Longshore industry.
(1957)

CARGO SHIP LOADING

An Analysis of General Cargo Loading In Selected U. S. Ports

The Maritime Cargo Transportation Conference

National Academy of Sciences—National Research Council

publication 474

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CARGO SHIP LOADING

AN ANALYSIS OF GENERAL CARGO LOADING IN SELECTED U. S. PORTS

by the

MARITIME CARGO TRANSPORTATION CONFERENCE

As part of a program undertaken at the request of the Departments of Defense and of Commerce

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FOREWORD

This analysis of general cargo loading operations in selected ports of the United States was undertaken on the recommendation of members of the Board of Advisors of the Maritime Cargo Transportation Conference (MCTC) of the National Academy of Sciences – National Research Council. The "Cargo Ship Loading" study is a sequel to the "S. S. Warrior" study, in which cargo ship loading was isolated as one of the general cargo transportation process segments most susceptible to significant improvement.

The loading study analyzes in detail the loading process in various U. S. ports and shows the extent to which the present break-bulk system is operating below its capability. It also identifies and evaluates the gains in productivity which can be achieved by certain technical improvements which do not involve a change in the basic system. The results are intended to provide a quantitative basis for future comparisons of the existing break-bulk loading system with unconventional loading systems under consideration by the maritime industry. The importance of the human relations problem became very apparent when attempts were made to isolate and identify the causes of observed inefficiencies in the current utilization of machinery and manpower.

The MCTC gratefully acknowledges the assistance rendered by the commercial operators and the Army terminal personnel in obtaining data for this study.

E. G. FULLINWIDER
Rear Admiral, USN (Ret.)
Director, Maritime Cargo Transportation Conference

January 1, 1957
Washington

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GENERAL SUMMARY

Introduction

This detailed analysis of current ship loading operations is a part of the program of the Maritime Cargo Transportation Conference (MCTC) in its search for system improvements in the sea transportation of general cargo and for measures to reduce the turn-around time of ships. It follows naturally from the findings and recommendations of an earlier study entitled, "The S. S. Warrior, An Analysis of an Actual Export Transportation System from Shipper to Consignee."[1] In that study it was recommended that ship loading be studied in detail as one of the process segments most susceptible to significant improvement. In carrying out this recommendation, the loading study evaluates the performance of the existing loading system and provides a quantitative basis for comparison with unconventional systems under consideration by the maritime industry.

The importance of studying the problems of the conventional system for discharging cargo is recognized. The special characteristics of the discharge operation will be treated in future studies.

Approach

The first step was to obtain industry opinion on certain aspects of the loading operation, particularly as to its "bottlenecks." This was done by sending a questionnaire (sample in Appendix I) to key individuals in a number of companies on the U. S. East, West, and Gulf Coasts. The information accumulated proved to be very interesting in comparison with our own findings and helpful in extending our coverage. Concurrently, a fruitless search for a comprehensive, up-to-date, quantitative study of ship loading operations was made. A study of cargo handling operations had been completed at UCLA.[2] based on a limited amount of data taken only in the Los Angeles and San Francisco areas. This data proved useful since it lessened the need for obtaining loading data on the West Coast.

[1] "The S. S. Warrior," National Academy of Sciences–National Research Council. 1954. Publication 339.

[2] An Engineering Analysis of Cargo Handling—II, UCLA—Dept. of Engineering field study of 1953.

It was then determined that MCTC should undertake a detailed study of loading operations on a sample basis in various East and Gulf Coast ports. The selection of ports and companies for observation was governed by the desire to cover major variations between ports in the general cargo loaded and in the methods of handling. Advice on this was obtained from a number of U. S. ship operators in a meeting set up by the American Merchant Marine Institute. Table 1 lists the commercial and military terminals at which data were obtained.

TABLE 1

Ports where data were collected	*Terminals*
New Orleans, La.	Commercial New Orleans Army Terminal
Hampton Roads, Va.	Hampton Roads Army Terminal
Baltimore, Md.	Commercial
Hoboken, N. J.	Commercial
Manhattan, N. Y.	Commercial
Brooklyn, N. Y.	Commercial Brooklyn Army Terminal

The basic data are time measurements and observations made by special checkers supervised by MCTC personnel and stationed on ships during actual loading operations. Data collection and analysis techniques are presented in Appendix II. A detailed listing of the reduced data has been provided in Appendix IV for those who wish to do further analysis. An important purpose of this study is to stimulate further research in the field of cargo operations and to provide information for those already engaged in such research.

Conclusions

Introduction

A careful study of loading operations in various ports reveals that the primary way of reducing direct costs without a major change of system is to improve the productivity of the longshore gang. Consequently, specific conclusions are divided into two groups, the first and most important group dealing with methods for improving longshore loading productivity, and the second dealing with the relationship of productivity to direct cost.

It is axiomatic that a study of longshore productivity for loading different types of cargo in various ports will be meaningful only in cases where the cargo handled is similar with regard to the stowage factor, weight, cube, and shape of the individual units. Consideration of the peculiarities in handling all of the different types of special commodities encountered in different ports is an interminable task which has not been attempted. Instead, the study concerns itself largely with the loading of packaged items. In all ports examined, these items of cargo are delivered to the hold in quantity by a married fall and then individually stowed. This break-bulk system of handling packaged cargo has been found to be a major problem common to all ports and will probably continue to be so for some time to come. Longshore productivity in this operation has been found to be considerably lower than in handling those special commodities susceptible to rapid handling.

It is not the intention of this study to consider the merits of systems of handling cargo other than the current break-bulk method. The study demonstrates, however, that while considerable improvements in the present system are possible, other handling systems must be sought for gains of larger magnitude.

The following conclusions on loading productivity pertain only to East and Gulf Coast operations although some UCLA West Coast data has been presented in the study for discussion purposes.

Conclusions on Break-Bulk Loading Productivity

1. The present system of loading general cargo is being operated for the most part well below the capability of the mechanical equipment and manpower employed.

2. Although technical means for correcting system inefficiencies are available and undoubtedly known to the controlling human elements, these means have not generally been employed.

3. In all loading operations observed, the hook is the primary bottleneck. Contrary to the sampled opinion of industry officials, the hold section of the longshore gang is not the bottleneck since it is idle over 40 percent of the time waiting for the hook to deliver cargo.

4. In most operations observed, the hook is not being used at maximum capacity to deliver cargo to the hold. This inefficiency is primarily due to insufficient draft size and unnecessary delays in the hook cycle. It does not result either from inadequacy of the pier apron to feed cargo to the hook or from mechanical limitations in the gear.

The following improvements to the hook operation promise gains in the loading rate up to 50 percent in terminals where operation of the hook is least effective and where a 12-man hold gang may be used:

a. Increase the size of the cargo draft, within the limits of safety.

b. Develop and employ special devices for the handling of uniformly packaged commodities, such as drum chime hooks and bale tongs. Such devices should have the effect of reducing avoidable delays to the hook while picking up the load at the apron and releasing it in the hold.

c. Insure that the winches are operated so as to minimize the hook transit time.

d. Reduce hook delays introduced by draft spotting which involves swinging of the load into position by the hold gang. This may be accomplished by installation of ship cranes or by modification of the burtoning system so as to facilitate spotting of the draft, as is the intention of Ebel and Farrell burtoning systems. Improvement in the hook cycle may also be achieved by development and more frequent use of stowing devices such as wagons, dollies, conveyors, and fork lifts. Such devices should tend to make the hold gang less dependent on spotting as a means of reducing the distance between the position where the hook places the load and where the load is ultimately stowed. This would release the hook to perform its primary function of delivering cargo to the hold.

5. When the hook operation is the bottleneck, use of more men in the hold or of any devices which improve only hold gang stowing productivity will not increase over-all loading productivity significantly. However, devices which reduce fatigue and improve hold working conditions may be highly desirable for longshore morale and safety reasons.

6. In all observed loading operations, whether at modern or outmoded terminal facilities, there

is no indication that the terminal has induced delays in the delivery of cargo to the hook so that the loading operation was slowed to a significant extent (more than ten percent). This is not intended to imply that poor terminal facilities might not have a more adverse effect, percentagewise, if loading rates are improved; nor is it intended to imply that these facilities should not be modernized for other reasons.

7. When and if the hook ceases to be the bottleneck, over-all break-bulk loading productivity could be increased significantly by improving hold gang productivity through adoption of the following measures:

a. Employ at least 12 men in the hold gang when stowing units which are susceptible to manhandling; the point of diminishing return, however, is undetermined.

b. Develop and utilize mechanical devices which accelerate stowing operations and reduce fatigue in the hold. Particularly, improve time-consuming operations involved in loading least accessible hatch wing regions. This may be achieved by development and use of wing stowing devices or by changes in ship design which make wings more accessible.

8. The effects of hold-gang fatigue on productivity are apparent as the proportion of hold gang work time to operating time increases. However, fatigue is not a limiting factor at work time percentages below about 60 percent. Most data lie in this area.

9. Under similar conditions, the work rate achieved by the members of the hold gang, while actually working, does not vary significantly from port to port.

10. With present ships, net[1] gang-hour break-bulk loading rates of about 50 to 105 measurement tons per hour, depending on general cargo package types, may be obtained by use of improvements suggested in 4 and 7. Where these improvements are already incorporated into the system, for example in the loading of certain types of cargo in New Orleans, these rates have been attained.

11. With all foreseeable cargo handling improvements including optimum ship designs, the break-bulk loading operation still would be limited by the process of handling individual items in the hold. Depending on the nature of the cargo, the process will permit *at most* loading rates from four to eight percent greater than are attainable as indicated in conclusion 10 with present ships and present cargo handling gear (assuming a 12-man hold gang). Postulating an adequate hook delivery, some gains may be possible through use of a hold gang of more than 12 men. However, beyond this, promise of a significantly greater improvement in productivity can come only from new systems which eliminate the current break-bulk process in the hold.

Conclusions on Loading Costs

1. The total cost of loading a vessel (either partially or completely) varies inversely with observed net loading rates per gang hour. Eighty-two to ninety-two percent of this cost is dependent on loading time. Thus, total cost at a net loading rate of 70 measurement tons per gang hour is about one-half that at 35 measurement tons per gang hour.

2. Differences in labor practices among ports affect total loading costs noticeably. For example, at some ports total costs could be reduced by as much as five percent if less work time were lost because of excess time-off for lunch, early quitting time, etc.

3. Judicious use of overtime reduces costs of loading by as much as five percent in ports with higher wage rates and by as much as 10 percent where wage rates are lower.

Recommendation

It is recommended that research effort be intensified to find fair and practical means of eliminating those conditions which prevent labor and management from employing existing technical improvements to increase productivity in the present system of handling general cargo.

NOTE: The technical conclusions above have not been rephrased into recommendations.

[1] Net gang-hour refers to time spent in loading only. The time consumed in dunnaging, rigging, gear changing, and housekeeping functions is not included.

Section II

QUESTIONNAIRE RESULTS

Table 2 is a summary of the results obtained by sending the questionnaire (Appendix I) to experienced personnel in key positions with various steamship and stevedore companies. It is evident both from the figures and from statements that the majority of those polled consider the hold to be the bottleneck in the loading operation. This is demonstrated in the figures by the fact that the estimate of hook capability in supplying cargo to the hold greatly exceeds the estimate of hold gang stowing capability. On the East and Gulf Coasts, the hook is generally served cargo by two pieces of mechanical handling equipment (fork lifts or tractors with trailers). This operation should never be a significant bottleneck since the doubled apron feed capability (for two pieces of equipment) is higher than either hold or hook capabilities, and a third piece of equipment may be added with relatively little extra cost when necessary.

It is interesting to note the wide dispersion in reported average cargo stowage factors. This alone could easily explain most of the spread in productivity figures.

TABLE 2

LOADING GENERAL CARGO—INDUSTRY OPINION

	Range *Weight Units*	Range *Measurement Units*
Apron Feed Capability[1]	15-30 LT/HR	30-84 MT/HR
Hook Cycle Capability	30-55 LT/HR	70-120 MT/HR
Hold Gang Capability	18-35 LT/HR	38-80 MT/HR
Actual Gang Performance	10-23 LT/HR	25-80 MT/HR
Load Per Draft	0.5-1.0 LT	1.5-2.5 MT
Actual Manhour Productivity	0.5-1.1 LT/MH	1.1-3.5 MT/MH
No. of Men Per Gang	16-23 Men	
Stowage Factor (CU FT/LT)	60-120	
Time Per Hatch-Rig-Open-Close	40-50 minutes	
Pallet Sizes	4′ x 6′ (4′ x 7′—5′ x 7′—5½′ x 7′)	
Bottleneck	HOLD	

No. of Operators Reporting: 13 (All U.S. Coasts)

Seattle—San Francisco—Los Angeles—New Orleans—Baltimore—New York—Boston

[1] *One* piece of mechanical handling equipment only.

Section III

OVERALL LOADING RATE COMPARISON

Practical considerations limited the amount of data taken to the loading of 14,000 long tons (25,000 measurement tons) of general cargo. For the purposes of this study it was desirable to separate the data into homogeneous categories as a means of making more meaningful comparisons. However, it is also recognized that over-all averages are very significant in determining ship turn-around time and cost. In the following presentation of over-all averages, the use of port names to describe data taken at different companies is not intended to imply that this data is necessarily typical of the port but only that the data has been subject to the special conditions which apply in general to the port. Some of these conditions are the number of men per gang, prevailing labor practices, and wages.

Non-Bulk Cargo

The sampling of cargo has not been regulated in any way to reflect the proper proportion of any one cargo category to the total foreign general cargo export tonnage of the port. In so far as possible, however, samples of each significant type of cargo have been obtained. Table 3 shows an approximate breakdown of foreign export cargo commodity categories for ports at which data has been taken. It shows the relative importance of special commodities such as cotton and non-bulk petroleum products in New Orleans and vehicles and metal products in New York and Baltimore. Many of these special commodities are handled differently from others and therefore loading rate figures including a significant proportion of them may be considerably biased.

Since the study is concerned mostly with the break-bulk handling of cargo, a determination of the fraction of cargo susceptible to this type of handling is deemed essential. For this purpose an IBM analysis was made of the manifested physical characteristics of all cargo handled in each commercial ship loading from which data were obtained. The results of this analysis (Table 4) indicate that in most cases observed, more than 75 percent of the cargo loaded fell into a break-bulk category. Break-bulk cargo is defined as meeting both of the following criteria:

(1) Cargo capable of being loaded with more than one unit to the draft, and

(2) Cargo capable of being manhandled into stowage position without the aid of mechanical equipment (rollers, conveyors, winches, fork lifts, etc.).

It will be noted in Table 4 that commercial manifests obtained at the port of New Orleans are not included in the IBM analysis. However, visual inspection of New Orleans commercial manifests also indicate a large fraction of cargo in the break-bulk category. Unfortunately, precise proportions by weight and cube were unobtainable from these documents.

In Table 4 certain cases such as Vessel A in Brooklyn and Vessel B in Hoboken indicate considerably lower percentages of break-bulk

TABLE 3

U. S. FOREIGN EXPORT SUMMARY FOR 1954

	Total L. T. Foreign Export	Bulk	Non-Bulk	Categories of Non-Bulk Cargo						
				Military	Metal Products Mach. & Veh.	Packaged Petrol. Products	Cotton	Chemicals	Textile Products	Other Non-Bulk
New Orleans	5,653,000	54%	46%	9%	7%	4%	4%	2%	—	20%
Norfolk	7,846,000	97	3	0.1	—	—	—	—	—	2
Baltimore	3,683,000	69	31	0.1	20	—	—	2	—	8
New York	6,319,000	14	86	6	32	4	—	6	3	35

Source: Waterborne Commerce of the United States, Calendar Year 1954
Department of the Army, Corps of Engineers

cargo. These vessels had a much larger proportion of cargo in the category of heavy machinery and vehicles.

It is apparent from both Tables 3 and 4 that the break-bulk category constitutes a significant proportion of export non-bulk cargo.

hour while Hampton Roads managed only about 25 long tons per hour. It is therefore obvious that a more detailed breakdown of the information into cargo categories is essential before the large variations in productivity between ports can be explained. For this reason, cargo at all

TABLE 4

PERCENT OF BREAK-BULK CARGO PER SHIPLOAD
(Commercial Operations Only)

		(1) Cargo loaded in break-bulk op. as % of total cargo*		(2) % of bagged goods to total cargo*		(3) % of cartons, cases, and bxs. less than 250 lbs. per unit to total cargo*		(4) % of steel and fiber drums to total cargo*	
		Wt.	Cube	Wt.	Cube	Wt.	Cube	Wt.	Cube
Brooklyn	Vessel A	34	45	0	0	10	19	16	12
Manhattan	Vessel A	88	84	1	1	51	44	24	22
	Vessel B	85	84	5	9	37	37	35	19
Hoboken	Vessel A	82	93	4	4	28	28	9	6
	Vessel B	34	44	1	4	3	4	12	11
Baltimore	Vessel A	86	84	21	18	45	48	2	1
	Vessel B	86	80	44	32	29	33	0	0
	Vessel C	77	76	37	27	25	31	1	1
	Vessel D	85	82	33	22	33	42	3	2

* Bulk grain and tallow excepted.

Cargo Considered in Break-Bulk Category:

All bagged commodities.

All baled commodities.

All commodities packaged in barrels, drums, kegs and pails.

Reels weighing less than 550 lbs.

All other package types with unit weight less than 250 lbs.

Figure 1 shows a comparison of over-all gang hour loading rates in measurement and long tons per hour for each port from which data were obtained. Loading rates are based on the composite of cargo examined at each port. These are net loading rates excluding time for rigging, opening and closing hatches, dunnaging, gear changing, and housekeeping chores. *The reader should not attempt to use these figures for interport comparison.* The stowage factor differences alone are enough to invalidate any such comparison. For example, the stowage factor for cargo observed at Hampton Roads Army Terminal was 95 as compared with New Orleans commercial cargo where the stowage factor was 53. Hampton Roads was able to load nearly 60 measurement tons per hour while New Orleans accomplished a little over 50 measurement tons per hour. Yet at the same time, New Orleans achieved 40 long tons per

ports covered has been sorted with reference both to the nature of the cargo and the way it is handled, into the following categories:

1. Cargo handled on pallets with stowage factor 60 or less.

2. Cargo handled on pallets with stowage factor over 60.

3. Special commodities not handled on pallets.

   a. Household effects (mostly military cargo consisting of large wooden cases handled by sling).

   b. Metal drums (mostly 55 gallon variety handled generally by chime hooks or drum clamps).

   c. Large bales (cotton, rags, paper handled by sling or bale hooks).

   d. Steel and/or tin plate on skids (handled by sling and frequently stowed with a fork lift).

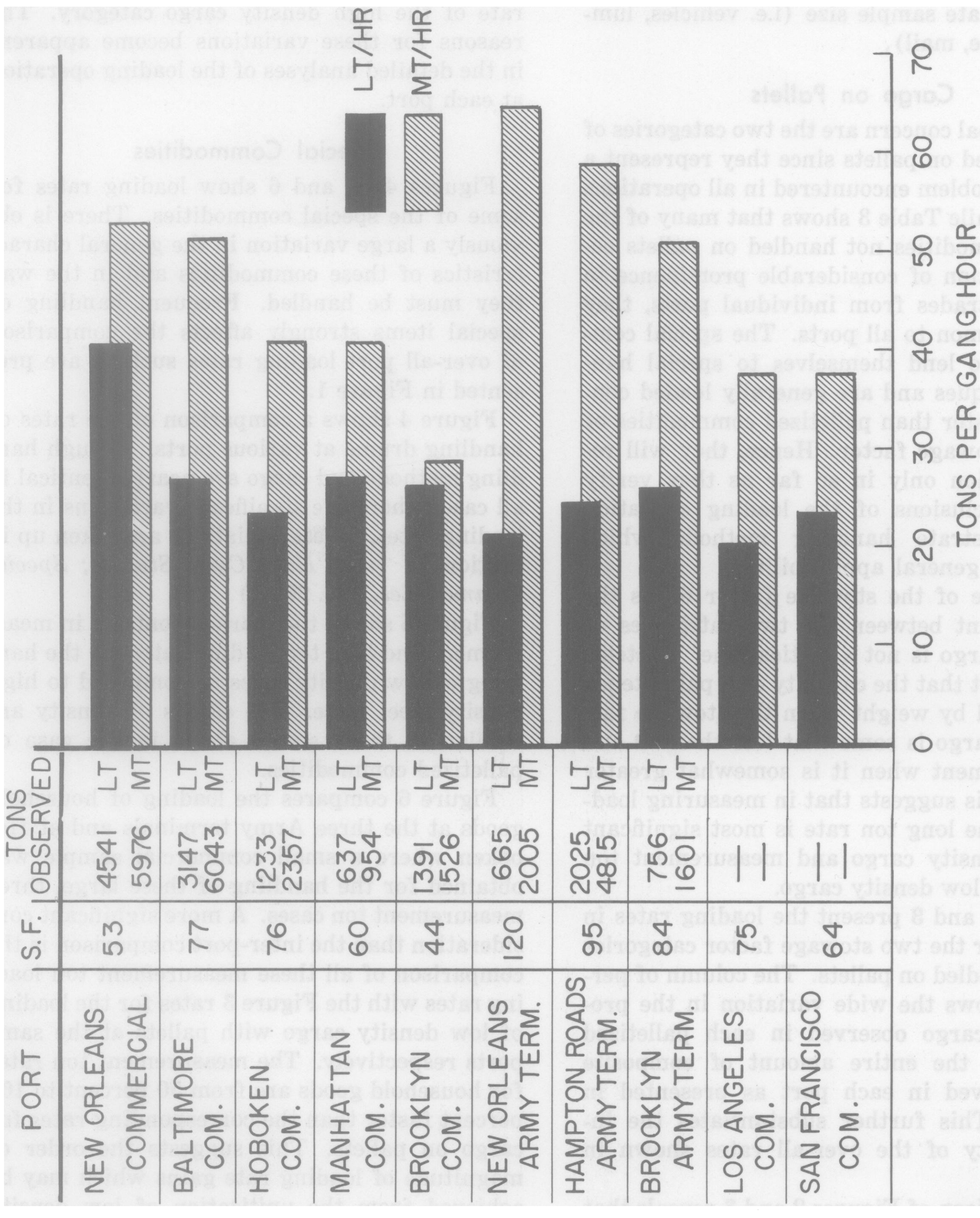


FIGURE 1
Composite Weight and Measurement Loading Rates
(Los Angeles and San Francisco figures are adapted from UCLA Report 55-2 of the Department of Engineering)

e. Other special non-palletized commodities not individually presented because of inadequate sample size (i.e. vehicles, lumber, pipe, mail).

Cargo on Pallets

Of principal concern are the two categories of cargo handled on pallets since they represent a universal problem encountered in all operations covered. While Table 3 shows that many of the special commodities not handled on pallets occupy a position of considerable prominence in the export trades from individual ports, they are not common to all ports. The special commodities also lend themselves to special handling techniques and are generally loaded considerably faster than palletized commodities of the same stowage factor. Hence, they will receive attention only in so far as they verify general conclusions of the loading operation and demonstrate handling methods which might have general applicability.

The choice of the stowage factor 60 as the dividing point between the two categories of palletized cargo is not a critical one. It stems from the fact that the capacity of a pallet tends to be limited by weight when the stowage factor of the cargo is somewhat less than 60 and by measurement when it is somewhat greater than 60. This suggests that in measuring loading rates, the long ton rate is most significant for high density cargo and measurement ton rate for the low density cargo.

Figures 2 and 3 present the loading rates in each port for the two stowage factor categories of cargo handled on pallets. The column of percentages shows the wide variation in the proportion of cargo observed in each palletized category to the entire amount of composite cargo observed in each port as presented in Figure 1. This further substantiates the incomparability of the over-all rates shown in Figure 1.

A comparison of Figures 2 and 3 reveals that high density cargo is consistently handled at higher long ton rates and lower measurement ton rates than the low density cargo. Conversely the low density cargo is handled at higher measurement ton rates and lower long ton rates. It is significant that even with this degree of data refinement, there is still a large inter-port variation in the measurement ton rate of the low density cargo category and in the long ton rate of the high density cargo category. The reasons for these variations become apparent in the detailed analyses of the loading operation at each port.

Special Commodities

Figures 4, 5, and 6 show loading rates for some of the special commodities. There is obviously a large variation in the general characteristics of these commodities and in the way they must be handled. Frequent handling of special items strongly affects the comparison of over-all port loading rates such as are presented in Figure 1.

