a confluence, the hypothetical midpoint is established by averaging.) The time requirements for traveling between the midpoint of a pool and each adjoining lock are included in the transit-time report.

TOWBOAT USE AND FLEET SIZE

Since every towboat is individually identified in the PMS records, establishing the size of the active fleet of towboats should be straightforward, with one exception: A lone towboat may be locked through as a light boat together with other light boats or with a flotilla, and in that case its identification number will not be in the PMS records. The VESUSE program treats light boats much like a tenth barge category. Observe, however, that a towboat may enter a pool as part of a flotilla and leave as a light boat, or vice versa, and that the program takes this into account.

The statistics on tow-use days are compiled in much the same way as those on barge-use days, but of course a flotilla may drop off or pick up a barge, but not a towboat, on its way through a pool. Furthermore, a towboat may enter a pool, refleet, and then turn around and go back out the same way; we assume that a barge does not do this without stopping to be loaded or unloaded. When a tow does this, we assume that it travels to the pool's hypothetical midpoint, drops off all its barges and picks up new ones, spends zero or more time idle, and travels back to the lock, where it exits.

Tow-use statistics are recorded in the tow-use report (see Figure 3).

SUMMARY

The VESUSE program provides us with very useful information on the use of towboats, barges, and flotillas. It serves our need for some insight into how towing equipment is used. A more sophisticated program is planned for the future as demand arises.

The Navigation Analysis Center will supply the program and the user's manual on request.

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State Water-Port Master Planning

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Existing state roles in transportation and water-port planning and their relationship to other planning activities are explored. A rationale for expanding states' water-port planning responsibility is discussed, and alternative approaches to developing a state water-port master plan and a description of the components of such a plan are presented. It is concluded that cooperation between state governments and local port agencies provides an effective political and operating mechanism for bridging the gap between national and local objectives.

A recently completed report by the General Accounting Office (1) raised serious questions about the ability of local port agencies to continue financing much-needed capital improvements. Without recommending a specific course of action, the report questioned the efficacy of the "go-it-alone" competitive environment in which ports currently operate. It recognized the national importance of ports and