Figure 4 shows a comparison of the rates of handling drums at various ports. Though handling methods and cargo are nearly identical in all cases, there are significant variations in the loading rates. These variations are taken up in Section IV (see *"Hook Cycle Studies; Special Commodities,"* pp. 20-24).

Figure 5 shows the marked contrast in measurement and long ton loading rates for the handling of low density bales as compared to high density steel plate. The effects of density are similar to those stated above in the case of palletized commodities.

Figure 6 compares the loading of household goods at the three Army terminals and at Hoboken where a small commercial sample was obtained for the handling of these large, three measurement ton cases. A more significant consideration than the inter-port comparison is the comparison of all these measurement ton loading rates with the Figure 3 rates for the loading of low density cargo with pallets at the same ports respectively. The measurement ton rates for household goods are from 50 percent to 100 percent faster than the corresponding rates for cargo on pallets. This suggests the order of magnitude of loading rate gains which may be achieved from the unitization of low density packaged cargo into units the size of household vans. The many considerations involved in unitization are discussed in "The NEAC Study, A Comparison of Conventional versus Unitized Cargo Systems." [1]

[1] "The NEAC Study," National Academy of Sciences —National Research Council. 1956. Publication 389.

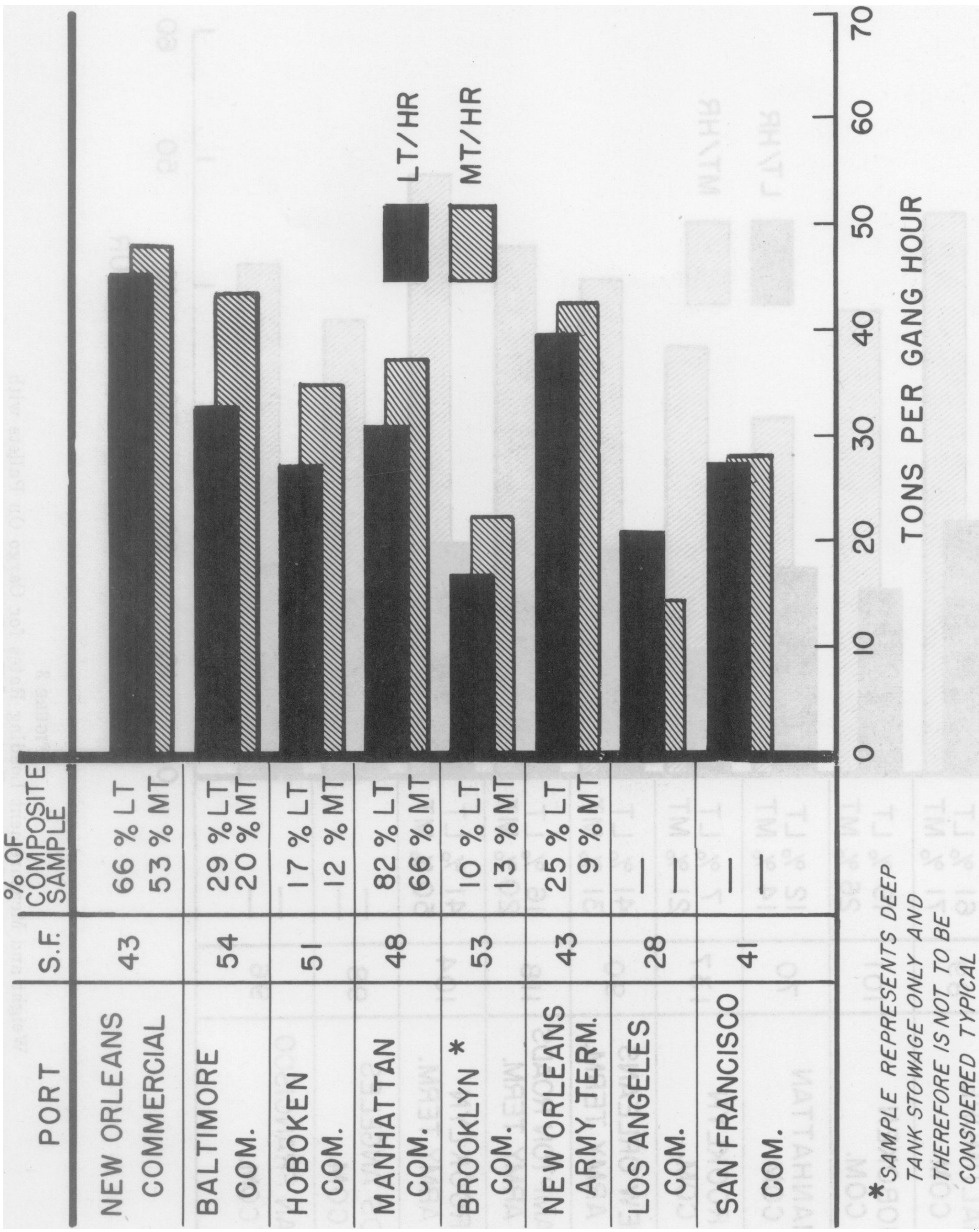


FIGURE 2

Weight and Measurement Loading Rates for Cargo On Pallets with Stowage Factor (S.F.) 60 or Less

(Los Angeles and San Francisco figures are adapted from UCLA Report 55-2 of the Department of Engineering)

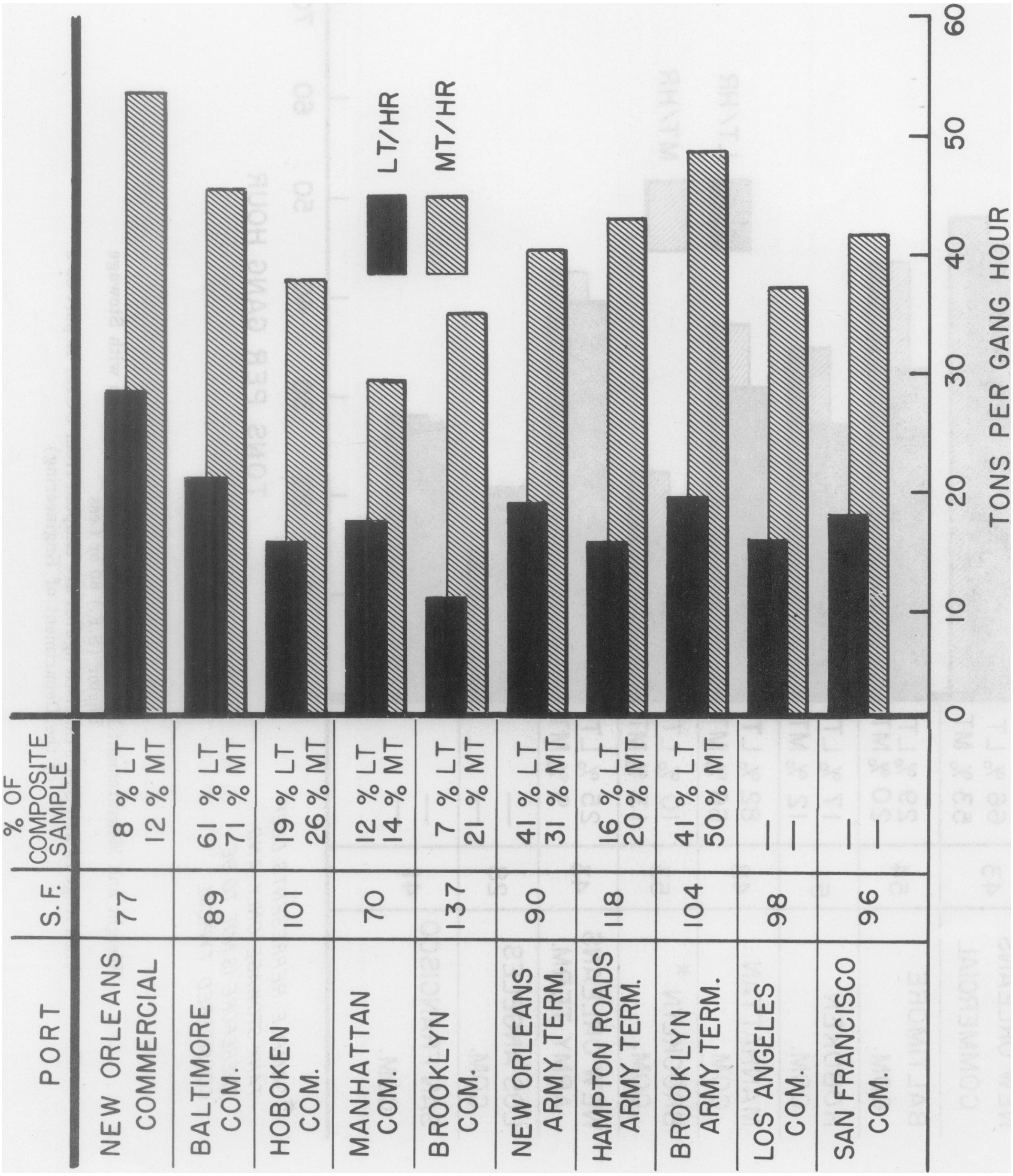


FIGURE 3
Weight and Measurement Loading Rates for Cargo On Pallets with Stowage Factor (S.F.) Over 60
(Los Angeles and San Francisco figures are adapted from UCLA Report 55-2 of the Department of Engineering)

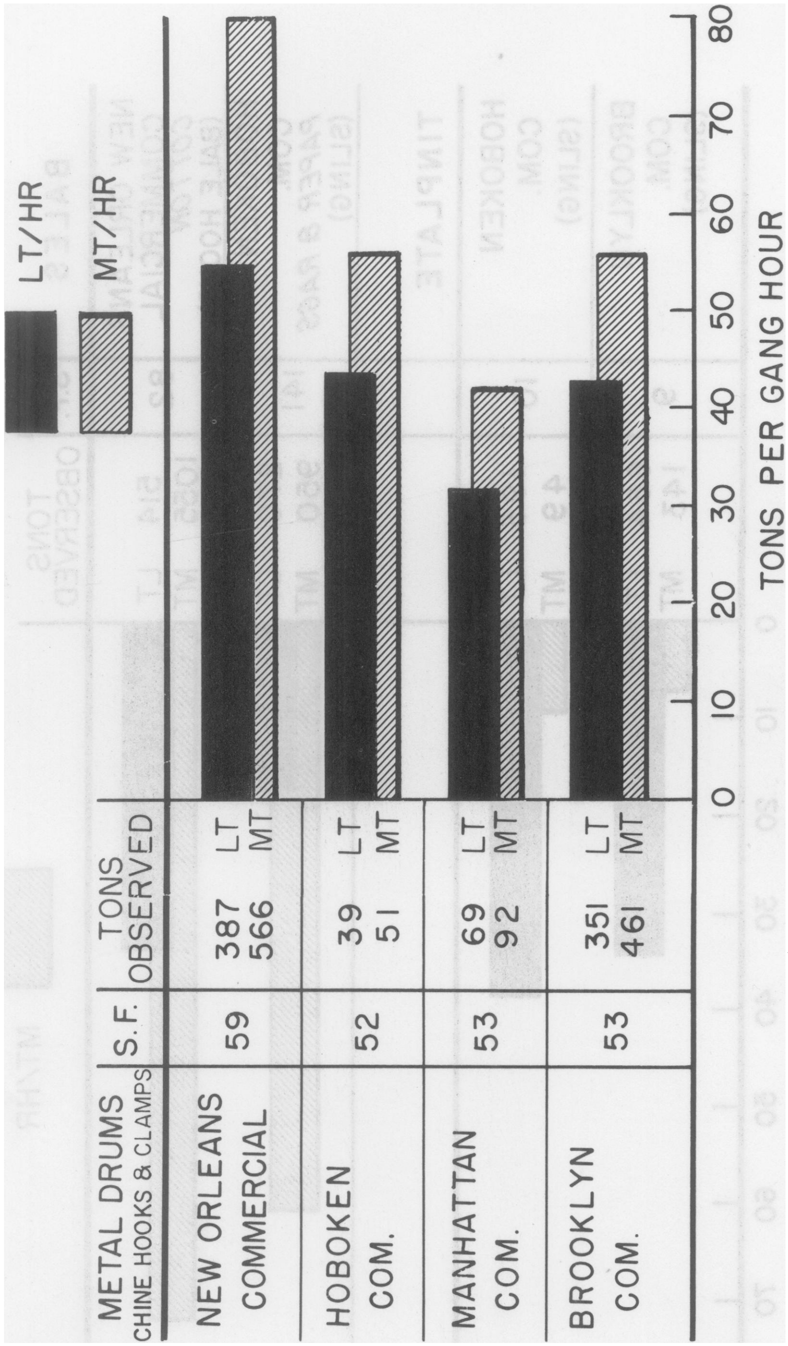


FIGURE 4
Weight and Measurement Loading Rates for Drums
(Handled with Chime Hooks or Clamps)

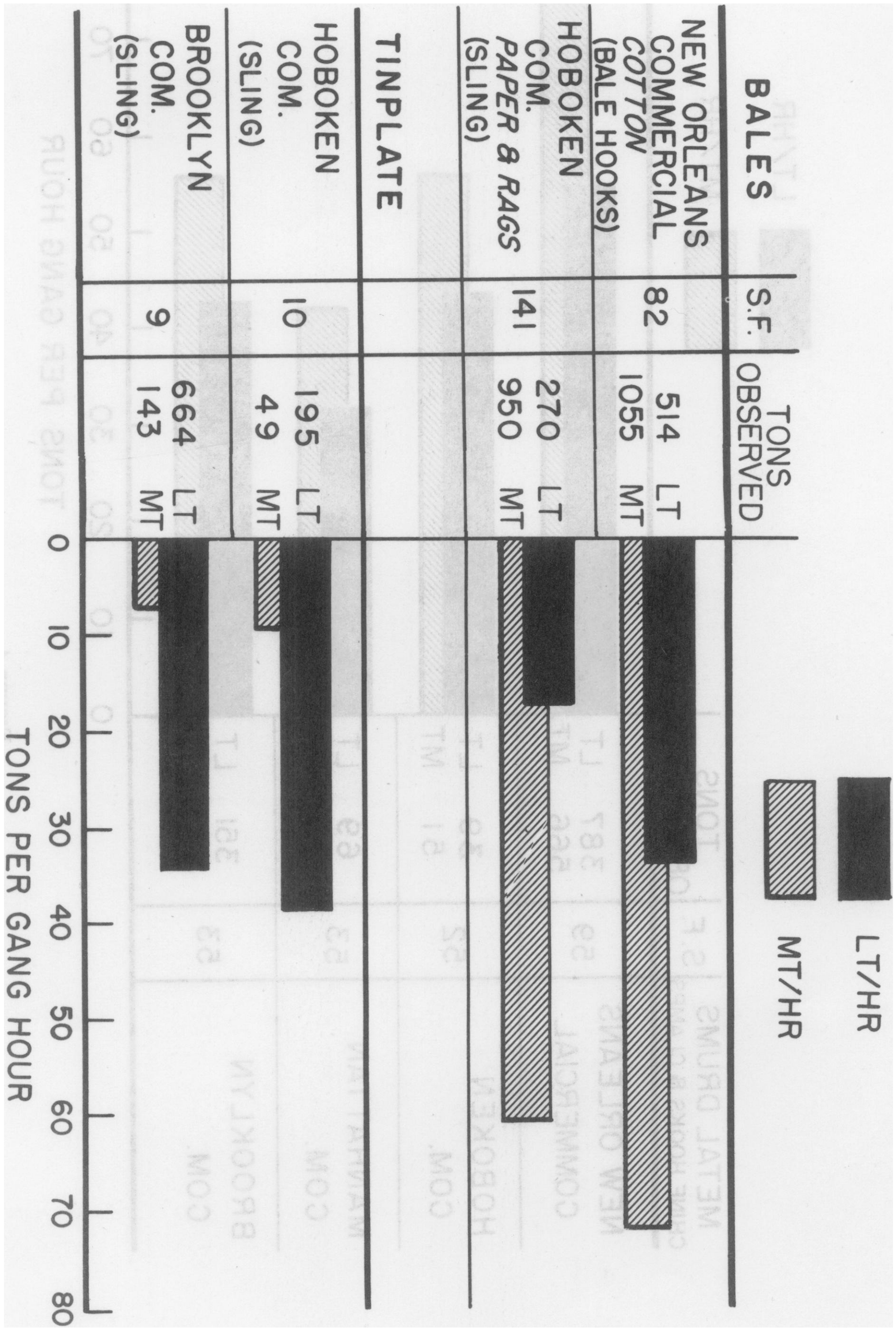


FIGURE 5
Weight and Measurement Loading Rates for Bales and Tinplate

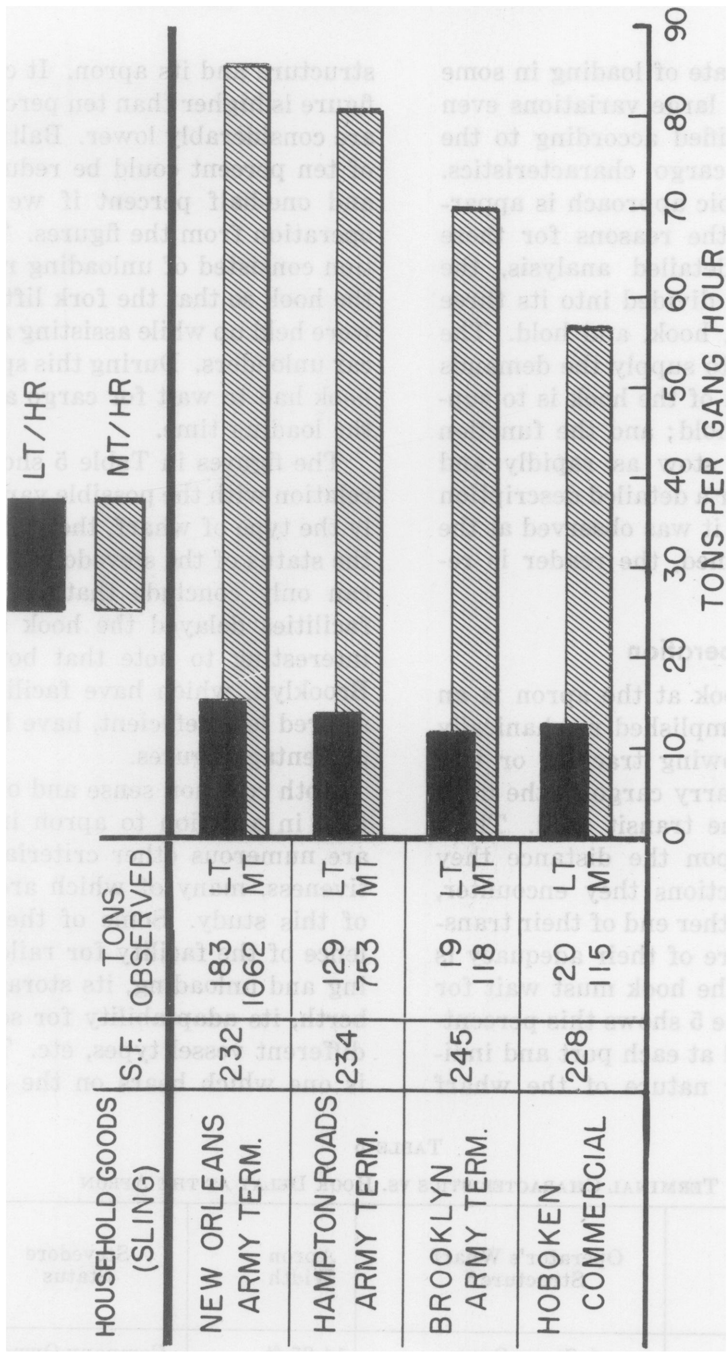


FIGURE 6
Weight and Measurement Loading Rates for Household Goods (Handled by Sling)

Section IV

THE LOADING PROCESS IN DETAIL

Having looked at the rate of loading in some detail, we have observed large variations even when the data are classified according to the handling methods and cargo characteristics. The need for a microscopic approach is apparent if we wish to find the reasons for these variations. For more detailed analysis, the loading process has been divided into its three component parts: apron, hook, and hold. The function of the apron is to supply the demands of the hook; the function of the hook is to supply the demands of the hold; and the function of the hold gang is to stow as rapidly and efficiently as possible. For a detailed description of the loading process as it was observed at the various terminals examined, the reader is referred to Appendix IV.

Apron Operation

The feeding of the hook at the apron is an operation generally accomplished mechanically by use of two trailer-towing tractors or two fork lifts. These units carry cargo to the hook from storage bays in the transit shed. Their effectiveness depends upon the distance they must travel, the obstructions they encounter, and delays incurred at either end of their transits. The primary measure of their adequacy is the percentage of time the hook must wait for cargo at the apron. Table 5 shows this percentage for all cargo covered at each port and indicates the corresponding nature of the wharf structure and its apron. It can be seen that no figure is higher than ten percent and most ports are considerably lower. Baltimore's high figure of ten percent could be reduced to about eight and one-half percent if we remove a special operation from the figures. This special operation consisted of unloading rail cars directly to the hook so that the fork lifts serving the hook were held up while assisting and waiting for the car unloaders. During this special operation the hook had to wait for cargo about 40 percent of the loading time.

The figures in Table 5 show no rational correlation with the possible variables listed, namely the type of wharf, the width of the apron, or the status of the stevedore. From this table one can only conclude that none of the terminal facilities delayed the hook significantly. It is interesting to note that both Manhattan and Brooklyn, which have facilities generally considered least efficient, have lower than average percentage figures.

Both common sense and observation indicate that in addition to apron induced delay there are numerous other criteria of terminal effectiveness, many of which are beyond the scope of this study. Some of these are the convenience of the facility for railcar and truck loading and unloading, its storage space per vessel berth, its adaptability for serving all hooks on different vessel types, etc. The latter criterion is one which bears on the assumption that in

TABLE 5

TERMINAL CHARACTERISTICS VS. HOOK DELAY AT THE APRON

Port	Operator's Wharf Structure [1]	Apron Width	Stevedore Status	% of Loading Time Hook Waits for Cargo at Apron (for All Cargo Observed)
New Orleans Commercial	1-Story Quay	14-25 ft.	Company Owned	3%
Baltimore Commercial	2-Story Modified Pier	14 ft.	Company Owned	10%
Hoboken Commercial	1-Story Double Pier	25 ft.	Company Owned	6%
Manhattan Commercial	2-Story Pier	5 ft.	Contract	2%
Brooklyn Commercial	1-Story Pier	5 ft.	Contract	4%
New Orleans Army Terminal	1-Story Quay	25 ft.	Contract	7%
Hampton Roads Army Terminal	1-Story Double Pier	28 ft.	Contract	4%
Brooklyn Army Terminal	2-Story Double Pier	5 ft.	Contract	3%
All Ports Covered	————	——	————	5%

[1] Terms as defined by Bryan, L. A., *Principles of Water Transportation*, Ronald Press Co., New York, 1939.

the break-bulk loading of packaged cargo, no one hook interferes with another, even in the case of double rigged hatches. This is supported by most observations in this study.

Conclusion

In all observed loading operations, whether at modern or outmoded facilities, there is no indication that the terminal has induced delays in the delivery of cargo to the hook, so that the loading operation was slowed to a significant extent (more than ten percent). This is not intended to imply that poor terminal facilities might not have a more adverse effect, percentagewise, if loading rates are improved; nor is it intended to imply that these facilities should not be modernized for other reasons.

Hook Operation

The hook operation refers to the means generally used to move cargo from the apron into the hold. The conventional married-fall burton system which is the characteristic method of performing this function involves two guyed booms, one of which is adjusted so that its head is directly over the desired hook-up position on the apron. The other is adjusted with its head on the off-shore side of the hatch so that the desired port and starboard positions for receiving cargo in the hatch are directly under a line joining the two boom heads. The off-shore boom may also be positioned over the square of the hatch. The hook to which the cargo draft is attached is controlled by two winches and hoisting cables which run through blocks at the head and heel of each boom and are connected at the hook. By careful coordination of the two winches, a draft of cargo can be lifted off the apron and set down in the hatch at any point directly under a line joining the two boom heads. Positioning of a load in the hatch forward or aft of the line between the heads of the booms is accomplished by a manual swinging of the draft by the hold gang in the direction of stowage. This may also be done by the more time consuming operation of readjusting the boom positions.

The time required for the electric winches generally installed on a C-2 type vessel to move a load from apron to hold under normal conditions is approximately 0.4-0.5 minutes. The time for the empty return trip runs from 0.2 to 0.3 minutes. In addition to its transit time, the hook must spend some time at the apron being hooked up to the load and some time in the hold being positioned and released. This may vary considerably depending on the type of gear used. Certain types of handling gear require additional hook time as in the case of pallets when empty pallet boards must be periodically removed from the hold.

Hook Delays

The determination of the adequacy of hook performance in the loading operation is complicated by many factors. However, as in the preceding treatment of apron operation some conclusions can be drawn from the percentage of time the hook delays the operation it feeds, namely, the hold gang stowing. It is interesting to compare this percentage with the percentage of time the hold gang delays the hook. Table 6 shows that the hold gang waits for the hook, on the average at all ports, more than 40 percent of the time. It further reveals that the hook waits for the hold less than 25 percent of the time. The number of men in the hold gang is shown so that the percentage of hold gang work time can be better appreciated. For instance, in New Orleans commercial data, where loading rates are known to be highest, it is significant that the hook can and does keep 12 holdmen busy 58 percent of the time. Yet in the three New York commercial ports with much lower loading rates (Figures 1, 2, 3, and 4) the hook fails to keep 8 holdmen busy more than 50 percent of the time. This further substantiates the conclusion that hook performance is the primary bottleneck in the loading operation. More detailed study of the fatigue factor is required before we can apply this generalization to New Orleans.

Considering the loading operation as a flow of commodities from the wharf to their final stowage position in the hold, the primary bottleneck is defined as that segment of the operation where the flow is most constricted. This implies that the bottleneck segment must be improved before the rate of flow can be increased. It also implies that improvement in other segments without eliminating the bottleneck will have little effect. Table 6 shows that the probable effect of improving the hook delivery rate would be to provide the hold gang with more work so that they work a larger percentage of the time. If New Orleans figures are rated as peak per-

TABLE 6

WORK AND WAIT TIMES FOR HOOK AND HOLD AS PERCENTAGES OF NET OPERATING TIME FOR ALL CARGO OBSERVED (EAST COAST)

Port	% Net Time Hook Works	% Net Time Hook Waits for Apron	% Net Time Hook Waits for Hold	% Net Time Hold Gang Works	% Net Time Hold Gang Waits for Hook	No. of Holdmen Used
New Orleans Commercial	78%	3%	19%	58%	42%	12
Baltimore Commercial	79%	10%	11%	45%	55%	8 and 12
Hoboken Commercial	90%	6%	4%	38%	62%	8
Manhattan Commercial	81%	2%	17%	50%	50%	8
Brooklyn Commercial	90%	4%	6%	43%	57%	8
Brooklyn Army Terminal	87%	3%	10%	42%	58%	12
New Orleans Army Terminal	72%	7%	21%	47%	53%	10
Hampton Roads Army Terminal	88%	3%	9%	38%	62%	12

formance, it would appear that the other ports can increase substantially the percentage of hold gang work time. A better hook-delivery rate also makes profitable the employment of more men in the hold when stowing units susceptible to manhandling. On the other hand if hold gang productivity is increased by use of machines or by adding more holdmen without increasing hook delivery rate, there will be very little increase in the loading rate. At most, the loading rate will be improved by this method to the extent that the percentage of hook-wait-for-hold time can be reduced. But this value is already very small in most of the ports and can never be completely eliminated.

Table 7 is included to show available information on West Coast loading operations. These results are not entirely comparable with the foregoing East and Gulf Coast results for several reasons. The UCLA data was not separated to distinguish hook-wait-for-hold time from hook-wait-for-apron time. Generally, only one fork lift or tractor-trailer combination was used to feed the hook. Hence the hook-wait-for-apron time may be a significant fraction of the hook wait time unlike the situation on the East Coast where delay at the apron is relatively insignificant. Furthermore a work practice was observed in Los Angeles of utilizing an eight-man split-hold gang by having only two men of each half work on a draft while the other two rest. This is difficult to compare with most East and Gulf Coast operations where usually each half of the hold gang works on every draft it receives. Inherently the use of fewer men on a draft should make the stowing of each draft last longer thus increasing the chance of the hook being forced to wait for the hold. In this case it is possible that the hook operation does not fit the bottleneck definition as well as it does in East Coast data, since more efficient use of the hold-gang might bring about a substantial decrease in the hook-wait-for-hold time and hence an equivalent increase in loading rate.

TABLE 7

WORK AND WAIT TIMES FOR HOOK AND HOLD AS PERCENTAGES OF NET OPERATING TIME (WEST COAST DATA)[1]

	% Net Time Hook Works	% Net Time Hook Waits for Apron and Hold	% Net Time Hold Gang Works	% Net Time Hold Gang Is Idle	No. Hold Men Used
Los Angeles	60%	40%	26%	74%	8[2]
San Francisco	59%	41%	64%	36%	8

[1] Adapted from results of UCLA Study.
[2] Working in turn so that only 2 men work on a draft with other two men idle.

It is evident that before more positive conclusions can be drawn from a study of the proportion of work time and wait time, knowledge of the factors affecting productivity during work time must be developed. The productivity performance of the hook is determined by the number of drafts delivered per hour and the amount of cargo loaded on the drafts. Unfortunately, these two quantities are not entirely independent of each other. For example, an increase in draft size may have the effect of reducing the draft rate. For convenience, the two aspects will be considered separately and their interrelationship handled later.

Hook Cycle Studies; Cargo on Pallets

Table 8 compares the draft rates for palletized cargo at the various ports covered. The first column, "capability," shows hook performance without delays. It represents the number of cargo drafts delivered divided by the total hook work time. Wait time for hold and apron has been excluded from hook work time as has time for dunnaging, gear changing, and the housekeeping chores. The second column presents the actual draft rate considering all time spent in loading operations except for dunnaging, gear changing, and housekeeping operations.

The table shows a substantial variation between ports as to both system capability and actual performance in terms of drafts per hour. It also reveals that cargo stowage factor variations are not responsible for the draft rate variation from port to port or even within the sample at any one port. The ships and their equipment were very much the same in all ports. The question arises as to why, for instance, Manhattan should not achieve the same draft rate with palletized cargo as was achieved in New Orleans. One might at least expect the draft rate capability to be approximately the same, but Manhattan's is 40 percent lower than New Orleans commercial.

TABLE 8

DRAFTS PER HOUR FOR CARGO ON PALLETS AND STOWAGE FACTOR COMPARISON

Port	Drafts Per Hour					
	All Cargo on Pallets		Cargo S.F. 60 or Less		Cargo S.F. Over 60	
	Capability[1] Drafts/ Hr.	Actual Drafts/ Hr.	Actual Drafts/ Hr.	% Inc. or Dec.	Actual Drafts/ Hr.	% Inc. or Dec.
New Orleans Commercial	51	40	41	+3%	38	–5%
Baltimore Commercial	42	34	30	–13%	35	+3%
Hoboken Commercial	31	27	24	–11%	29	+7%
Manhattan Commercial	30	24	25	+4%	21	–13%
Brooklyn Commercial[2]	18	17	14	–18%	19	+12%
New Orleans Army Terminal	56	37	38	+2%	37	–½%
Hampton Roads Army Terminal	32	23	Insuff. data		23	—
Brooklyn Army Terminal	36	34	Insuff. data		34	—

[1] Capability is hook performance exclusive of delays.
[2] Sample represents mostly deep tank stowage and is not considered typical.

Figure 7 shows, for all palletized cargo at each port, the average length of time for the various components of the hook cycle and the corresponding components of the cycle for each half of the hold gang. It is generally the custom to divide the hold gang into two sections. One section generally loads on the port side of the hatch and the other section loads on the starboard side. The hook customarily feeds each section alternately. Thus, on Figure 7 at zero time, the hook is assumed to be delivering a draft to the port hold gang section. The port section immediately commences to unhook and stow the draft. In the meantime, for time period number 1, the hook deposits its load and remains in the hold to be unhooked and to pick up empty pallets if necessary. For time period number 2, it returns to the apron. For time period number 3 it deposits empty pallets at the apron and is hooked up to another draft. For time period number 4, the hook carries the load to the starboard hold gang section which in most cases has been waiting. Hook delays in waiting for cargo or in waiting for the hold gang are accumulated at the end of the cycle although they may occur within any of the four time periods. The apparent contradiction of the hook waiting for the hold while the hold waits for the hook is explainable partly because of the effect of averaging. Even though the hold gang sections wait for the hook on most drafts there will always be some drafts on which stowing operations are held up and the hook must wait for the hold. There is still some possibility of both hold and hook waiting for each other on the same draft. If, for instance, the hook

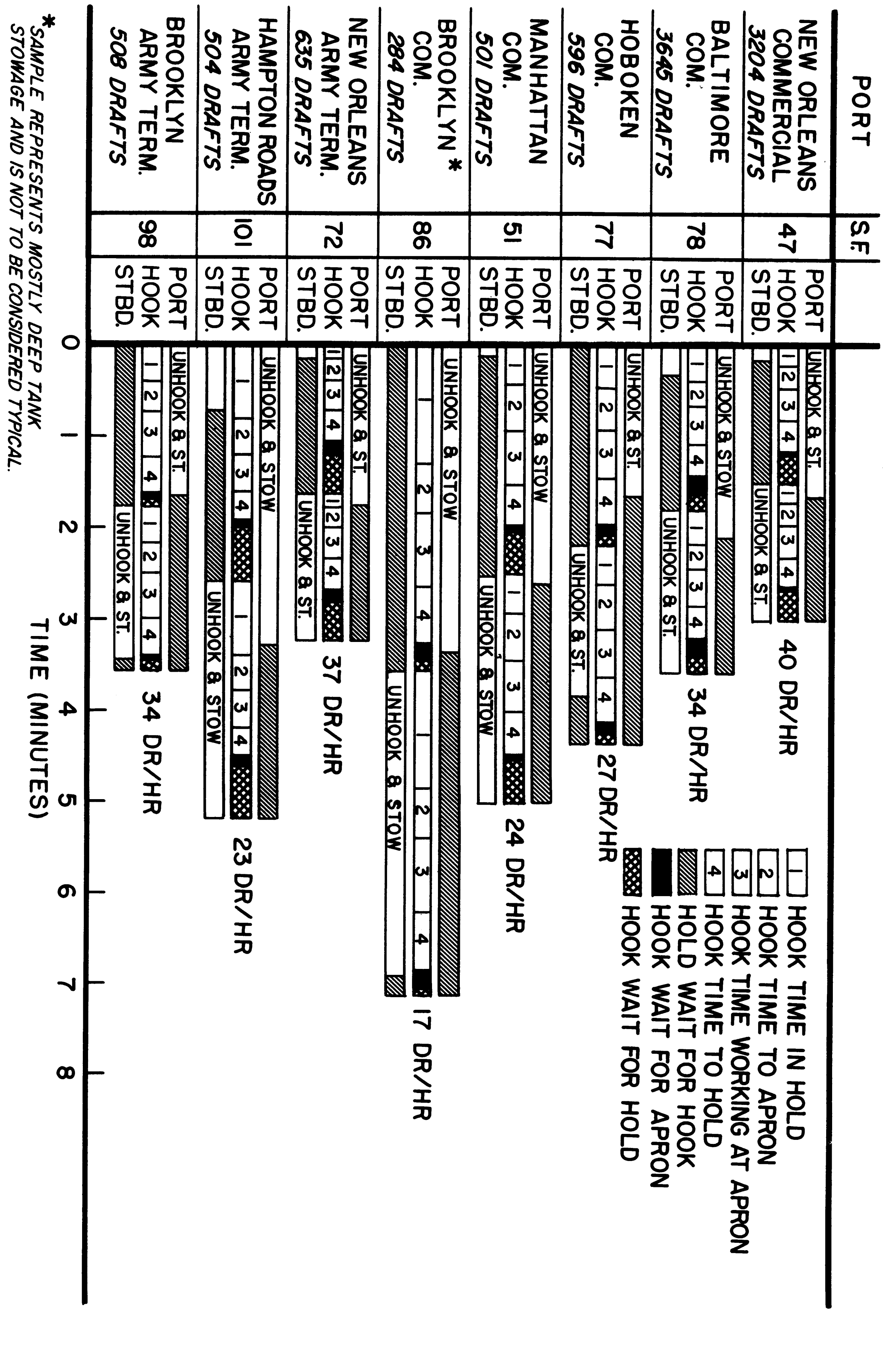


FIGURE 7
Average Hook and Hold Cycle Times for All Cargo On Pallets

has been held on deck waiting for the hold gang to finish stowing, the hold gang must then wait until the hook reacts and the draft is lowered into the hatch.

Figure 7 shows, for cargo handled on pallets, the same large fraction of hold-wait-for-hook time as observed previously for all cargo in Table 6. It again points out that the hook waits for hold and apron for only a small fraction of its average cycle at all ports.

A comparison of the component segments of the hook work cycle is presented in Table 9. It is interesting to note that both the hook transit segments (2) and (4) are substantially greater in the three New York area commercial ports than in the other ports. The operation of the winches to a large extent controls gang-hour productivity. It is essential that the hook be moved as rapidly as the capabilities of the equipment and the demands of safety permit.

It may be quite significant that in New Orleans operations where the hook work cycle time is lowest, the two cargo winches are operated by a single operator rather than by two operators as required in other ports studied. The Baltimore results indicate that this explanation cannot account for all of the difference between New York and New Orleans. In Baltimore the winches are handled by two winch operators. Although the Baltimore hook work cycle is significantly larger than the New Orleans hook work cycle, it is not nearly so great as the New York hook work cycle.

In the New York area, with the exception of Brooklyn commercial operations, there is no evidence of an unfavorable bias in the data since the nature of the tasks performed and transit distances were much the same. In addition, a careful study of average transit times (segment 2 and segment 4) in Baltimore under identical conditions shows a negligible increase in transit time of only about 0.02 minutes when loading the same commodity in a lower hold of a C-2 as compared to an upper-tween deck. This small difference indicates that most of the hook transit time may be consumed in acceleration and deceleration of the load and not in the straight hauls in between. Thus, installation of faster winches is not likely to result in an appreciable reduction in hook transit time.

Table 9 also shows that the hook spends more time on the apron in New York area ports than in other ports. This is somewhat surprising since the New York commercial operations were the only commercial ones studied where four men instead of two are actually utilized on the dock for hooking up pallet loads. The narrow aprons in Manhattan and Brooklyn facilities might be considered a cause of this phenomenon if larger work-at-apron times were not also demonstrated in the Hoboken data where the apron width is 20 feet or more.

In column 1 of Table 9, the hook time in hold figures for New Orleans Army and commercial terminal data are significantly lower than at other ports. If these approximations are correct, in view of the assumption in Note 1, Table 9, there is room for considerable improvement in this interval at other ports. Careful spotting of the load for the convenience of the hold gang or for fore and aft segregation of the cargo may be responsible for some of the higher figures. There is no apparent explanation for the

TABLE 9

COMPARISON OF TIME SEGMENTS OF AVERAGE HOOK WORK CYCLE FOR CARGO ON PALLETS

	(1) Min. in Hold	(2) Min. to Apron	(3) Min. working at Apron	(4) Min. to Hold	(5) Min. total Work Cycle
New Orleans Commercial[1]	0.20	0.25	0.35	0.35	1.15
Baltimore Commercial	0.39	0.25	0.43	0.35	1.42
Hoboken Commercial	0.44	0.47	0.52	0.52	1.95
Manhattan Commercial	0.42	0.50	0.59	0.47	1.98
Brooklyn Commercial[2]	1.28	0.54	0.81	0.64	3.27
New Orleans Army Terminal[1]	0.13	0.25	0.33	0.35	1.06
Hampton Roads Army Terminal	0.79	0.40	0.40	0.32	1.91
Brooklyn Army Terminal	0.40	0.32	0.49	0.41	1.62

[1]Data collection forms used at New Orleans did not define the details of the hook work cycle as clearly as subsequent forms at other ports. The figures at New Orleans have been obtained by assuming that the hook time to apron and time to hold was the same in New Orleans as in Baltimore. These hook transit segments could not have been much longer in New Orleans or they could not have been contained in the accurately measured total work cycle time.

[2]Sample represents mostly deep tank stowage and is not to be considered typical.

significantly large hook time-in-hold figure for Hampton Roads.

The methods of taking data may be responsible for some inconsistencies in the values for segment 1. In determining hook work time, all hook time-in-hold has been considered work time. For the most part, this has been observed to be true. However, the winch operator has occasionally been observed to rest an empty hook in the hold in anticipation of a wait elsewhere in the next cycle or in an effort to pace the operation. In most cases, efficient operation demands that the hook continue as far as it can go on its cycle so that if it must wait, it can be as near as possible to where it is needed. There is no reason for the empty hook tarrying in the hold because the hold gang is held up. The hook should transit to the apron, pick up the next draft and then wait on deck if necessary. Thus when the hold gang is ready, the time lag before cargo can be delivered is a minimum. Indeed, if the hook is performing its function well, it should frequently be loaded and waiting on deck for the hold gang.

Hook Cycle Studies; Special Commodities

So far little has been said about the effect of different types of nonpalletized cargo and different types of handling gear on the hook cycle components. Figures 8, 9, and 10 show for certain special commodities a detailed breakdown of the hook cycle as presented previously for cargo on pallets.

Figure 8 shows the different hook cycles for drums handled by drum clamps and chime hooks. Both of these devices make possible the handling of the drums aboard ship without pallets. The drum clamps, working on the ice tong principle, lift six drums off a standard pallet and deposit them on end in the hold. The chime hooks pick up 6 drums with hooks individually engaging the chimes at the ends of each drum. The drums must be on their sides when picked up and are delivered in the same direction. This requires additional manpower on the apron to place the drums on their sides. Since drums are easily rolled, they may be quickly stowed at considerable distances from where the hook delivers them without the need for wagons, dollies, or conveyors.

The numbers of drafts per hour for metal drums handled by special gear are significantly higher in three of the four ports shown (Figure 8) than the drafts per hour for cargo handled on pallets (Figure 7). In New Orleans data there is also a large sample of drums handled on pallets where the observed figure of 42 drafts per hour is very close to the average in Figure 7 of 40 drafts per hour for all cargo on pallets. The 10 per cent increase to 46 drafts per hour occasioned by the use of clamps and chime hooks is statistically significant. Proof of the fact that this increase is brought about by a reduction in hook work cycle time is indicated in the hook cycle distribution graphs, Appendix figures A3 and A4.

Most of the Brooklyn data represents stowage in deep tanks. A 49 draft portion of the sample surprisingly went into the lower hold at a rate slightly slower than that for the remainder of the sample which went into the deep tanks. It is apparent that compared to 17 drafts per hour (the rate of deep tank stowage for all Brooklyn cargo on pallets in Figure 7) the rate for the drums with chime hooks is most impressive. This reflects to a large extent the advantage of not having to deal with pallets in the small hatch opening and confined working space of the deep tanks.

The data on the handling of the large wooden vans (100-120 cu. ft.) containing household goods is characteristic of the problems in the use of the wire sling which was universally employed for the operation. Figure 9 shows the cycle components for the three Army terminals where most of this data was obtained and Hoboken commercial operation where only a small sample was available. All of the samples show short hook transit segments 2 and 4 which are no greater than the transit segments for pallet cargo. Segment 3, hook time working at apron, ranges from 0.6 to 0.8 minutes which is significantly greater than the 0.4 to 0.5 minutes characteristic of pallet operations. The problems at the apron of freeing the wire sling and adjusting it properly on the load are sufficient to account for this.

Segment 1, hook time-in-hold, is the interval in which the disadvantage of sling operations is most manifest. Some of this time interval is consumed in careful spotting operations where the large load is pushed into final stowage position in or near the square, or lowered onto rollers for manhandling into the wings. However, much of this time interval is utilized for disengaging the sling from its load. Here the

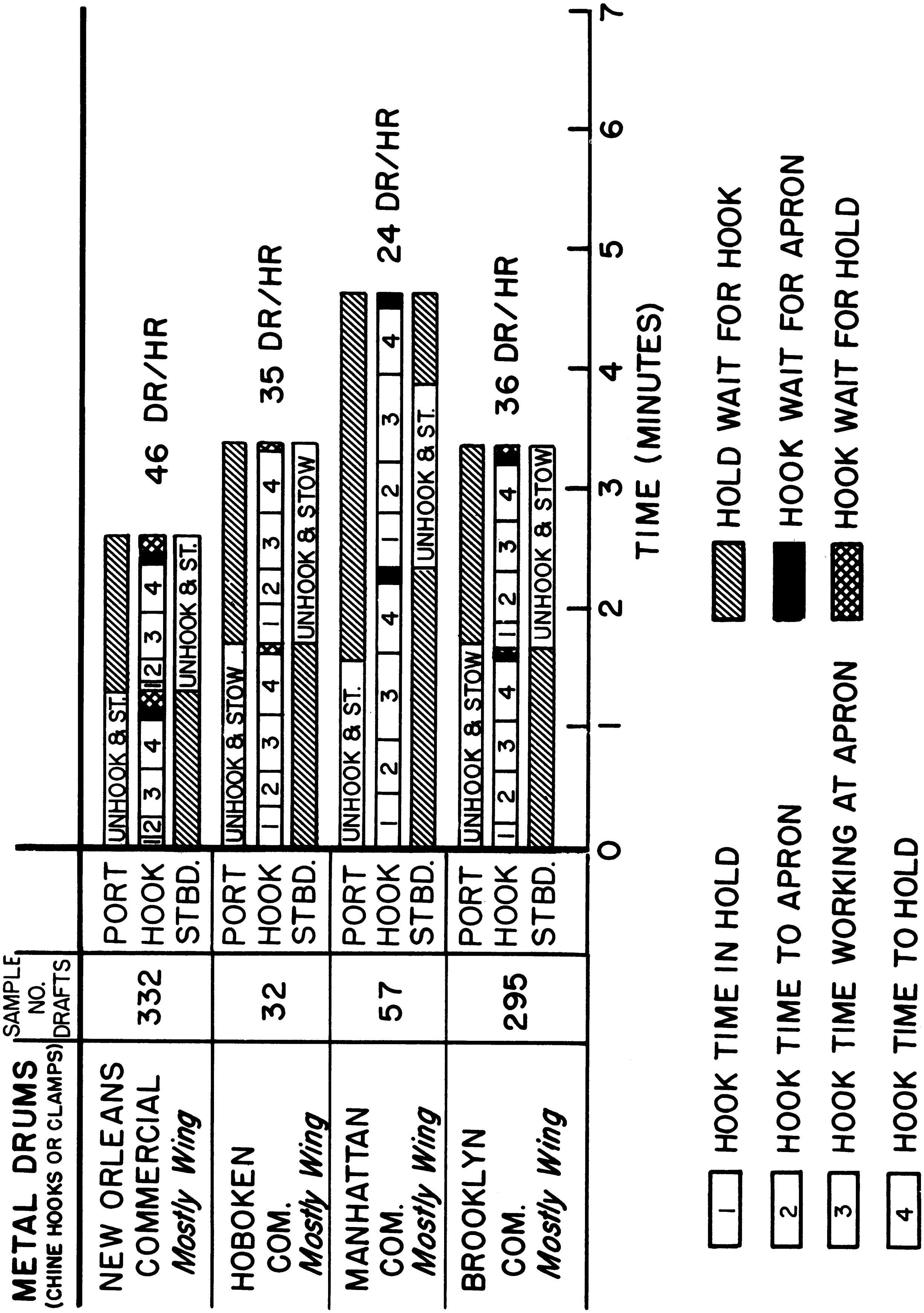


FIGURE 8
Average Hook and Hold Cycle Times for Metal Drums Handled by Special Gear

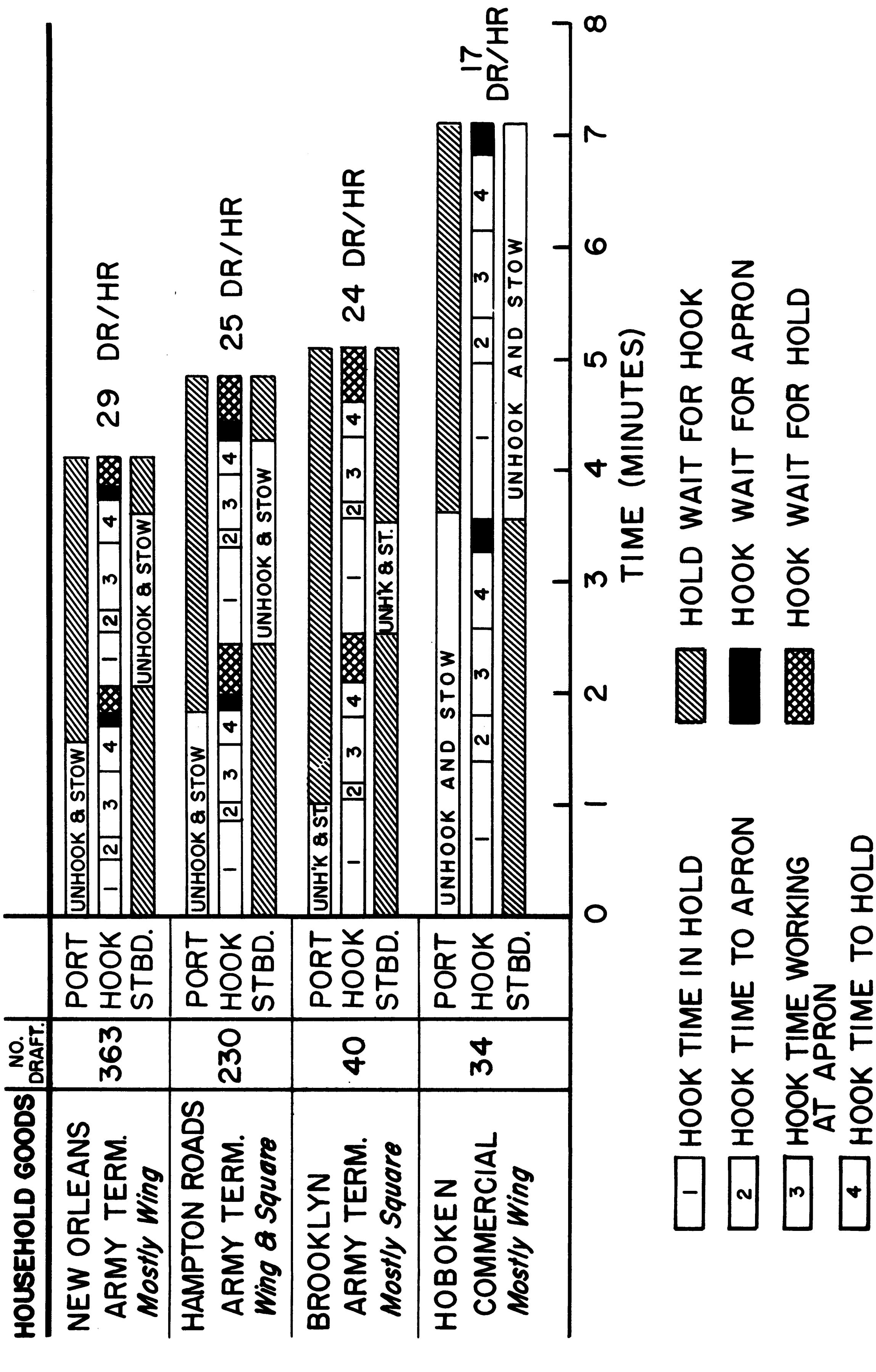


FIGURE 9
Average Hook and Hold Cycle Times for Household Goods Handled by Sling

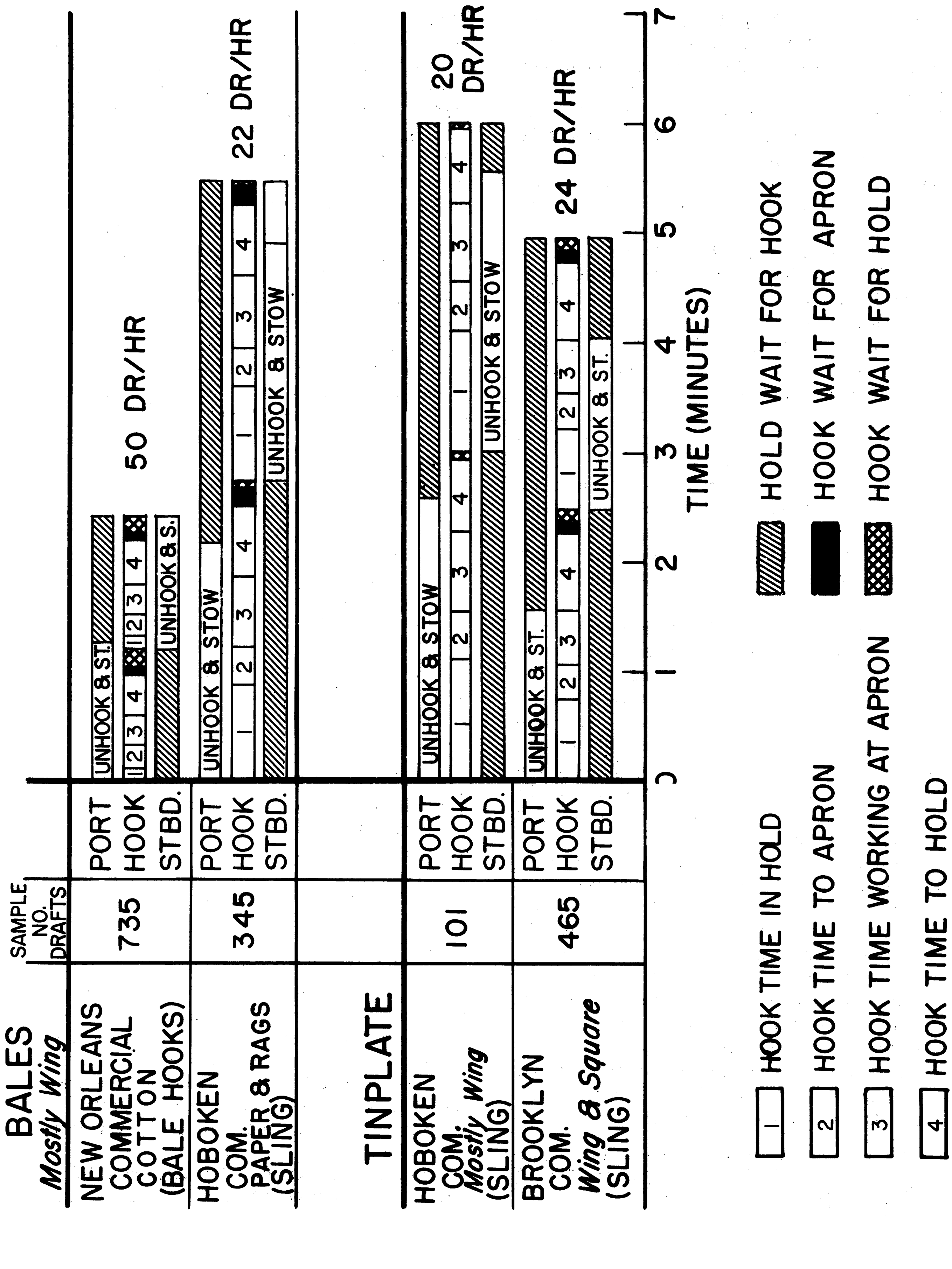


FIGURE 10
Average Hook and Hold Cycle Times for Bales and Tinplate

winch operators are frequently called upon to use the winches to jerk the sling free. The use of fork lift equipment for the handling of these large items in the hold has been seldom observed. The one occasion in Hampton Roads when fork lifts were used resulted in halving the hook time-in-hold so as to cause over a 30 percent increase in drafts per hour. In Hoboken where the amount of household goods being stowed was small, the stevedore might have saved as much as a minute per draft by use of one or at the most two fork lifts in the hold. The half hour saved in the handling of 34 drafts would have been more than sufficient to bring the mechanical handling equipment in and out. There is no doubt that use of such equipment would provide considerable saving in hold gang manhandling effort, thus lessening fatigue and providing for a safer operation. The Hoboken gang, perhaps inexperienced in handling the large vans, required about three and one half minutes per draft to manipulate them into the wings. It must be remembered, however, that saving of time in the hold gang stowing operation, does not affect total output to the extent that the saving in hook cycle time does.

The tinplate cargo in the data samples presented in Figure 10 consisted of one ton bundles of flat plates on skids. These were delivered by sling and generally handled by fork lift when stowed in the wings. The observed draft rate for this cargo in Hoboken is held down by a series of 31 drafts in which a fork lift was not used in stowing the wings. Instead, the drafts were dragged or snaked into the wing by a winch from an idle adjacent rig. Because of the increased problems of spotting and disengaging the sling, draft delivery rate dropped from about 36 drafts per hour, which was the average with normal fork lift operations, to 15½ drafts per hour, and the hook was forced to spend over a minute longer in the hold. In the Brooklyn data there is an interesting contrast between hook operations when using fork lifts for wing stowage and when dropping drafts in final position in the square. Brooklyn hooks averaged 37 drafts per hour[1] when serving fork lift stowing operations and stayed in the hold about 0.3 minutes per draft. When depositing drafts in final position in the square, the hook averaged 19 drafts per hour and spent over 1.2 minutes per draft in the hold. This large amount of time-in-hold is again due to draft spotting and the sling disengaging process.

It is perhaps unfair to compare in Figure 10 the handling of 900 pound bales of rags and paper at Hoboken with the handling of 500 pound bales of cotton in New Orleans. The main purpose for the juxtaposition of the two samples is to show what can be done in the hook cycle with special handling equipment for special cargo. The New Orleans commercial bale hooks pick up three bales of cotton much as three blocks of ice would be picked up with three pairs of ice tongs. The hook time in the hold is practically negligible. The hook's cycle time of nearly 3 minutes per draft in Hoboken might have been substantially reduced by use of gear better adapted to the cargo.

It is apparent that, in the handling of special commodities as well as in the handling of pallet cargo, the loading operation is penalized when the hook is utilized to assist the hold gang in stowing cargo. The hook should not be diverted from its main function of transporting cargo from the dock to hold. In certain cases significant gains in hook cycle time can be achieved by use of special hook gear and, where appropriate, by use of fork lifts in the hold.

Draft Size

The rate of cargo delivery is also contingent upon the size of the draft. Size is used here to refer to either weight or volume. It is necessary to consider both cargo weight and volume since for very dense cargo the weight limits the draft size, while for very bulky or non-dense cargo the volume or measurement limits the draft size.

Unfortunately, for presentation purposes draft size and hook cycle time are not entirely independent. An increase in draft size appears to increase the stow time per draft. This makes more probable and hence more frequent the instances in which the hook must wait because the hold is not ready for the next draft. In studying draft size, therefore, hook cycle time cannot be ignored.

Figures 11 and 12 show for cargo handled on pallets the observed effect of hook cycle time

[1]This draft rate figure includes proper time adjustments to remove time lost because of interference by an adjacent rig and to remove hook wait for hold time when only 4 holdmen were available.

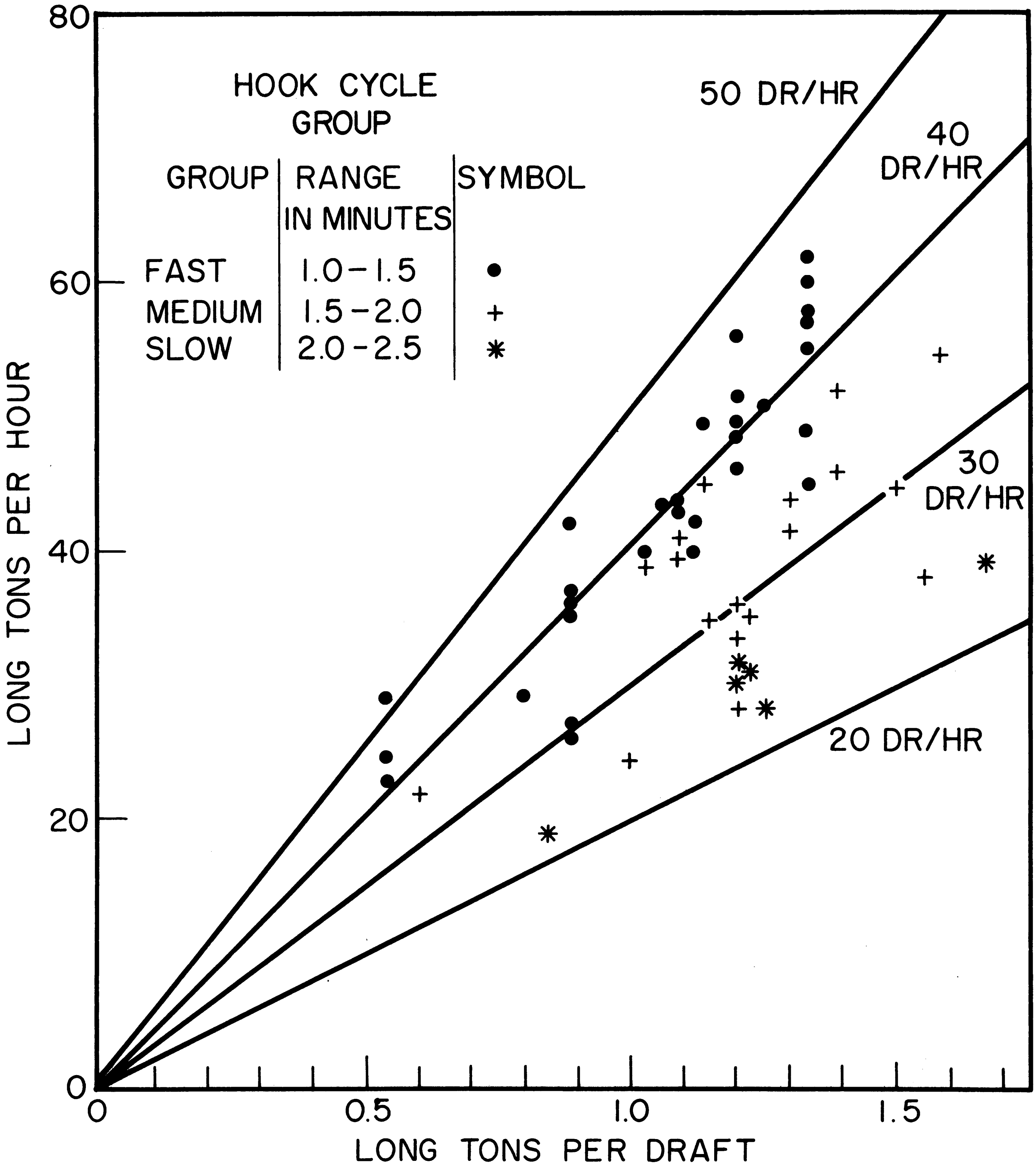


FIGURE 11
Loading Rate Versus Draft Size for Cargo on Pallets with Stowage Factor 60 or Less
Note: The range in minutes refers to the range of time intervals for average total hook cycle minus wait-for-hold.

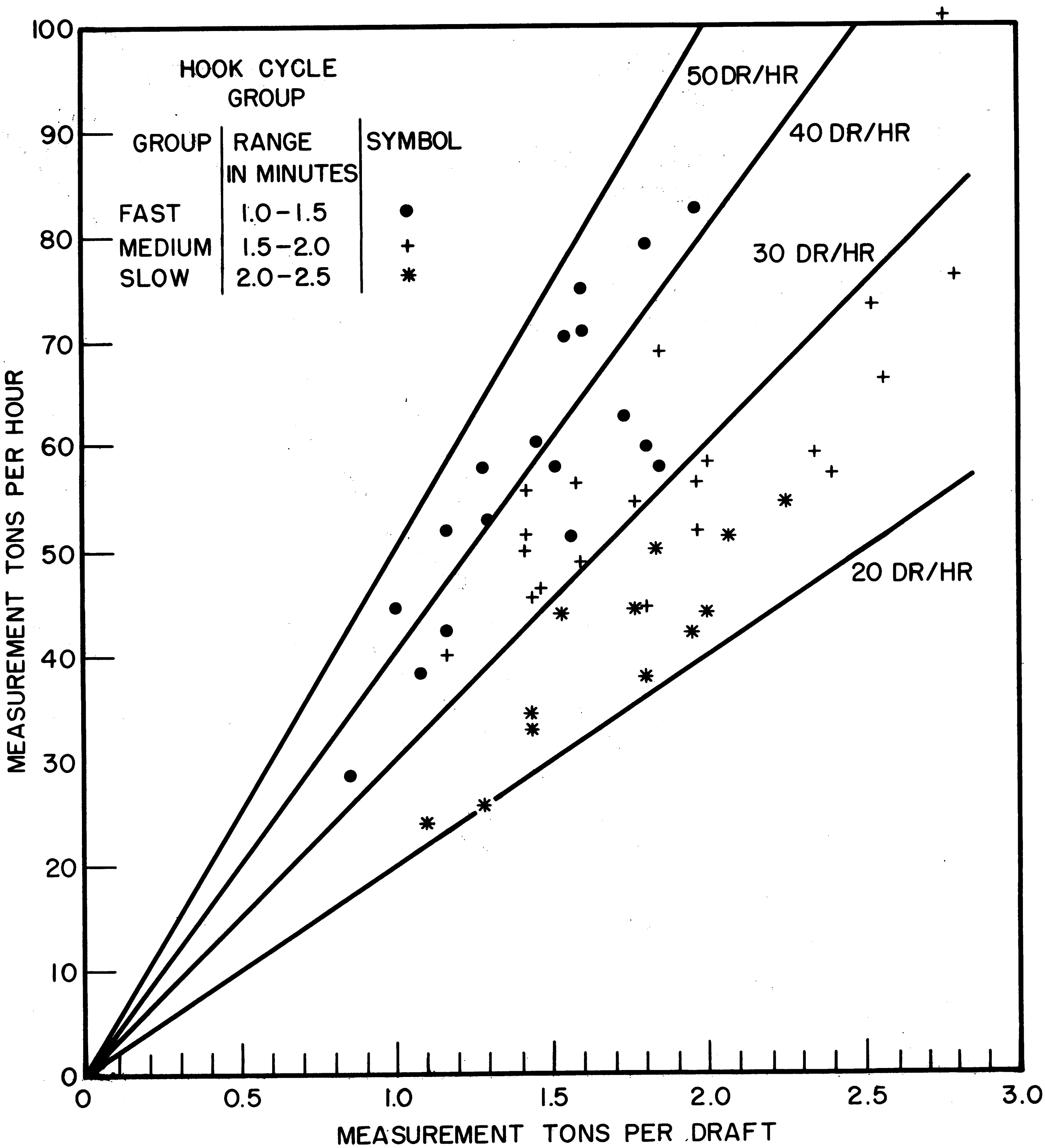


FIGURE 12
Loading Rate Versus Draft Size for Cargo on Pallets with Stowage Factor Over 60

Note: The range in minutes refers to the range of time intervals for average total hook cycle minus wait-for-hold.

and draft size on loading rates for cargo in each of the two stowage factor categories. Each point represents an average of 30 drafts or more and hence has an accuracy of better than 15 percent.[1] Samples have been included from each of the ports covered. The three hook cycle time groups into which the points are coded represent a sorting of the points according to the portion of the hook cycle which is practically unaffected by draft size. This portion is all of the hook cycle except the time spent waiting for the hold. The wait-for-hold time would be expected to vary with draft size because of variations in the time required for the hold gang to stow different sized drafts.

The diagonal lines on each figure represent lines of equal drafts per hour. The positions of the points relative to these lines indicate drafts per hour rates for the points. Thus a point located half way between the 30 drafts per hour and the 40 drafts per hour lines has a rate of approximately 35 drafts per hour. Even without the data these lines show an interesting relationship between the important variables involved. If a stevedore finds he can load one measurement ton drafts at a rate of 30 drafts an hour, he will still gain ten measurement tons per hour in over-all output if he doubles his draft size and thereby causes the draft per hour rate to drop to 20.

It is apparent from the data that increasing draft size, within the range currently employed, does not cause a decrease in drafts per hour sufficient in magnitude to prevent an increase in the loading rate. For example, the stevedore with a fast hook loading one measurement ton drafts at 40 drafts per hour (40 MT/HR) can follow the trend of the dots on Figure 11. If he doubles the size of his load to about two measurement tons he can expect to attain between 60 and 80 measurement tons per hour loading rates. There is little or no indication that he would not get further gains from tripling his draft size to three measurement tons were it possible.

Similarly increasing with draft size are the trends of the crosses which represent a medium speed hook cycle and the stars which represent a slow hook cycle. At two measurement tons per draft the stars reach a level ranging from 40 to 50 measurement tons per hour instead of the 60-80 measurement tons per hour range attained at this draft size by the fast hook cycle data. The difference in loading rate for these two groups measures the penalty incurred by the slow hook cycle group. Similar conclusions can be drawn from the data on cargo with stowage factor less than 60 presented on Figure 12.

Verification for the case of a single commodity was provided in one instance at New Orleans. After loading 97 drafts of bagged fertilizer with 32 bags in each draft, the longshore gangs were ordered by the union delegate to load only 24 bags per draft. The resulting 25 percent decrease in draft size caused a 17 percent decrease in loading rate.

In general it appears that the loading rate for both weight and measurement cargo does not reach a maximum within the range of draft sizes currently employed. This strongly justifies our earlier conclusion that the hook is the bottleneck. If the hold gang were the bottleneck it would imply that the men were receiving ample cargo to keep them busy and that the delivery of more cargo would not result in any significant increase in loading rate. Furthermore the trend of the fast hook cycle group indicates that even New Orleans has something to gain by preventing occasions when draft size is small. A study of draft size distribution reveals that all ports load a great many drafts which are well below the size limits which custom or safety impose. Figure 13 shows histogram distributions of draft size for cargo on pallets as sampled in each port. The samples are divided into the two basic stowage factor categories. For drafts of cargo with stowage factor less than 60, the graphs show the percentage of the port sample in each one-tenth of a long ton per draft interval. Weight is plotted in this stowage factor category because it is the limiting characteristic. For drafts of cargo with stowage factor over 60, the graphs show the percentage of the sample in each one-tenth of a measurement ton interval. In this category measurement is a more limiting characteristic than weight.

It is apparent that while all ports handle a good fraction of their weight cargo (stowage factor less than 60) in drafts weighing from 1.1 to 1.2 long tons there are some drafts weighing more than 1.5 long tons and many drafts weighing less than 1.0 long ton. This suggests

[1]See Appendix III, Accuracy and Precision of Data.

that careful attention to draft weight in the dense cargo category might push the average at any port up 25 percent to about 1.5 long tons per draft without exceeding the maximum weight now in common use. While the safe working load of five-ton booms is not likely to be exceeded before the burtoned load reaches about three weight tons, it is recognized that other safety considerations may apply to keep the load smaller. The cargo may be of such a nature, as for instance, fiber drums, odd sized boxes, and crated machinery that it cannot be safely or conveniently stacked on pallets. However, many types of cargo in this stowage factor category such as bags, regular cartons, and regular boxes should be amenable to stacking up to a reasonable working height, particularly when safety devices such as nets or temporary bands preclude the chance of toppling.

Similarly, pallet capacity is seldom reached when handling bulky low density cargo in the stowage factor category greater than 60. In this instance the draft size is limited by volume so that the size of the pallet becomes a significant factor.

However, a great deal depends upon use of space available. Figure 13 shows that Hampton Roads Army Terminal got more measurement tons on a standard four by six foot pallet than either New Orleans or Brooklyn commercial loaded on larger pallets. There is much reason to believe that any port could average at least two measurement tons per draft of high stowage factor cargo on present four by six foot pallets. It is emphasized again that no compromise should be made with safety and greater consideration should be given to the use of safety devices to prevent toppling. It is also recognized that the shape or irregularity of some cargo prevents stacking on a pallet. In such cases consideration might be given to special types of collapsible container pallets designed to support stacks of units safely.

Pallet Size

Whether an increase in pallet size would result in a faster loading rate is questionable. Indications from the distribution data shown are that the maximum capacity of the present standard four by six foot pallet is seldom utilized in most ports. An increase in pallet size will certainly not significantly improve the situation for cargo in the less than 60 stowage factor category where weight is generally the limiting characteristic.

Some of the disadvantages of utilizing larger pallets were apparent at the Brooklyn commercial terminal surveyed, which was experimenting with five and one-half by seven and one-half foot pallets weighing nearly 400 pounds. It was observed that these pallets were difficult to handle. They could not be stacked aside from the receiving position in the hold and thus the hook was called upon to remove empty pallets almost every load. This contrasts with the case of the smaller standard pallet which may be stacked aside so that the hook must be delayed only once every six to eight cycles for pallet stack removal. Further problems were encountered when maneuvering the large pallets into the small deep tank openings and in the crowded space below. The results of the data taken indicate that the extra time required for handling the larger pallets was enough to negate the advantage of having more cargo on the draft. However, it is quite possible that simple improvements in handling techniques and pallet design may make the bigger pallets pay for themselves handsomely. The foresight and courage of the stevedore in undertaking such an experiment is highly commendable.

Conclusions

1. In all loading operations observed the hook is the primary bottleneck. Contrary to the opinion of industry officials, the hold gang is not the bottleneck, since it is idle over 40 percent of the time waiting for the hook to deliver cargo.

2. In most operations observed, the hook is not being used at maximum capacity to deliver cargo to the hold. This inefficiency is primarily due to insufficient draft size and unnecessary delays in the hook cycle. It does *not* result from either the inadequacy of the pier apron to feed cargo to the hook or from mechanical limitations in the gear.

The following improvements to the hook operation promise gains in the loading rate up to 50 percent in areas where operation of the hook is least effective and where a 12-man hold gang may be employed:

a. Increase the size of the cargo draft, within the limits of safety.

b. Develop and employ special devices for the handling of uniformly packaged commodities, such as drum chime hooks

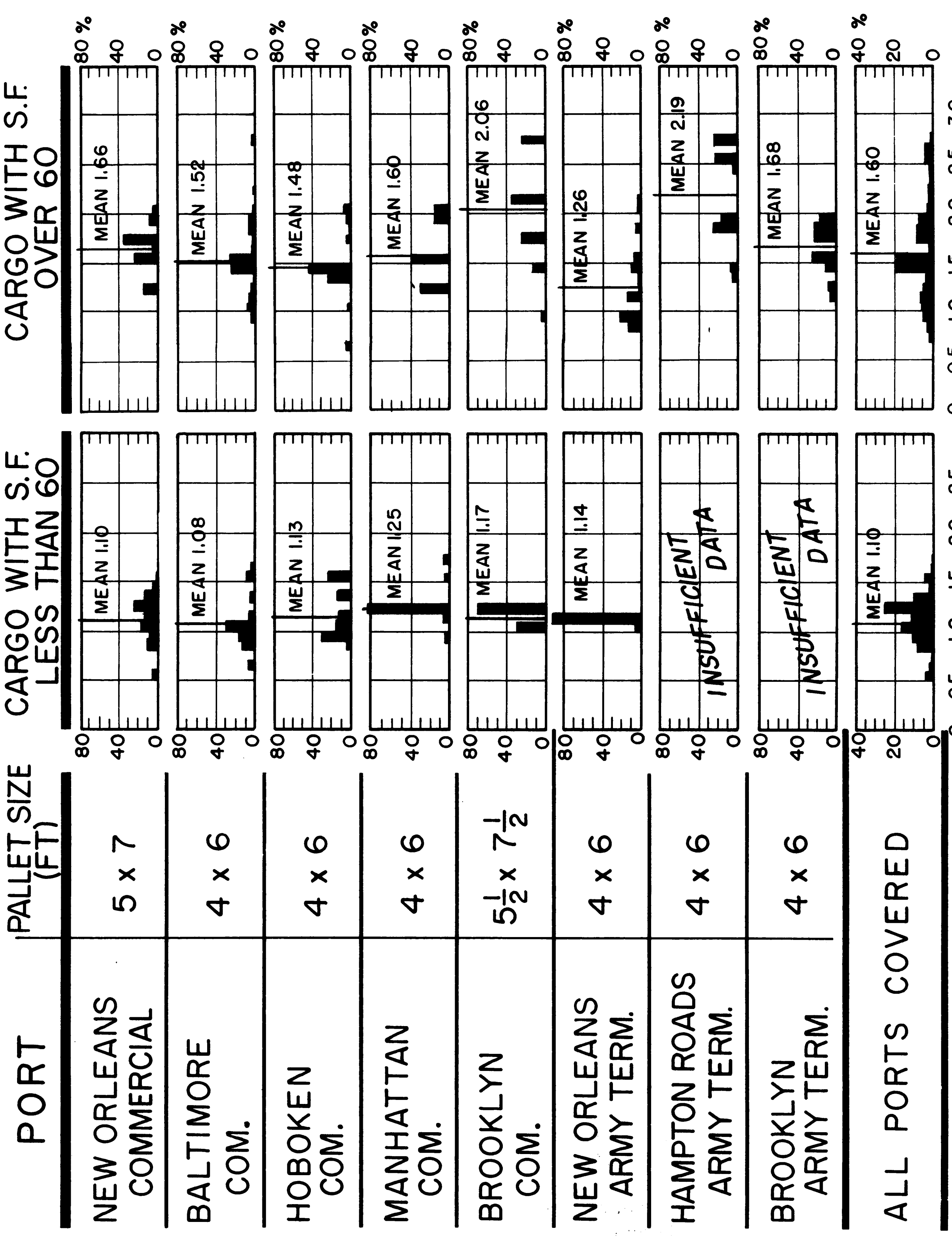


FIGURE 13
Draft Size Distributions for Cargo on Pallets

and bale tongs. Such devices should have the effect of reducing avoidable delays to the hook while picking the load up at the apron and releasing it in the hold.

c. Insure that winches are operated so as to minimize hook transit time.

d. Reduce hook delays introduced by draft spotting which involves swinging of the load into position by the hold gang. This may be accomplished by installation of ship cranes or by modification of the burtoning system so as to facilitate spotting of the draft, as is the intent of Ebel and Farrell burtoning systems. Improvement may also be achieved by development and use of more stowing aids such as wagons or dollies and conveyors. Such devices should tend to make the hold gang less dependent on spotting as a means of reducing the distance between the position where the hook can place the load and where the load is ultimately stowed. This would release the hook to perform its primary function of delivering cargo to the hold.

3. When the hook operation is the bottleneck, use of more men in the hold or of any devices which only improve hold gang stowing productivity will not increase over-all loading productivity significantly. However, devices which reduce fatigue and improve hold working conditions may be highly desirable for longshore morale and safety reasons.

Hold Operation

The function of the hold gang is to stow rapidly and efficiently the cargo delivered by the hook. The over-all productivity of the hold gang is directly related to the rate at which cargo is delivered, the nature of the cargo, the area in which the cargo is being stowed, the number of men in the gang who are actually available to stow cargo, and the type of mechanical equipment used to assist them. As has been pointed out, the current bottleneck in the loading operation is the inability of the present method of hook utilization to supply sufficient cargo to the hold gang. When this deficiency is overcome, the break-bulk operation will be limited only by the factor of the hold gang itself and its ability to cope with the nature of the cargo and the stowage area. Hypothesizing a completely adequate delivery rate of cargo into the hold, the question is, what loading rates can be expected?

The Hold Gang

Three considerations under which the hold gang will be discussed are the following: fatigue, change in the size of the hold gang, and hold gang delaying the hook. In addition, there exists the hypothesis that a fundamental difference exists in longshore labor from port to port. Certain evidence pertaining to this hypothesis was derived during analysis of the basic data, and a discussion of this evidence is given as a corollary following the sections on fatigue and hold gang size.

Fatigue

In break-bulk operations, the hold gang works in short spurts ranging from fractions of a minute to about four minutes on each draft, and then waits for the next draft to arrive. Since the method used in collecting the basic data included a direct measurement of the actual time spent in stowing each draft, and a count of the hold men working each draft, it was possible to compute actual work rates (long tons or measurement tons stowed per hour of actual work time) per man in the hold gang. In addition, the basic data provided a direct measurement of the rest time available to the hold gang. This rest time is the same as "hold-wait-for-hook" time referred to in the section of this study on the hook operation.

Taking over-all port averages, the effect of decreasing rest time on the rate of stowage in long tons, for general cargo with stowage factor less than 60, is shown in Figure 14. Points are given for Los Angeles and San Francisco, as derived from UCLA data; however, West Coast data were not used in statistical computations. Analysis indicates that 70 percent of the change in actual work-rate (see upper curve, Figure 14) can be attributed to the influence of percentage work time. The only apparent reason for this interrelation is a fatigue factor.

The curve and points at the bottom of the graph present the same information in terms of over-all productivity. If a longshoreman works 50 percent of the time at the actual work-rate of eight long tons per work-hour, his over-all productivity is four long tons per hour of operating time.

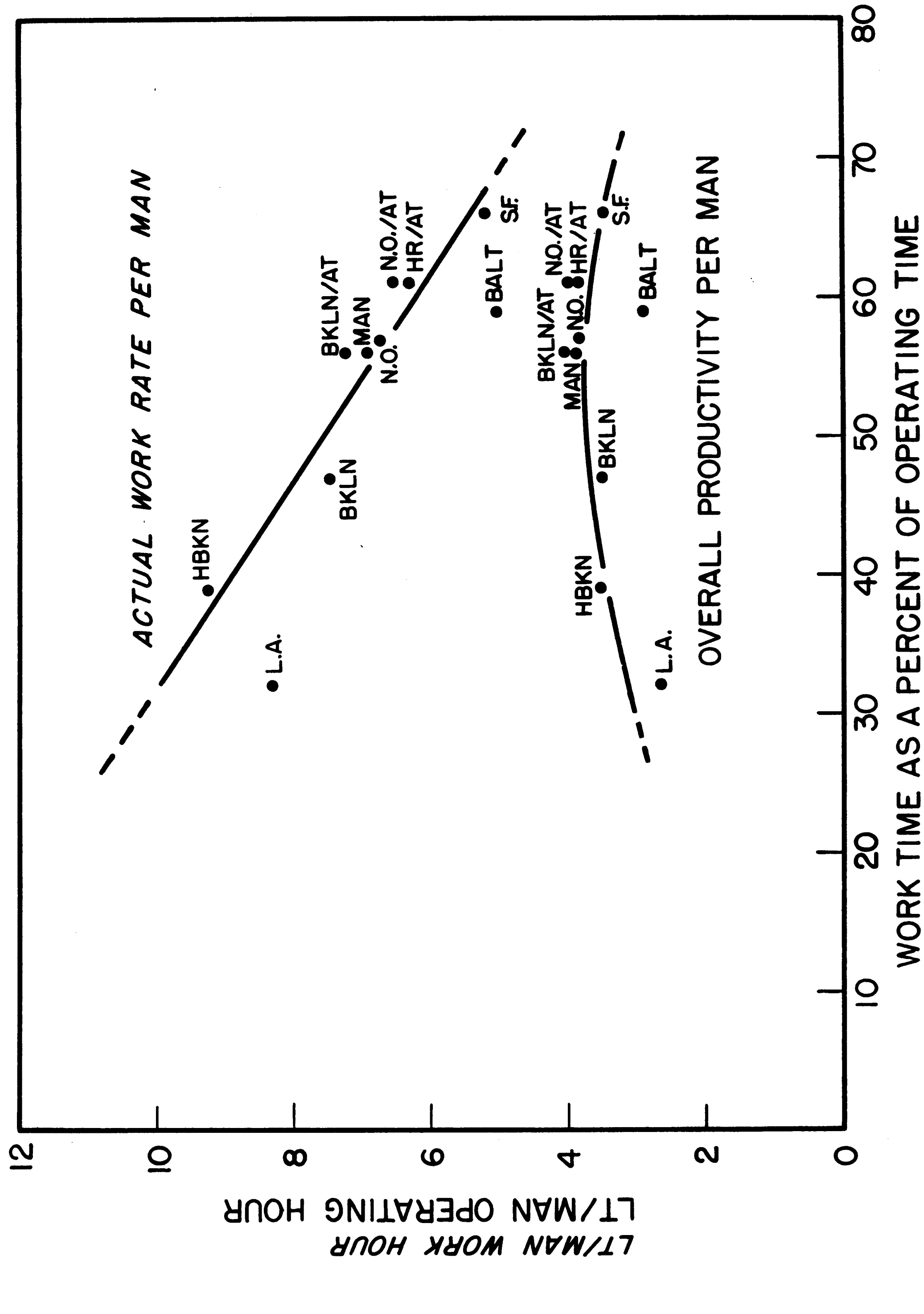


FIGURE 14
Actual Work Rate and Over-All Productivity as a Function of Percent Work Time for Cargo on Pallets, Stowage Factor 60 or Less.
(Los Angeles and San Francisco figures are adapted from UCLA Report 55-2 of the Department of Engineering)

With this evidence on hand of what appears to be a fatigue factor, a further study was made of specific types of cargo for similar effects. The fatigue factor was observed in break-bulk handling of bags, bales, and cartons and boxes up to four cubic feet each. Insufficient data on cartons and boxes above four cubic feet prevented complete analysis, although available data does indicate a similar effect.

The one exception occurred in the analysis of drum stowage. Drums are normally kicked and rolled to place of stow and upended to final stowed position. The energy consumed in carrying the cargo from the square to place of stow is almost totally avoided. Variations in rate of stow are more likely attributable to factors other than fatigue.

Figure 15 shows the fatigue effect in stowage of bags weighing about 100 pounds each, and measuring approximately three cubic feet. In this analysis, any variations due to different commodity characteristics have been removed by maintaining a uniform commodity throughout the sample. Special operations such as blocking out and using wagons to stow in the far wings have also been rejected. The result is an analysis of fatigue in a pure break-bulk operation including both wing and square stowage. The results indicate in this case that 81 percent of the change in work rate per man can be attributed to the variation in the percentage of time the men work. The effect of percentage work-time on over-all productivity as illustrated in Figures 14 and 15 indicates that no decrease in over-all productivity can be expected as work time increases up to about 60 percent. Beyond 60 percent work-time, the data is insufficient to determine whether the trend has definitely leveled off or is falling.

Measurement ton work rates for general cargo with stowage factor greater than 60 reveal a similar effect. However, over-all productivity indicates even less of a tendency to level off as higher percentage work times are reached. Again, insufficient data has prevented analysis of the trend in over-all productivity above 60 percent hold work time.

It must be kept in mind that this analysis of the effects of varying rest times does not refer to a relief system of operation. When the men in the hold gang are relieved for a specific amount of time every hour, instead of obtaining their rest periods in short intervals while the loading operation is going on, the effect may be quite different. This analysis pertains only to operations in which the rest period consists of short waits between drafts.

Hold Gang Size

The hold gang section of the standard longshore gang consists of eight men divided into two teams of four men each. These two teams generally work alternate drafts and stow port or starboard in the hold. The longshore gangs on the Gulf and East Coasts also contain four men designated as dockmen, whose original function was to move cargo to the hook and make up drafts on the dock. However, when these men are not needed on the dock, some or all of them are used as part of the hold gang. The teams in the hold gang then consist of five or six men each.

In analysis of available data no significant difference could be found in work rates per man among the varying hold gang sizes. This indicates that potential hold gang productivity is directly proportional to the size of the hold gang.

In Figure 14, port averages are compared in terms of work rates and over-all productivity per man. It can be seen that the productivity and work rates per man for Manhattan and New Orleans do not differ significantly, although hold gangs usually consisted of eight men in Manhattan, and twelve men in New Orleans. Although productivity per man is comparable for both Manhattan and New Orleans, it is apparent that the productivity per gang is dependent on the number of men in the hold. Since New Orleans uses a hold gang 50 percent larger than the usual Manhattan hold gang, the productivity for the entire gang in New Orleans is 50 percent greater than for the Manhattan gang. The same effect can be seen in the data presented in Figure 15. In this graph, which treats cargo of a uniform nature, points derived from eight-man and twelve-man hold gangs have been indicated. No significant difference can be determined between the per man productivity rates of the eight-man and the twelve-man hold gangs. The peculiar feature that the gangs which worked more than 50 percent of the time were mainly twelve-man hold gangs, demands an explanation.

The original data used in Figure 15 were obtained mostly from Baltimore loadings, and are

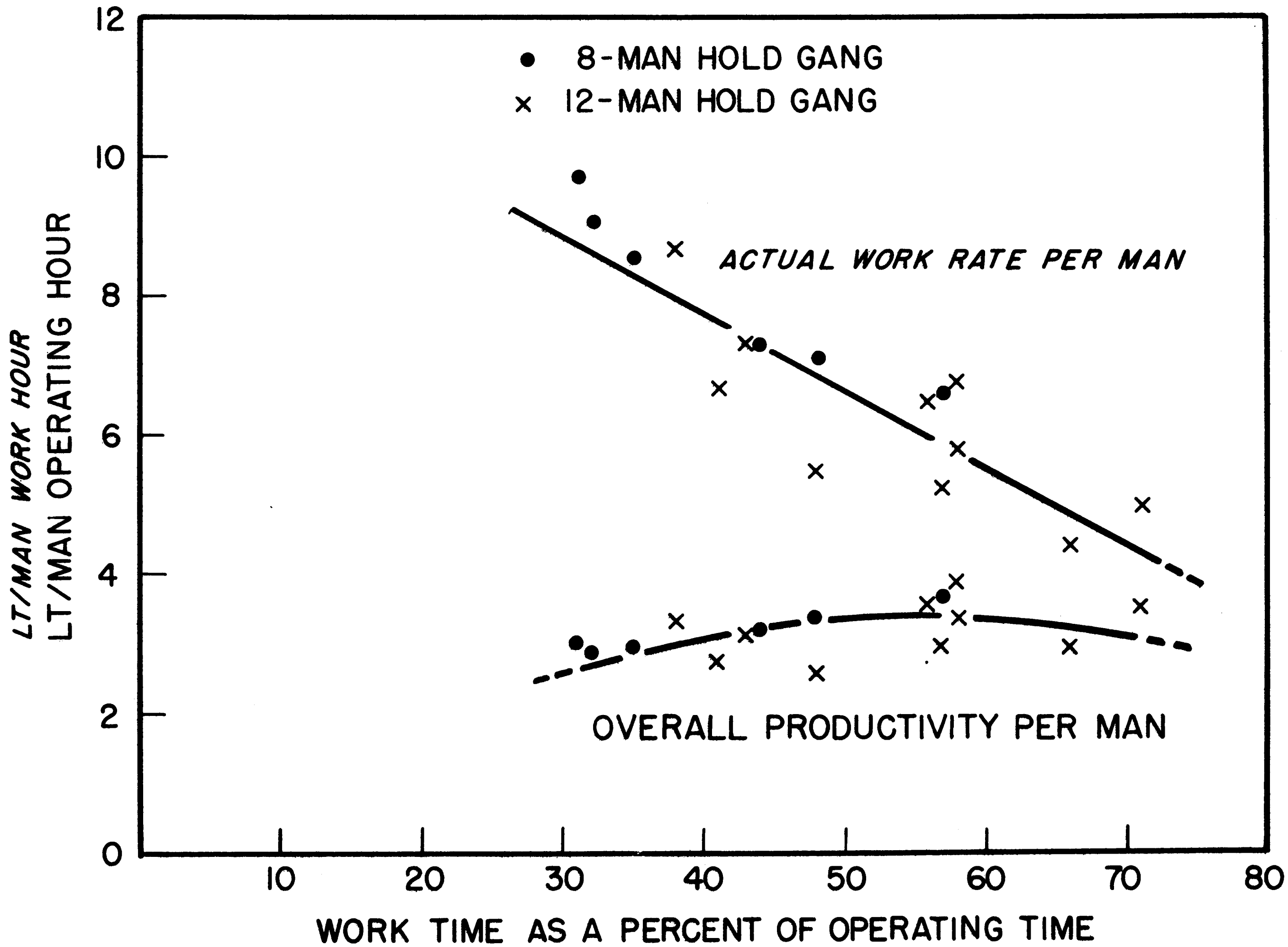


FIGURE 15
Actual Work Rate and Over-All Productivity as a Function of Percent Work Time for Bags.
(S.F. 60-69; 2.8-3.0 cu. ft. each; 93-100 lbs. each)

based on an actual count of men working. When the hold gang consisted of eight men, a special operation was in process on the pier. This special operation consisted of unloading rail cars directly to the hook, so that the fork lifts serving the hook were held up while assisting and waiting for the car unloaders (four dockmen from the regular longshore gang). During this operation the hook had to wait for cargo at the apron about 40 percent of the loading time. When cargo was delivered to the hook directly from the cargo pile, the four dockmen were added to the hold gang. The fork lifts were able to increase the cargo delivery rate to the apron, and take advantage of the increased productivity potential to the twelve-man hold gang.

Conversely, had there been no delay to the hook at the apron when the hold gang consisted of eight men, the increased cargo delivery rate of the hook would have raised over-all productivity by increasing the percent of time the hold gang was working. Obviously, had some measure to increase the cargo delivery rate not been taken when the hold gang was increased to twelve men, the additional men in the hold would only have added to the cost of the operation.

While it can be concluded that, with an adequate cargo delivery rate, productivity will increase in proportion to the number of men added to the hold gang, little can be stated for hold gangs larger than twelve men. Given a limited area in which to work, it can be expected that the optimum size of the hold gang will be limited. However, the data indicates that a twelve-man hold gang is not beyond this limit. It should be noted that this discussion relates only to packaged cargo. Obviously a twelve-man hold gang would not increase the stowage rate of large packages such as household goods particularly when stowed in the square.

Corollary:

Port to Port Variations in Hold Gang Work Rates per Man

Throughout the analysis, no significant difference could be found in the reaction to fatigue of the individual men in the hold from port to port, nor did actual work rates per man vary significantly from port to port for any given type of cargo. With regard to fatigue, for instance, it became apparent that port to port variations in work rates could be explained in the same terms used to explain variations within any one port. In Figure 14, there is no significant difference in actual work rates per man for the various ports, when the effects of fatigue are considered. The difference in work rates given for Hoboken and New Orleans, for instance, is the result of the difference in percentage of work time rather than to any fundamental difference in labor between the ports. The ten percent greater productivity per man in New Orleans as shown in the lower curve on Figure 14, follows similarly from the difference in percent work time. Manhattan, as another example, differs in practically no way from New Orleans with regard to both actual work rates and productivity. If the percentage of work time for Hoboken, Manhattan, and New Orleans were identical, it can be assumed that they would occupy the same points along both the actual work rate curve and the over-all productivity curve. Because of the difference in hold gang size, over-all productivity for the entire longshore gang in New Orleans will, of course, be 50 percent higher than for a gang in Manhattan, provided the hook delivers a proportionally larger amount of cargo. This has been pointed out in the preceding section on hold gang size. In addition, hold gangs of the same size will work at different levels of over-all productivity depending on differences in percentage work time. In this manner, Hoboken, working only 39 percent of the time, was ten percent lower in productivity than gangs of the same size across the river working an average of 56 percent of the time.

The hypothesis that there is a fundamental difference in longshore labor from port to port is not validated from a study of the hold gang. While it is true that over-all productivity for the entire longshore gang varies significantly from port to port, these differences can be attributed to practices limiting draft size and drafts per hour and variations in the size of the hold gang.

Hold Work Delaying the Hook

As the percentage of hold work time to operating time increases, the winch operator finds that he has to delay drafts more often since the hold gang is still occupied with preceding drafts. General practice under these circumstances is to stop the draft on deck until the hold gang can accept it. In instances when the draft is actually stopped, accurate time readings are possible, and the over-all effect can be measured. However, when delays occur very frequently, the winch operator may slow down the transit of each draft to reduce or eliminate the need for an actual stop in his operation. In this case, the delay cannot be measured accurately and may be larger than it should be since the hook may not be on hand when it is needed. Table 10 and Figure 16 are based primarily on measures of actual hook stops and possibly understate hook wait-for-hold, particularly when the hold work time is above 55 percent. Loading operations in the square produce a similar delay in the hook cycle, but for a different reason, and samples of square loading have been eliminated here, for treatment later. The apparent conflict in having the hold wait for the hook while the hook is waiting for the hold is explainable when these statistics are understood as averages. Hold work time and hook cycle time for individual drafts fluctuate widely. Thus, in any particular cycle it is possible for one, both, or neither of these delays to occur. The averages are therefore more indicative of the relative importance of these delays to the over-all operation.

TABLE 10

PERCENT HOOK WAIT FOR HOLD VS. PERCENT HOLD WORK

(All Ports)

Hold work percent	16-25	26-35	36-45	46-55	56-65	66-75
Av. percent hook work for hold	0	4.8	5.4	7.6	13.4	16.4
Standard deviation of average	0	1.5	1.7	1.3	1.8	1.7
Number of samples	4	13	16	25	31	17
Average sample size (drafts)	54	53	50	59	57	48

Table 10 and Figure 16 illustrate this additional limiting factor in the present break-bulk operation. In addition to possible loss of hold-gang efficiency when the gang is working a high percentage of the time, the concurrent delay of the hook may also tend to limit maximum over-all productivity.

Effects of Stowage Area on Hold Gang Work

Certain stowage operations affect the hold gang by varying considerably the amount of work necessary for the gang to stow the same amount of cargo. However, as long as the hook remains the limiting factor in the loading operation, the effects of stowage area on the hold gang may not change over-all productivity. When and if the hook ceases to be the limiting factor, measures to eliminate special time consuming stowing operations in the hold will materially increase the over-all loading rate.

Blocking Out

A blocking-out operation involves lifting cargo and stowing it on top of other cargo in the wing area, generally in confined quarters against the overhead. Without the aid of mechanical handling equipment, the cost of this operation in man-energy and time increases tremendously. Figure 17 illustrates the increased cost of stowing a draft of drums when blocking-out, over normal wing-stowage or square-stowage. In this instance, the hold gang actually became the limiting factor in the loading operation with its work time per cycle increasing to 76 percent. As a result, hook wait-for-hold averaged two-thirds of a minute for each draft (cf. pages 34-35). When blocking out must be done, its adverse effects on over-all productivity are rarely overcome.

Use of Wagons and Dollies

Usually when the area in which cargo is to be stowed is more than fifteen feet from the square, the entire draft can be landed on a wagon or dolly and rolled to the stowage area, with a saving in the amount of energy which would be required if each piece had to be carried over the distance. Inefficiencies in this operation result from the fact that generally the entire team is needed to move the wagon, and work time increases accordingly. Moreover, raised coamings in the 'tween decks make the draft very unstable on the wagon as the draft is pushed into the wings, further increasing the amount of energy required to stow the draft. In addition, the hook may have to wait for a wagon to be positioned to receive each draft. Wagons are more difficult to use effectively on top of cargo already stowed.

Figure 18 illustrates the effect on work time of a wagon operation. Work time increased to 74 percent of cycle time, with a coinciding increase in hook wait-for-hold. It should be noted here that despite considerable variations in the

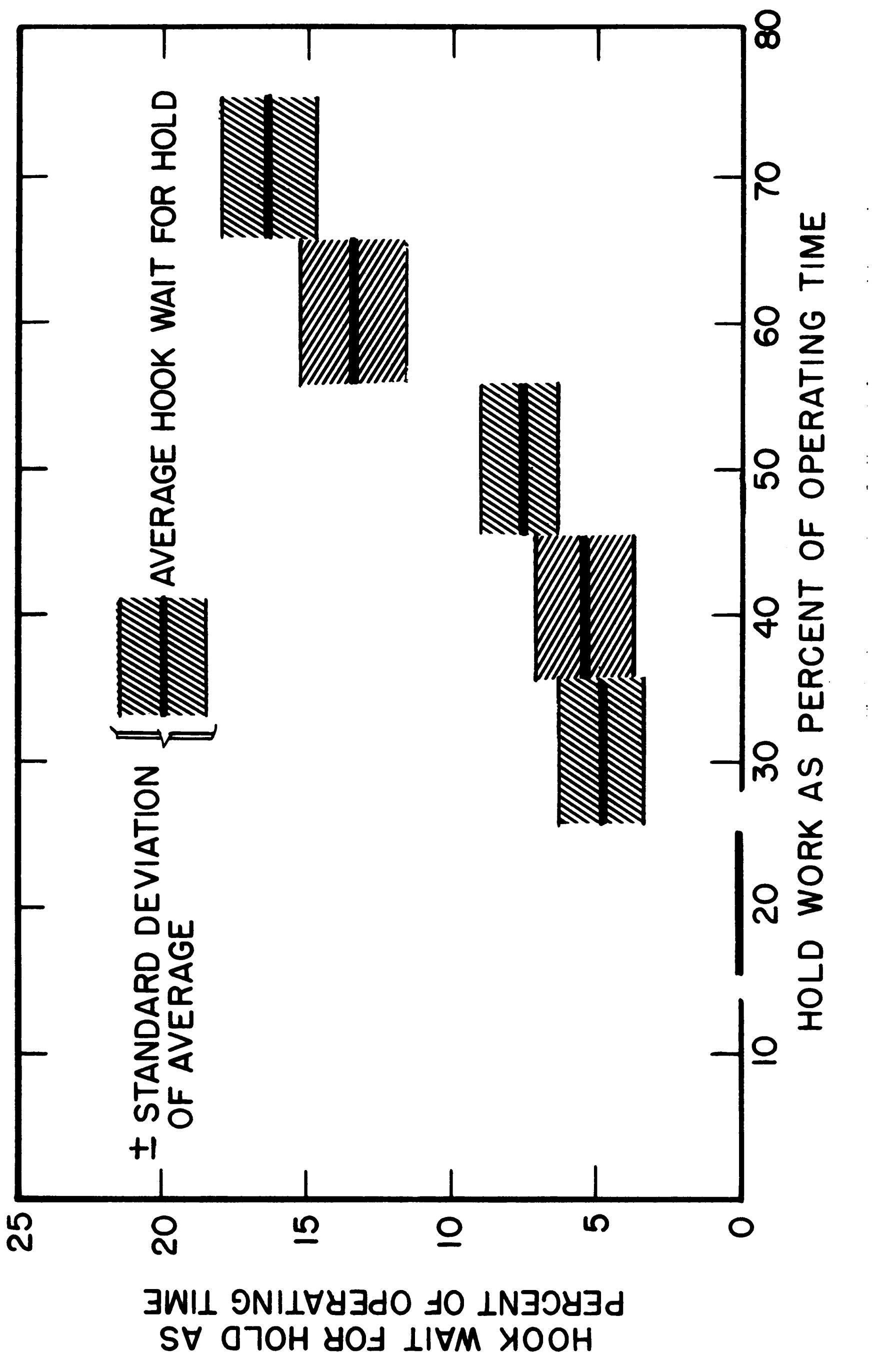


FIGURE 16
Effect of Percent Hold Work on Hook Wait-for-Hold (All Ports)

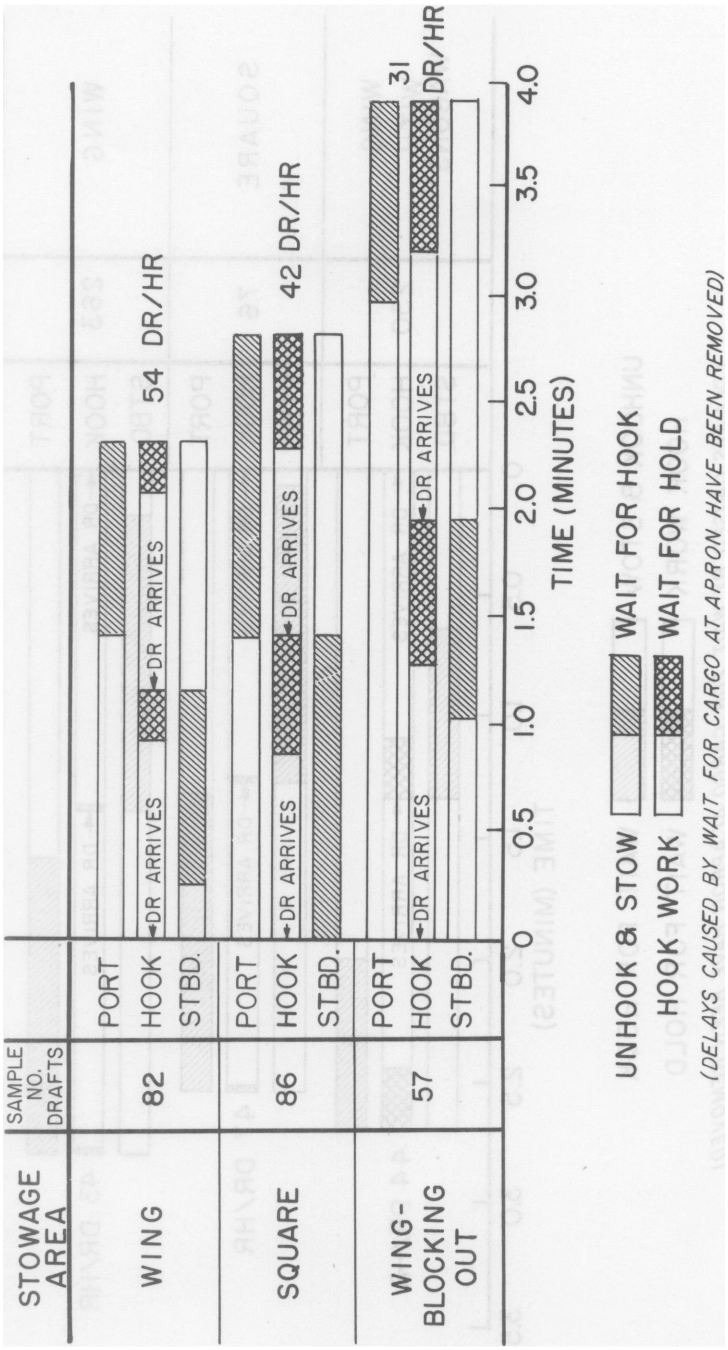


FIGURE 17
Effect of Stowage Area on Hook and Hold Cycles for New Orleans Commercial Drums (6 per Draft, S.F. 53-63)

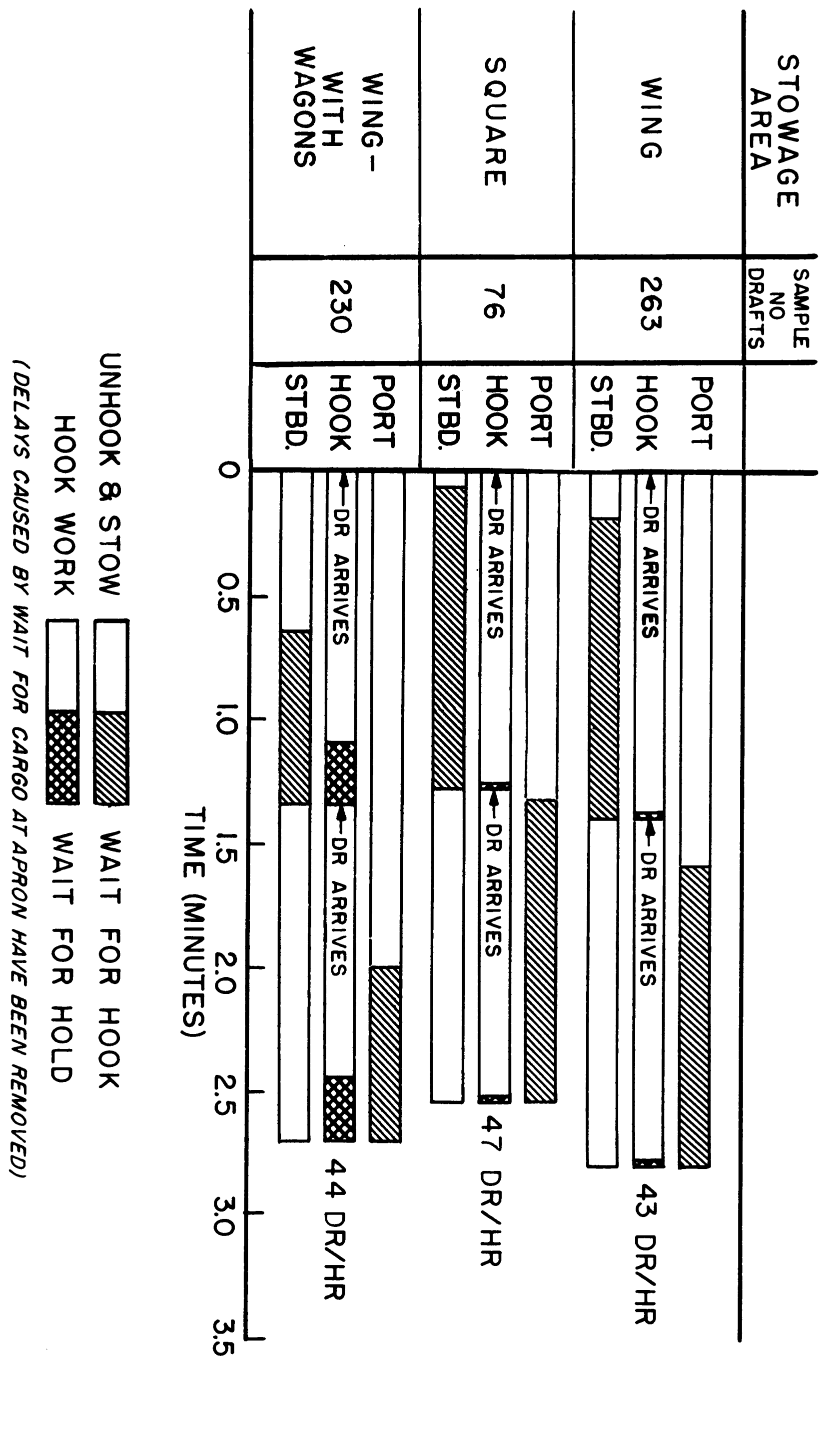


FIGURE 18
Effect of Stowage Area on Hook and Hold Cycles for Baltimore Commercial Bags
(110 lbs., ea., 20 per Draft, S.F. 60-67)

percentage of time spent by each hold gang section in stowing a draft of cargo in different areas, the hook cycle changes very little.

Stowing in the Square

While it can be shown that in some instances the amount of time a team uses to stow a draft in the square is appreciably less than the time it takes to stow a similar draft in the wings, over-all productivity may actually be higher for wing stowage, since the hook can deliver a draft to the second team while the preceding draft is still being stowed. In general, it is considered a matter of safety procedure never to lower a draft into the hold while men are working nearby in the square. When stowing is going on in the square, therefore, it is necessary for the hook to wait until the preceding draft has been completely stowed before bringing in another draft, or to interrupt the working team in order to bring in a draft for the second team. Figure 17, New Orleans drums, illustrates the increased hook wait for hold resulting from stowing in the square. In this instance, the hook waited for the men to complete stowing the preceding draft. Hook wait for hold was 40 percent of cycle time as compared with only 20 percent for wing stow, or an increase to an average of half a minute per draft from 0.2 minutes. This translates to net draft per hour rates of about 42 for square stow, and 54 for wing stow. Figure 18, Baltimore bags, illustrates the effect of interrupting the working gang, with negligible hook wait-for-hold in the case of both wing and square stowing. Observe that, on the average, one team had not finished stowing its draft at the time the second team received its draft. Hook wait-for-hold was less than one percent.

A possible solution to avoid excessive hook wait-for-hold when stowing in the square would be to have the entire hold gang work each draft. The amount of time necessary to stow a draft would then be reduced, and the hook wait-for-hold would probably be insignificant. Where the two team system must be used, the working team should be interrupted rather than delay the hook.

Stowage Area Summary

Normal stowage in the wings in break-bulk operations is not significantly slower than stowage in the square when only hold gang work time is considered. However, normal stowage in the wings may yield higher over-all productivity because a draft may be brought in while the preceding draft is still being stowed.

Stowing far wings with the aid of wagons or dollies and blocking-out in the wings demand a considerable increase in hold gang work. The work required for blocking-out, in particular, is often great enough to reduce over-all productivity. Whenever the hook ceases to be the bottleneck, definite advantages will be found in devices which facilitate these two operations, particularly the blocking-out operation.

Cargo Characteristics

Package size, shape, and weight, individually and in combination, influence the ability of the hold gang to stow cargo in a given area. This fact is well known to the stevedore whose commodity rates are based in part on the effect of the physical characteristics of the cargo on the over-all loading rate. The data presented here are designed to show the effect of package size, shape and weight on the hold gang only, omitting consideration of hook and apron reactions.

Boxes, Cases and Cartons

The available samples of cartons, cases and boxes susceptible to handling in a break-bulk type of operation were broken down into four stowage factor categories as follows: stowage factor range 41-70, 71-110, 111-150, and 250-300. Most of the usable samples within the stowage factor range 40-150 were packages measuring four cubic feet or less. These manageable units, consisting of boxes, cases, and cartons measuring less than four cubic feet per unit, represent a significant volume and weight of total cargo manifested in many trades. (See Table 11.) As much as 42 percent

TABLE 11

PERCENT OF BOXES, CASES AND CARTONS PER SHIPLOAD
(Commercial Operations Only)

		Total Boxes, cases, cartons		Less Than 4 cu. feet Per Unit	
		Weight	Cube	Weight	Cube
Brooklyn:	Vessel A	22%	40%	7%	10%
Manhattan:	Vessel A	57	54	50	42
	Vessel B	38	39	37	37
Hoboken:	Vessel A	33	32	26	28
	Vessel B	15	23	2	2
Baltimore:	Vessel A	48	52	40	37
	Vessel B	32	38	26	24
	Vessel C	28	35	23	23
	Vessel D	37	47	30	33

of the total measurement tonnage manifested, and 50 percent of the total weight tonnage manifested aboard ships surveyed in the ports indicated, consisted of cargo in this package type and size category.

Analysis indicated that the hold gang work rate for cartons, cases, and boxes measuring four cubic feet or less was sensitive to variations in package size rather than package weight. The rate of stowage in the hold, measured in units stowed per man work hour decreases as the unit size increases. This is illustrated in Figure 19. The curved line running through the points represents a rate equivalent to seven measurement tons per hour of actual work time. The tendency of the points to follow a constant measurement ton work rate curve indicates that regardless of package size, measurement ton productivity in the hold remains constant for boxes, cases and cartons up to four cubic feet each. Deviations vertically from this line are, to a large extent, due to variation in the percentage of actual work time to net operating time, for the different samples. Points above the line show the high work rates accompanying low percentages of work time, while points below the line show the low rates accompanying high percentages of work time to total operating time.

In Figure 19, a plot of the same samples based on unit weight indicates the apparent lack of correlation of work rates with unit weight. Thus it would appear that the weight of these manageable package types does not affect the hold gang measurement ton stowage rate.

Samples of cartons, cases, and boxes in the range of stowage factor 250-300 covered packages averaging 18 cubic feet per unit, with a spread as high as 31 cubic feet. Greatest unit weight was 280 pounds, and none of the samples involved the use of mechanical handling equipment. The measurement ton actual work rate for the samples averaged 15.6 measurement tons per man work hour. Indications are that for units *within a manageable unit weight* limit, measurement ton productivity rises as package

TABLE 12

COMPARATIVE HOLD GANG AVERAGE WORK RATES AND PRODUCTIVITY RATES FOR VARIOUS MAJOR PACKAGE TYPES

Commodity	LT/HR Work rate per man[1]	MT/HR Work rate per man[1]	% of Work time to net op. time	LT/HR Productivity rate per man[2]	MT/HR Productivity rate per man[2]
Cartons and Boxes 0.7-4.0 cu. ft./unit S.F. 40-150	*	6.9±0.3	67	*	4.6±0.2
Bags 100 lbs. ea. 2.8-3.2 cu. ft. ea. S.F. 61-69	6.3±0.4	10.8±0.5	49	3.2±0.1	5.3±0.1
Steel Drums 10-12 cu. ft., 422-498 lbs. ea. S.F. 48-62	11.5±0.8	15.6±1.3	44	5.1±0.4	6.9±0.6
Large Boxes and Cases 5-31 cu. ft. each S.F. 250-300	2.3±0.3	15.6±0.8	45	1.05±0.05	7.0±0.4
Bales—Cotton (New Orleans Only) 20 cu. ft. each S.F. 82	6.6±0.3	13.9±0.2	46	3.1±0.2	6.4±0.4
Bales—Pulp (New Orleans Only) 10 cu. ft. each S.F. 45	6.5±0.2	7.3±0.2	49	3.2±0.1	3.6±0.1
Bales—Paper and Rags (Hoboken Only) 50-65 cu. ft. each S.F. 140	5.8±0.6	20.6±2.1	37	2.2±0.05	7.7±0.4

*Varies with Stowage Factor.
[1]Rate based on actual work time.
[2]Rate based on net operating time.

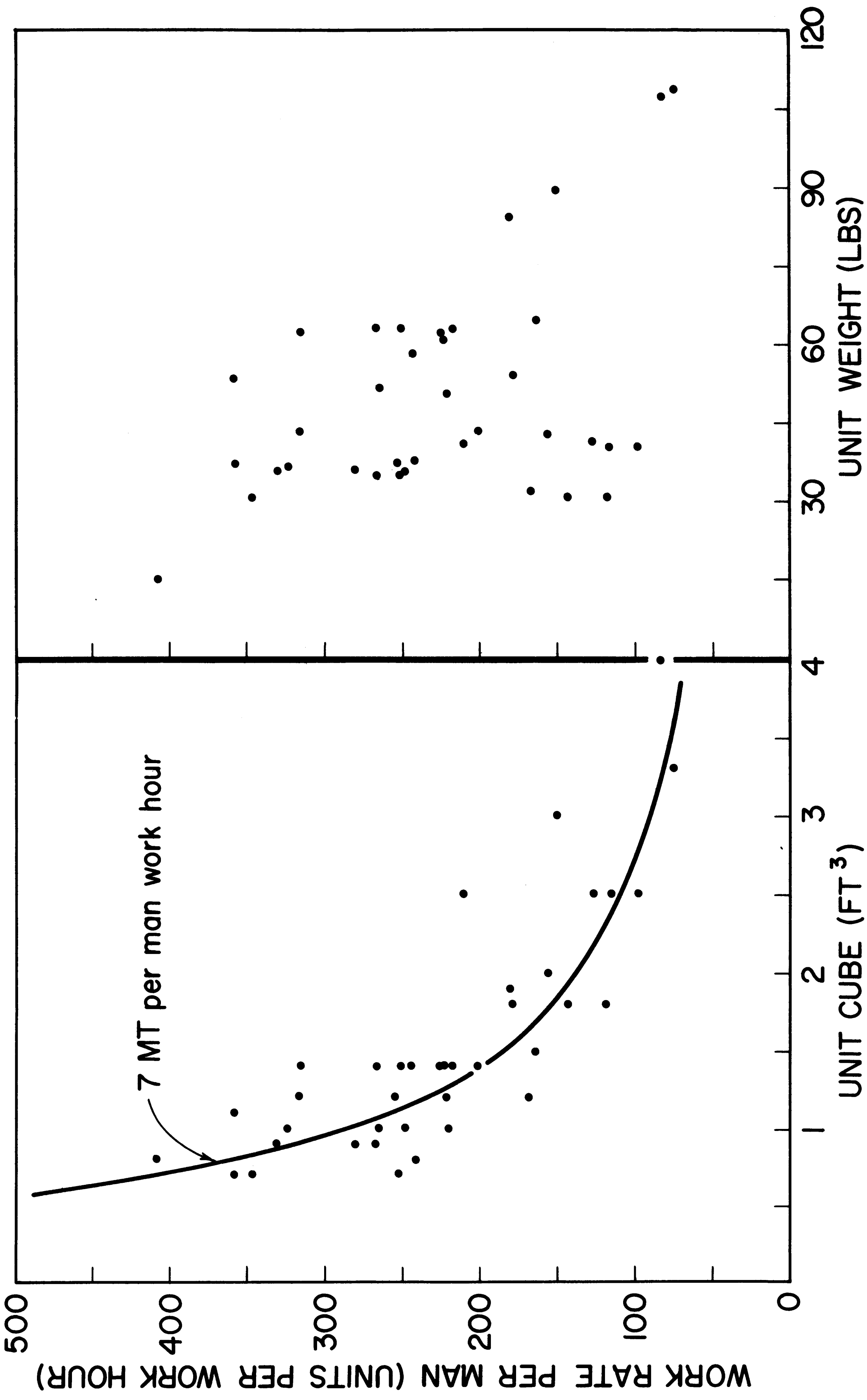


FIGURE 19
Unit Cube and Weight Versus Hold Productivity for Cases and Cartons at all Ports (S.F. 40-150; 38 samples, Minimum Sample Size 15 Drafts)

size increases beyond four cubic feet per unit. However, insufficient data prevents quantitative analysis of this effect.

Other Package Types

Table 12 indicates average work rates and productivity rates per man, observed for specific package types. Of importance here are the high long ton rates for stowage of steel drums, indicating that the ease in handling which accompanies the shape of the drum can pay off in drastically decreased loading costs per long ton.

As compared to cartons and boxes below four cubic feet per unit, most other package types show a definite advantage in rate of stowage, particularly with regard to measurement ton rates. In addition, the average percentages of hold work time were significantly below that observed for cartons and boxes. The hold gang, therefore, might yield even higher productivity rates for other package types if cargo were made available to it at a rate high enough to increase the percentage of work time to the level observed for cartons and boxes measuring up to four cubic feet per unit.

Conclusions

1. When and if the hook ceases to be the bottleneck, over-all break-bulk loading productivity could be increased significantly by improving hold gang productivity through adoption of the following measures:

a. Employ at least 12 men in the hold gang when stowing units are susceptible to manhandling; the point of diminishing return, however, is undetermined.

b. Develop and utilize mechanical devices which accelerate stowing operations and reduce fatigue in the hold. Particularly, improve time-consuming operations involved in loading least accessible hatch wing regions. This may be achieved by development and use of wing stowing devices or by changes in ship design which make wings more accessible.

2. The effects of hold gang fatigue on productivity are apparent as the proportion of hold gang work time to operating time increases. However, fatigue is not a limiting factor at work time percentages below about 60 percent. Most data lie in this area.

3. Under similar conditions, the work rate achieved by the members of the hold gang, while actually working, does not vary significantly from port to port.

Section V

COST

Preceding sections of this study have been devoted mainly to the nature of the break-bulk loading operation and its effect on net gang-hour loading rates. Analysis of the operation has indicated that with the present longshore gang, and equipment currently in use, the net gang-hour loading rates can be materially improved. This section of the study shows the relationship of longshore productivity to the cost of loading a vessel and estimates the dollar savings which accrue from improved productivity.

The importance of reducing cargo handling costs cannot be overemphasized. In the "Warrior Study,"[1] published in 1954, it was found that costs assignable to loading 11,200 measurement tons of cargo aboard the Warrior in New York (including charges to vessel while on berth for loading) were 1.5 times the cost of the ocean voyage of the cargo from New York to Bremerhaven.

This study recognizes that other cost aspects of the transportation system also need careful study. This section, however, strongly justifies primary concentration on the loading segment of the transportation system as an area in which a considerable reduction in cost is possible by a moderate increase in longshore productivity. When the effect of longshore productivity on the total cost of loading is isolated, it proves to be the controlling factor behind more than 80 percent of loading costs. Moreover, previous sections of this study have also shown that longshore productivity varies considerably between ports. These variations can be attributed to port labor practices and management inefficiencies even after consideration is given to differences in characteristics of general cargo among the ports.

In order to establish a basis for comparison of costs both between ports and for different gang-hour loading rates, a cost computation was made for the complete loading at each port of a C-2 type vessel with 12,090 measurement tons of general cargo. It was assumed that all of the cargo was susceptible to pallet loading. This amount of cargo is based upon the bale cubic measurement of a standard C-2, less 15 percent allowance for broken stowage (space lost for revenue purposes due to irregularities of packages, inaccessibility of certain areas in the hold, and space occupied by dunnage material). While it is understood that this is an artificial example which may not apply to any individual carrier's normal operation, nevertheless the resulting cost curves are adequate for the comparisons indicated.

[1] "The SS. Warrior," National Academy of Sciences—National Research Council, 1954. Publication 339.

Variable Costs

Elements of direct cost of a loading operation have been separated into two categories: those which vary with the time required for loading (variable costs) and those which do not (fixed costs). The major costs are those in the variable cost category and of these, the largest single element is the outlay for longshore labor which accounts for 48 to 61 percent of the total loading cost. Given a constant cost per gang hour, the magnitude of the longshore labor cost is determined by longshore gang productivity. In addition, the time spent in loading influences the length of time the vessel must remain on berth. Longshore gang productivity therefore becomes the controlling factor behind an additional 27 to 35 percent of the total loading cost composed of vessel expenses, depreciation, and dockage fees while on berth.

Longshore Gang Costs

The cost of longshore gangs necessary to load a vessel is the product of the number of payable gang-hours and the hourly wage cost per gang which includes fringe benefits such as pension, welfare and vacation payments, payroll taxes, workmen's compensation, etc. Total payable hours are computed on the basis of time consumed for the following operations:

1. Actual moving and stowing of cargo (net operating time).

2. Laying dunnage and gear handling during the loading operation.

3. Initial opening of hatches, rigging and final closing of hatches.

4. Daily covering and uncovering of hatches at beginning and end of the working day.

5. Payable time lost before and after regular lunch hour due to early quitting and late arrival of gangs.

The time consumed in actual moving and stowing cargo will, of course, vary with net gang productivity. All of the other elements of longshore gang costs are based, for this analysis, on observed times for each of the operations listed, in each port surveyed. In general, payable time used by longshore gangs for operations other than the actual movement and stowage of cargo remained uniform for all East and Gulf Coast terminals surveyed, with New York area terminals constituting a lone exception as shown in Table 13.

TABLE 13

PAYABLE TIME NOT SPENT HANDLING CARGO OR DUNNAGE MATERIAL AT FOUR PORTS

Port	Initial opening, rigging and final closing of hatches		Daily covering and uncovering hatches	Early knockoff for and late arrival from regular lunch hour
	Hatches 1 & 5 (Min.)	Hatches 2, 3 & 4 (Min.)	(Min.)	(Min.)
New York Area	75	90	30	24
Baltimore	66	75	20	5
Norfolk	66	75	20	5
New Orleans	66	75	20	5

NOTE: These figures are based on actual observations but are presented primarily for sample calculation purposes. They represent only order of magnitude accuracy and are considered typical only of M.C.T.C. data samples.

In general, the time differentials observed between New York and the other ports, as shown in Table 13, can be attributed to "pier-gate to pier-gate" employment practices in New York whereas longshoremen are usually ready to begin work aboard ship at the beginning of each shift in the other ports.

Time consumed laying dunnage and handling gear during the loading operation is based on consideration of these operations at all ports observed and is taken to be about ten percent of net operating time.

Table 14 lists the hourly wage rates per gang in the various ports for which total loading costs were computed. In addition the following contract conditions were also taken into account in estimating total cost:

1. Gangs beginning work at 8:00 a.m. are guaranteed a four hour minimum.
2. Gangs which have worked the morning shift are guaranteed a two hour minimum if called back after the noon lunch break.
3. Gangs working after 3:00 p.m. are guaranteed a half-hour's pay for each half-hour or fraction thereof worked.

Checker Costs

The use of cargo checkers to insure an accurate tally of cargo being loaded varies from company to company. For the purposes of this study it has been assumed that one checker is employed for each longshore gang at an eight hour day minimum guarantee. Straight time wage scales for checkers are given in Table 15.

Mechanical Handling Equipment

The cost of mechanical handling equipment (MHE) includes the cost for the use of fork lifts, tractors, wagons, etc., used in moving cargo from the pier storage bays to the hook. It was assumed for these cost computations that the mechanical handling equipment consisted of two 4,000 lb. fork lifts per gang at $1.50 per fork lift hour. Drivers have been included in costs for the regular longshore gang.

Vessel Expense and Dockage Fees

Since the ship must remain tied up continuously from the time loading begins until it is completed, all ship costs during this period must be considered as part of the total loading costs. These costs include depreciation and interest on investment as well as normal daily operating and maintenance expenses in port. The total of these charges, taken from the Warrior Study, is $1,950 per day.

The dockage fee is a charge assigned to the loading of each vessel which covers a pro-rata

TABLE 14

GANG SIZES AND GANG-HOUR WAGE RATES AS OF JAN. 1, 1956

Port	Men per gang	Straight time *wage rate* (including workmen's compensation payments, pension assessments, etc.)
New York Area	23	$76.10
Baltimore	23	69.65
Norfolk	22	64.57
New Orleans	20	56.44
Los Angeles[1]	16 3/5	47.69 (8 a.m.-3 p.m.)
San Francisco[1]	14 1/2	43.84 (8 a.m.-3 p.m.)

[1]In Los Angeles and San Francisco the regular day shift is 9 hours of which the first six hours are at the straight-time rate, and the last 3 hours at time and a half.

portion of the depreciation and maintenance on the pier. The approximate amount of this charge has been computed in the Warrior Study by assuming reasonable values for pier cost, pier life, etc. The estimated dockage fee for the Warrior Study was found to be approximately $315 per day, and this figure has been applied to all terminals surveyed.

Fixed Costs

Fixed costs are those loading charges which are independent of loading time, and therefore not influenced by changes in longshore gang productivity rates. These fixed costs are predetermined by the quantity and characteristics of the cargo to be loaded. Briefly, they include carpentry and shoring costs for securing cargo in the hold, cost of dunnage material, and the cost for the use of pallets.

In the Warrior Study, computation of these costs based on 11,200 measurement tons loaded showed that they were very small compared to the total loading cost. Computation of fixed costs for the purposes of this study have, therefore, been based on data from the Warrior Study, dunnage costs excepted, with the knowledge that these fixed costs will vary from vessel to vessel, but that variations by as much as 50% will not change the fixed costs enough to have a substantial effect on the total cost of loading.

TABLE 15

CHECKERS WAGE SCALES (JAN. 1, 1956)

Port	Base Rate		Total with Fringe Payments	
	Straight Time	Over Time	Straight Time	Over Time
New York Area	$2.43	$3.65	$3.17	$4.62
Baltimore	2.43	3.72	2.85	4.21
Norfolk	2.43	3.65	2.98	4.20
New Orleans	2.33	3.50	2.57	3.86
Los Angeles	2.37	3.55	3.05	4.29
San Francisco	2.37	3.55	3.05	4.29

Carpentry and Shoring

Costs for carpentry and shoring are assumed to be fixed by the volume of cargo stowed. Adjustment of Warrior data to compensate for the larger volume of cargo considered in this study results in an estimate of shoring and carpentry costs at $675.

Dunnage and Lashing Material

The cost figure covering dunnage and lashing materials expended on a voyage has been arbitrarily set in this study. It depends to a great extent on the particular trade in which the vessel is operated, the ability to re-use dunnage for a return voyage, and the possibility of selling the dunnage at destination. Wide fluctuations in this cost figure can be observed from vessel to vessel, and even from voyage to voyage of a vessel in one trade. It has been assumed, after a survey of actual costs to a number of vessels, that the hypothetical shipload would cost $3,250 in dunnage and lashing gear unsalvageable at the end of the voyage.

Cost of Pallets

The cost for the use of pallets is the sum of interest and depreciation charges directly assignable to the loading of a given vessel. It was found in the Warrior Study that approximately 75 percent of the cargo was on pallets at one time, and that pallets were held loaded for as much as 15 days before the cargo was moved aboard ship. The following assumptions were used in computing charges for pallet use: initial cost of pallet, $13; useful life of four years; interest charge of three percent; number of pallets used, 5,670. Computation yielded a charge for pallets of $911.

Summary of fixed costs for loading 12,090 MT of general cargo:

Carpentry and shoring labor	$ 675
Dunnage and lashing material	3,250
Pallet charges	911
Total fixed costs	$4,836

Total Cost by Port

Straight-time Only

Preliminary treatment of the total cost to load a C-2 with 12,090 measurement tons of general cargo will be based on straight time rates only. This less complicated method of computation facilitates presentation of the overall effect of changes in gang productivity on total costs. The use of overtime, as will be shown, can have a noticeable effect on total cost. This effect, however, is not as great as the effect of changes in gang productivity.

Figure 20 presents graphically the effect of changes in gang productivity on total loading costs for each of the ports surveyed. Figure 21 presents the same information for the ports of Los Angeles and San Francisco with all elements of cost, except the gang-hour wage scale, assumed to be the same as at the port of Baltimore.

The curves in Figures 20 and 21 demonstrate that the total cost of loading varies inversely with the net gang-hour loading rate. As the net loading rate is increased, total cost drops sharply. For example, it was found that the present net loading rate in New York is about 35 measurement tons per net gang-hour for general cargo handled on pallets, with stowage factor greater than 60. This would place the total cost of loading 12,090 measurement tons of such cargo aboard a C-2 in New York at $59,000. The net loading rate for similar cargo in New Orleans was observed to be 60 measurement tons per net gang-hour. If gang productivity in New York were as high as in New Orleans, a saving of $22,000 per vessel or $1.82 per measurement ton would result. If the loading rate in New York were increased by only 15 percent from 35 to 40 measurement tons per net gang hour, a savings equal to $0.62 per measurement ton would be attained (13 percent of total cost at the lower rate).

Table 16 presents a breakdown of total cost into significant components at various net loading rates. Straight-time wage rates only were used in all wage computations.

Overtime

Although the computations of loading costs discussed thus far are based only on payment of straight time wage rates, moderate savings can be attained by the judicious use of overtime. The advantage, costwise, of overtime work is that the loading will be completed and the vessel released earlier. This will result in a saving in vessel costs which may outweigh the additional expense incurred.

Ship operators are not unaware of the cost advantages in overtime work. However, the number of variables involved in estimating the optimum number of gang-hours of overtime yielding minimum total costs has made it necessary for them to treat each voyage as a special case. No attempt has been made in this study to present a "master formula" for determining the amount of overtime gang hours which will yield lowest total cost. However, by applying overtime considerations to the hypothetical ship loading already developed, certain general conclusions appear to be valid.

The number of gang-hours of overtime which must be used to release the vessel an hour earlier is basic in computing savings from use of overtime. For example, at New York where the straight time rate is $76.10 per gang-hour, overtime work adds an extra cost of $38.05 per gang hour. However, if vessel expense and dockage fees of $2265 per day are pro-rated over 24 hours, vessel costs are roughly $94 per hour, or 2½ times the extra cost of one gang-hour of overtime. Use of less than 2½ gang-hours of overtime in New York to save one hour of ship's time is therefore economically practical. In ports where the overtime premium is less than in New York, the dollar savings from use of overtime will be greater.

A second factor which must be taken into consideration is the minimum guarantee (see contract conditions listed on page 44). Longshore labor contracts specify that gangs must be paid for a minimum number of hours once they have been called to work. Consequently, attention must be given to the time of day the loading would end, if a certain amount of overtime is utilized, in order to avoid the expense of paying gangs for day-shift hours not worked. It appears that the optimum amount of overtime will generally be such as to permit completion of the loading operation at 5:00 p.m., either one or two evenings before the day on which loading would be completed if no overtime were used. If, without overtime, the loading would be completed early in the week (Monday, for instance), then greater use of overtime to avoid the weekend would be profitable.

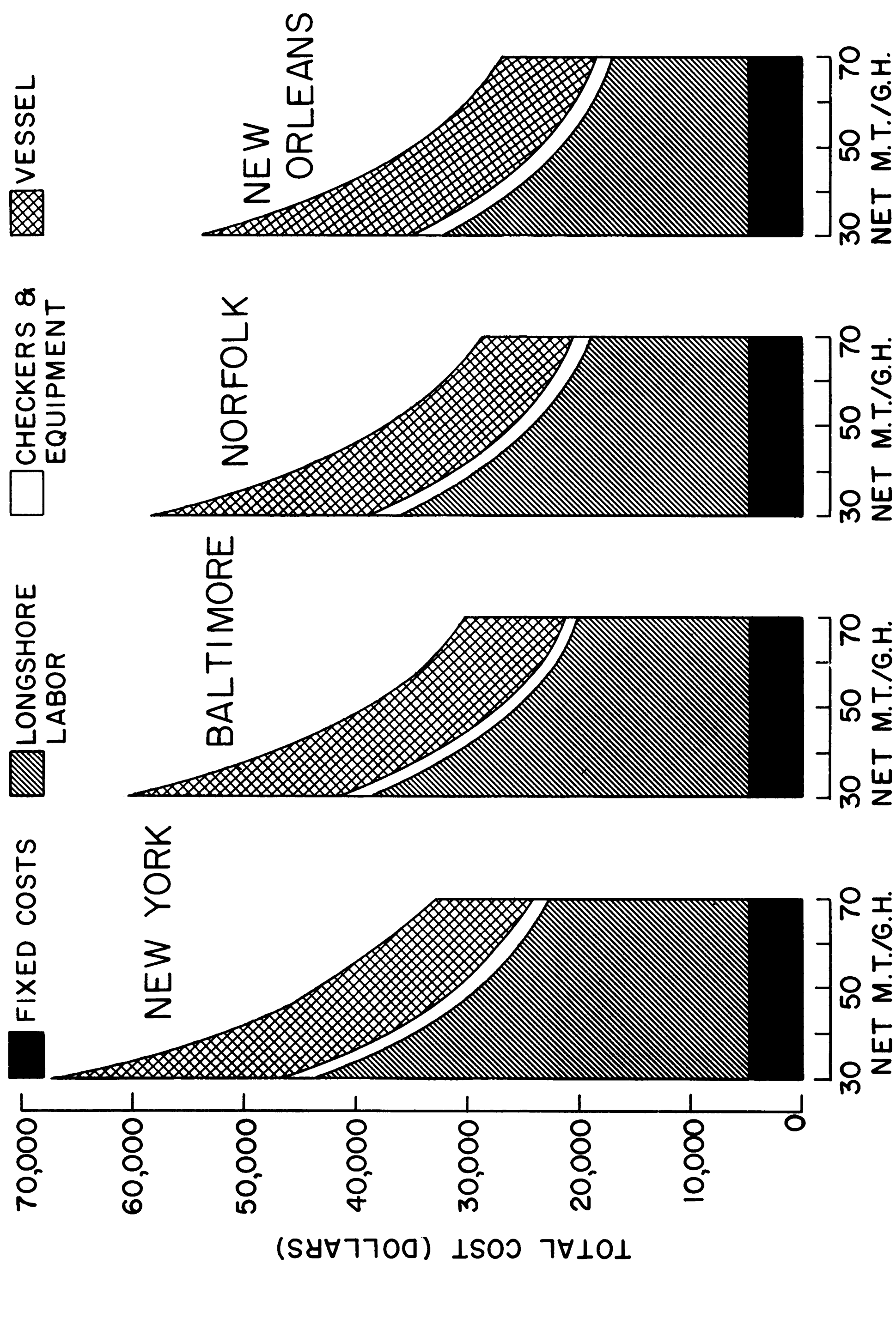


FIGURE 20
Net Productivity Versus Total Cost to Load a C-2 (East Coast Ports)

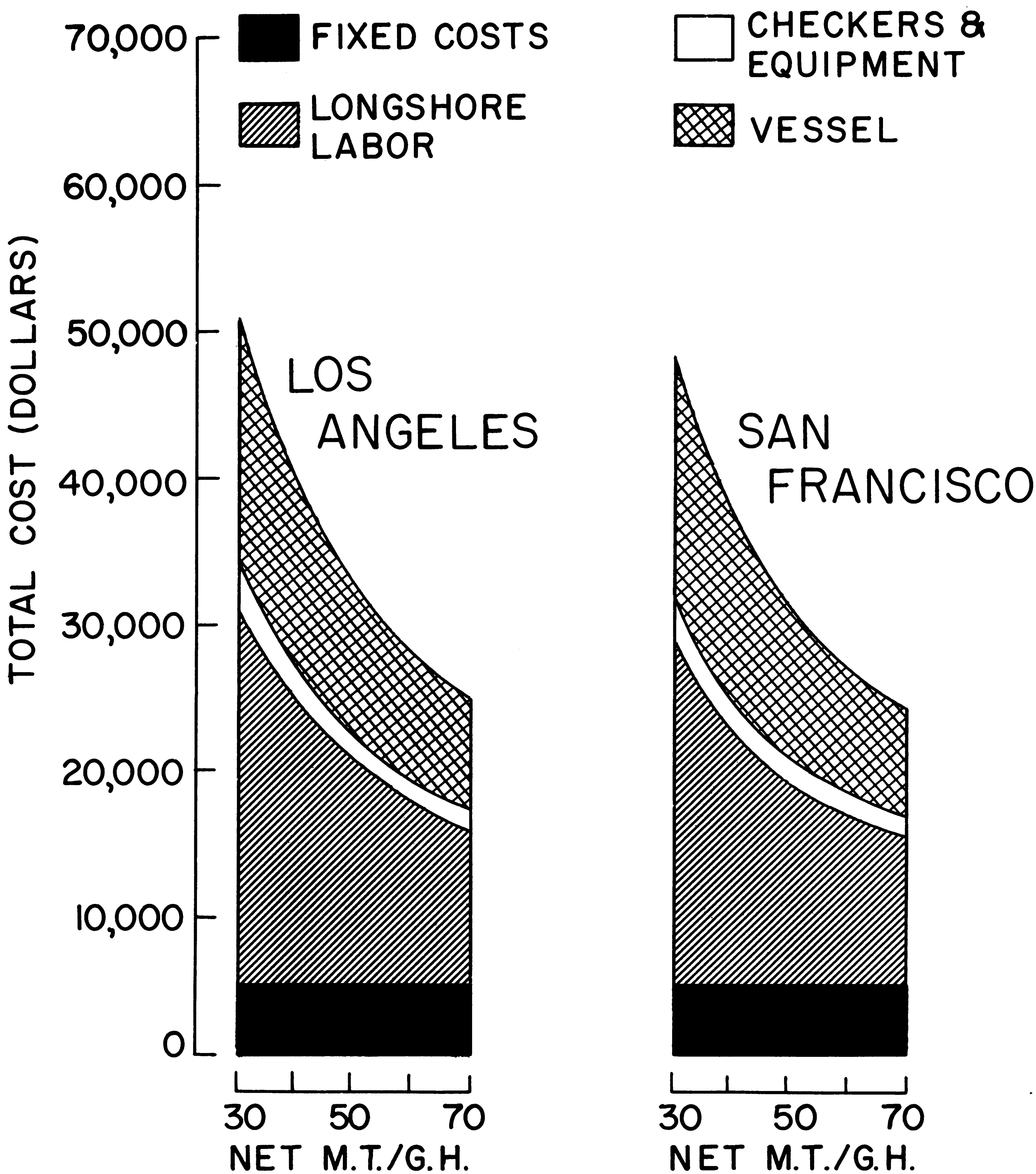


FIGURE 21
Net Productivity Versus Total Cost to Load a C-2 (West Coast Ports)

For a vessel loaded entirely at one port sailing, time can be moved up as much as 3½ days.

Figure 22 demonstrates for our hypothetical ship loading operation the effect of overtime work on total cost for the high wage scale ports of New York and the lower wage scale port of New Orleans at the loading rates of 40 and 70 measurement tons per gang hour. Computations are based on the assumption that loading starts at 8:00 a.m. the first day, and that all gangs work at the same productivity rate. Total cost with no overtime, and minimum total cost with the estimated optimum amount of overtime, are given in Table 17. The table shows that the judicious use of overtime will result in a greater cost reduction at ports with lower labor costs.

Reductions in total cost can be obtained through judicious use of overtime regardless of loading rates or wage scales. The effect of

TABLE 16

SIGNIFICANT COMPONENTS OF TOTAL COST AT VARIOUS NET LOADING RATES

Net Gang[1] Productivity	Gang Hrs.	Days Loading	Fixed Costs	Gang Costs	Checkers Costs	MHE Costs	Vessel Expenses	TOTAL
New York								
30	509	8.9	$4836	$39117	$1613	$1526	$20181	$67273
40	385	6.5	4836	29494	1220	1154	14722	51426
55	276	4.8	4836	21850	875	828	10917	39306
70	225	3.9	4836	17723	711	673	8856	32799
Baltimore								
30	476	8.4	4836	33963	1358	1429	18913	60499
40	360	6.3	4836	26050	1026	1080	14292	47284
55	264	4.6	4836	18884	751	791	10464	35726
70	209	3.7	4836	15249	597	628	8290	29600
Norfolk								
30	476	8.4	4836	31421	1420	1429	18913	58019
40	360	6.3	4836	24150	1073	1080	14292	45431
55	264	4.6	4836	17507	785	791	10464	34383
70	209	3.7	4836	14137	624	628	8290	28515
New Orleans								
30	476	8.4	4836	27521	1224	1429	18913	53923
40	360	6.3	4836	21109	925	1080	14292	42242
55	264	4.6	4836	15302	677	791	10464	32070
70	209	3.7	4836	12357	538	628	8290	26649
San Francisco								
30	473	7.4	4836	24568	1505	1420	16716	49045
40	358	5.6	4836	18255	1134	1073	12616	37914
55	263	4.1	4836	13681	833	788	9287	29425
70	208	3.2	4836	10869	658	624	7339	24326
Los Angeles								
30	473	7.4	4836	26726	1505	1420	16716	51203
40	358	5.6	4836	19859	1134	1080	12616	39525
55	263	4.1	4836	14893	833	788	9287	30637
70	208	3.2	4836	11350	658	624	7339	24807

[1] Measurement tons per net gang hour.

TABLE 17

EFFECT OF OVERTIME ON TOTAL COST OF LOADING IN NEW YORK AND NEW ORLEANS

Port	Gang Hour Wage Rate	Loading Rate	Loading Cost No Overtime	Minimum Loading Cost	Maximum % Reduction in Total Cost	Gang Hours Overtime Required for Min. Cost
New York Area	$76.10	40 MT/GH	$51,400	$50,200	2.3%	13 GH
		70 MT/GH	32,800	31,300	4.6%	33 GH
New Orleans	$56.44	40 MT/GH	42,200	40,400	4.3%	40 GH
		70 MT/GH	26,600	24,500	7.9%	18 GH

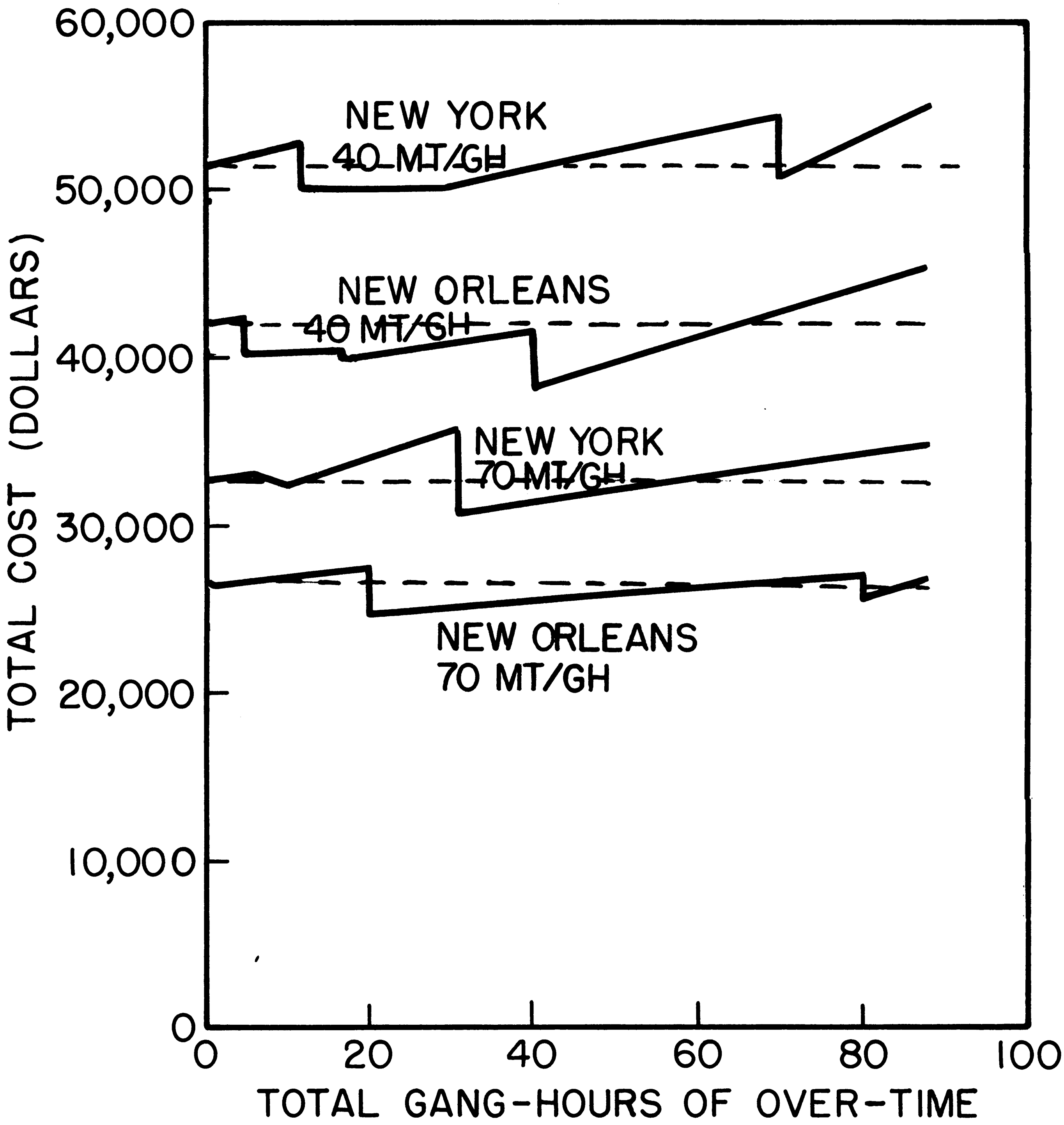


FIGURE 22
Total Cost Versus Overtime

these reductions in East and Gulf Coast ports, however, would probably not be greater than ten percent of total cost when no overtime is worked. The advantages of overtime are strongly dependent on the expense of the ship while alongside the pier. The higher amortization costs of ships newer than the current C-2 fleet will favor the greater use of overtime.

Elements of Labor Cost

Figures 20 and 21 show that the total cost for loading at a given rate varies considerably among the ports surveyed. The primary reason for this variation can be traced to the differences in labor costs between ports. These differences in labor cost are due to variations in gang size, the extent of employee benefits, the cost of workmen's compensation,[1] and work practices in effect in the several ports. For example, Table 13 on page 44 shows that New York gangs spend as much as one half-hour more per work day in non-productive time than do gangs in the other ports. The excess cost attributable to this lost work time is indicated on the lower graph in Figure 23 as it varies with net productivity. At observed net productivity rates, this amounts to about five percent of the total cost per shipload. The top graph in figure 23 shows the effect of this work practice on gross productivity which considers the loading rate calculated on the basis of all payable time. The effects of many other work practices such as, unwritten draft size limitations, hold gang size limitations, on-and-off hold gang work schedules, and winch lagging are inherent in the net loading rate. They have been treated in other sections of the study.

Less Than Full Ship

The discussion of loading costs so far has been concerned exclusively with loading an empty vessel to capacity. However, consideration must be given to partial loadings at one port, and the effect of partial loading on cost. All operations on which data were taken fall into the partial loading category. Computations for fractions of a shipload show that the determining factor of cost, measured in dollars per measurement ton loaded, is the distribution of the cargo to be loaded among the number of gangs and hatches available. Least cost is attainable when cargo is so distributed that as many gangs as possible can work the ship simultaneously without interfering with one another. If the cargo for a C-2 is apportioned evenly to all eight gangs working simultaneously, the loading cost per measurement ton for as low as one-third vessel capacity (4030 measurement tons for a C-2) is not significantly different from the loading costs per measurement ton for a capacity shipload. Partial loads of less than one-third vessel capacity are accompanied by rising cost per measurement ton because of the greater influence of payable hours spent in non-productive operations such as opening and closing hatches.

Although apportionment of cargo to all hatches is the key to lower loading costs for partial shiploads, it is recognized that operators are often forced to place considerations of port sequence and accessibility of cargo ahead of the economics of loading. The decision concerning the number of holds into which a partial load is to be stowed must, therefore, be guided by practicality and considerations of the volume to be loaded and the discharge sequence.

Conclusions

The conclusions with regard to cost of loading may be summarized as follows:

1. The total cost of loading a vessel (either partially or completely) varies inversely with observed net loading rates per gang hour. Eighty-two to ninety-two percent of this cost is dependent on loading time. Thus, total cost at a net loading rate of 70 measurement tons per gang-hour is about one-half that at 35 measurement tons per gang-hour.

2. An optimum amount of overtime use of labor gangs reduces loading costs by as much as ten percent in ports where wage rates are low. This reduction is somewhat less in ports with high wage rates.

3. Differences in labor practices among ports affect total loading costs noticeably. For example, at some ports total costs could be reduced by as much as five percent if less work time were lost because of early quitting time, excessive lunch period time, etc.

[1]For further information see Longshore Safety Survey, National Academy of Sciences—National Research Council. 1956. Publication 459.

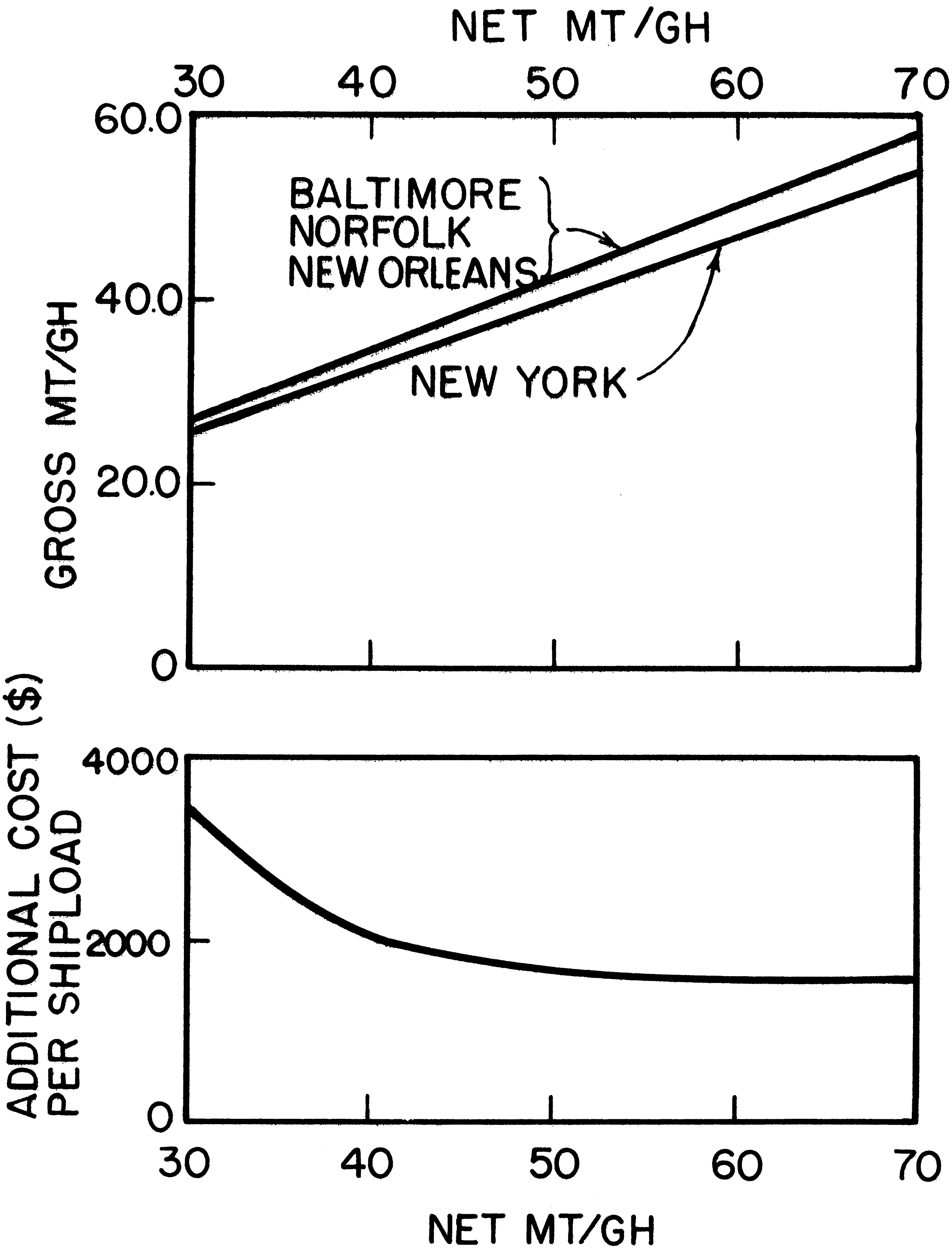


FIGURE 23
Effect of New York Lost Work Time on Cost and Gross Productivity

Section VI

ESTIMATED BREAK-BULK LOADING CAPABILITIES

The purpose of this section is to define the reasonable outer limits of potential productivity attainable in a break-bulk loading operation. When the present bottle-neck created by the hook is eliminated, the final limits will be determined by the ability of the hold gang to stow the cargo delivered by the hook. In this section, observed hold gang performance is used as the basis for estimating maximum productivity rates which can be expected in the break-bulk operation. Significantly higher loading rates can be obtained only by a major change in the system designed to eliminate the break-bulk nature of the loading operation. This may be accomplished through systems of unitizing cargo such as, fastening cargo on a pallet, placing it in a container, or stowing it in a trailer body (for roll-on, roll-off operations).

Estimated Rates With Optimum Hold Characteristics

Naval architects and marine engineers have given some consideration to new hatch designs and shipboard gear which would eliminate certain of the limiting factors present in the break-bulk process. Almost without exception such efforts have been directed toward accelerating the rate at which cargo can be loaded in the wings through the use of devices such as rolling wing decks, wing-loaders which spot each draft in the wings, flush coaming enabling greater use of fork lifts in the hold, oversize hatch squares which reduce wing area, etc. Their value in a break-bulk operation lies in their ability to reduce or eliminate special stowage operations such as blocking out and remote wing stowage which lower hold gang productivity.

Table 12 in Section IV indicates hold productivity rates observed for large samples of various commodities. The samples used in computing these rates were carefully selected to avoid the inclusion of low rates resulting from special stowage operations. Rates in this table are given on a "per man" basis. For the purpose of arriving at an outer limit of hold gang productivity, it will be assumed that a 12-man hold gang is used throughout the break-bulk operation. Analysis of 8-man hold gang performance versus 12-man hold gang performance in the section on hold gang size, indicates that there is no significant productivity loss per man due to an increase in the size of the hold gang up to 12 men. As a preliminary step, therefore, the per man productivity rates given in Table 12 are multiplied by twelve to adjust for a 12-man hold gang (Column I of Table 18).

In order to arrive at reasonable outer limits of productivity rates attainable in the break-bulk operation, an additional adjustment was made to take into consideration the higher productivity resulting from higher percentages of work time. When the hook ceases to be the bottleneck, the amount of cargo made available to the hold gang will increase and yield a higher percentage of hold gang work time to net operating time. A ten percent productivity increase is used to adjust the estimated productivity rates upward, assuming that the percentage of actual work time rises to 60 percent. This ten percent figure is supported by over-all per man productivity rates shown on Figures 14 and 15 of Section IV.

Table 18, Column III lists the measurement ton loading rates attainable when the ship is modified so that no special stowage operations are required. The computation of the rate for cartons and boxes less than four cubic feet each did not include the ten percent increase mentioned above, since average percentage work time for these items is well above 60 percent in the sample presented.

Estimated Rates With Present Hold Characteristics

The loading of an entire compartment in a conventional cargo vessel entails a number of difficult and time consuming operations such as: beam stowage, blocking-out, and stowage in wing areas remote from the square. Since the methods used in collecting data were guided by the objective of acquiring information covering complete compartment loadings, it was possible to obtain some measure of the amount of special operations such as blocking-out and remote wing stowage required to load a ship completely. These special operations accounted for approximately 15 percent of the cargo loaded in a break-bulk operation, and net productivity rates during these special operations were 30 percent below the rates attained in normal stowage operations. In addition, the percentage of work time to net operating time observed for these special operations was generally in excess of 60 percent. The rates attainable with present ship hold characteristics are given in Table 18, Column IV. They are derived by considering 85 percent of cargo as being loaded at the rates given for improved ship types in Column III and 15 percent of the cargo loaded at the lower rates for special stowage operations given in Column II.

These estimated attainable productivity rates for present ships and cargo gear, represent sizeable areas of improvement for most ports. The port of New Orleans, where the best productivity rates were observed, comes close to these estimated rates since the actual cargo delivery rate of the hook in the port is sufficiently great to bring about a high utilization of the 12-man hold gang. Significantly, the greatest area for improvement in productivity observed in New Orleans has been in handling certain special commodities such as cotton bales and drums. The commonly accepted draft size for these commodities is insufficient to permit the hook delivery rate to match the hold gang stowing capability. An increase in the hook delivery rate for these commodities can yield improvements in productivity ranging from 15 to 30 percent, through greater use of the hold gang potential.

Conclusions

1. With present ships, net gang-hour breakbulk loading rates of about 50 to 105 measurement tons per hour, depending on general cargo package types, may be obtained by use of improvements suggested in the sections on Hook Operation and Hold Operation. Where these

TABLE 18

NET PRODUCTIVITY

(Measurement tons per net gang hour)

Commodity Cube and Stowage Factor	I Table 12 Observed per Man Rates × 12	II Adjust. for Special Stow. Operations (Col. I —30%)	III Improved Ships Ideal Hook Performance (Col. I+10%)	IV Current Ships Ideal Hook Performance (85% of Col. III +15% of Col. II)
Cartons & Boxes 0.7-4.0 cu. ft./unit S.F. Range 40-150	55	39	55[1]	52
100 lb. Bags 2.8-3.2 cu. ft./unit S.F. Range 61-69	64	45	70	66
Steel Drums 10-12 cu. ft./unit S.F. Range 48-62	83	58	113[2]	105
Large Boxes & Cases 5-31 cu. ft./unit S.F. Range 250-300	84	59	92	87
Bales—Cotton (New Orleans Only) 20 cu. ft./unit S.F. 82	77	54	85	80
Bales—Pulp (New Orleans Only) 10 cu. ft./unit S.F. 45	43	30	47	45
Bales—Paper & Bags (Hoboken Only) 50-65 cu. ft./unit S.F. 140	93	65	102	96

[1]No ten percent adjustment applied because percent work time for observed sample was over 60 percent indicating adequate hook performance.

[2]Since analysis of drum stowage indicated a constant work rate regardless of the percentage of work time to operating time, the adjustment used is in direct proportion to the increase in work time from 44 percent to 60 percent.

improvements are already incorporated into the system, for example in the loading of certain types of cargo in New Orleans, these rates have been attained.

2. With all foreseeable cargo handling improvements including optimum ship designs, the break-bulk loading operation is still limited by the process of handling individual items in the hold. Depending on the nature of the cargo, the process will permit *at most* loading rates from four to eight percent greater than are attainable as indicated above with present ships and present cargo handling gear (assuming a 12-man hold gang). Postulating an adequate hook delivery, some gains may be possible through use of a hold gang of more than 12 men. However, beyond, promise of a significantly greater improvement in productivity can come only from new systems which eliminate the current break-bulk process in the hold.

Section VII

SUMMARY AND EVALUATION

The main areas of concentration in this study have been loading productivity and cost. The productivity analyses show that the present break-bulk system of loading cargo in most cases is operating well below its capability. The cost analyses show that shipping companies and stevedores have much to gain from increasing productivity. Where possible, technical methods of improving productivity have been identified and evaluated.

It is recognized, however, that the problem of increasing productivity is far larger than the scope of this study which deals only with the technical aspects of the problem. Most technical methods suggested in this report for improving productivity in the current cargo-handling system were actually observed in operation at some ports. The operations observed in New Orleans, for instance, seemed to be quite efficient, already employing to a large extent most of the operating procedure suggestions of this study. Labor and management at other less efficient ports cannot be ignorant of the relatively simple changes which would make their operations efficient. If inefficiency is knowingly tolerated in such ports, its causes must lie in factors (economic, sociological, psychological, etc.) affecting labor and management, the human elements which organize and control the system. A real improvement in productivity depends on these controlling human elements.

Conclusions

1. The present system of loading general cargo is being operated for the most part well below the capability of the mechanical equipment and manpower employed.
2. Although technical means for correcting system inefficiencies are available and undoubtedly known to the controlling human elements, these means have not generally been employed.

Recommendation

It is recommended that research effort be intensified to find fair and practical methods of eliminating those conditions which prevent labor and management from employing existing technical improvements to increase productivity in the present system of handling general cargo.

Appendix I

INDUSTRY OPINION QUESTIONNAIRE

The Maritime Cargo Transportation Conference of the National Research Council has undertaken a broad study of maritime general cargo movement. A major objective of this study is the reduction of turnaround time of ships. In its investigation of the ship-loading function, the Conference desires to determine the average, actual performance and the potential capability of each of the three principal phases of the loading operation:

1. Feeding the hook
2. Movement from apron to hold
3. Stowage in the hold

The objective of this particular survey is to find out which of the three phases constitutes the bottleneck, and to establish the order of magnitude of that bottleneck as compared with the other phases of the loading function. For example, if all evidence were to indicate that two fork lifts were capable of delivering 40 measurement tons of general cargo per hour to the hook (this would be a maximum average *capability* assuming no waiting for the hook), the hook cycle were *capable* of delivering 50 measurement tons to the hold (this would be maximum average *capability* assuming no waiting for drafts at apron and no waiting for gang in the hold), and the hold gang actually manages to stow an average of 20 measurement tons per hour, then obviously the hold would be the bottleneck; the hook feed capability would be twice that of the hold; the hook cycle capability would be two and one half times that of the hold.

The following questions are designed to assist in developing the foregoing information:

1. How many days does the average shipment lie on the pier awaiting loading?
2. What is the average productivity in long tons per longshore gang-hour for loading mixed general cargo?[1]
3. What is the average size of the longshore gang used to load mixed general cargo?
4. What is the distribution of the longshore gang among the different functions on pier, deck of ship, and in the hold?
5. Is a different gang used for receiving cargo from trucks, railcars and lighters? If so, what is size and composition of this gang? If not, how many men of the longshore gang are used for this purpose?
6. What is your estimate of average fork lift delivery *capability* of cargo to ship's tackle over a stated average haul distance in long tons per hour? What is the *capability* of any other equipment used (such as tractor-trailer rigs)? What is requested is the rate of feed to hook that mechanical equipment *can* accomplish if the hook takes drafts away as fast as they *can* be delivered.
7. How many fork lifts do you use on an average to feed general cargo to one set of ship's gear?
8. What is your standard pallet size?
9. What percentage of your mixed general cargo is palletized?
10. What is average lift per pallet (in long tons and measurement tons)?
11. What is the ratio of measurement to weight in your mixed general cargo?
12. What is your estimate of hook delivery *capability* to the hold in long and in measurement tons per hour? What is desired is the rate at which the hook *could* deliver drafts to the hold *if* the hold gang were able to stow as fast as hook could deliver and *if* drafts were always available for lift from the apron.
13. What is your estimate of the *capability* of your hold gang to stow cargo if that gang never has to wait for the hook? Time for rigging and opening and closing hatches is to be included in the hold gang time.
14. How much time in an average 8-hour shift is devoted to rigging and opening and closing hatches?
15. What percentage of your cargoes is made up of individual packages exceeding 10,000 lbs. in weight?
16. Which phase of the loading operation do you believe is the bottleneck and reasons?
17. In your opinion, what steps might be taken to improve the performance of general cargo loadings?

[1]Mixed general cargo herein is taken to mean: Miscellaneous goods packed in boxes, bales, cases, bags, cartons, barrels, drums, etc., not to include individual items exceeding 10,000 lbs. or 35 feet in length.

Appendix II

DATA COLLECTION AND ANALYSIS TECHNIQUES

The basic data for the loading study were derived from two principal sources. The first of these is through time measurements and observations made by special checkers stationed on the vessels during actual loading operations. The measurements consisted of recording the times at which certain successive specified events in the loading cycle transpired. In addition, observations were made of the number of men actively engaged in the operation, the location of the operation, and certain characteristics of the cargo to which the time data related. Since not all the pertinent cargo properties were evident through observation alone, company documents constituted a second principal data source. These documents served both to provide a check on the observations, and to yield fundamental information on such items as cargo weight and volume.

The following section presents in detail how the data were collected and describes the principal steps in the data reduction process.

Method of Data Collection

A team of four observers was assigned to each longshore gang for the collection of data. One observer, stationed on the deck of the vessel, was responsible for recording data primarily relating to the hook cycle. The hatch cycle data were accumulated by two observers, one assigned to each of the two hold gang teams working in the hatch. These observers were generally stationed in the hold just above the location where the longshoremen were working. Whenever the hold gang teams coalesced to work as a single unit, just one of the hatch observers was selected as responsible for the collection of the data. The fourth observer acted as a relief man for the other three. There were never more than three teams collecting data at any one time. These teams were usually under the on-the-job supervision of two members of the MCTC staff.

The observers for the MCTC study were selected from union checkers. The experience of checkers with types of gear, types of packages, commodity classifications, etc., made them particularly qualified for the task of collecting data. In addition, it was felt that the familiarity of the checkers with the environment of loading operations in general would reduce the possibility of accidents. The arrangements with the union were made through company personnel who suggested which individual checkers were likely to prove satisfactory observers. It was always possible to arrange with the union to keep the same men as observers for the period during which measurements were being collected. It was found that efforts to obtain more than 2 or 3 teams usually would strain the sources of supply of experienced men who of course were needed by the stevedore as well as by MCTC.

The most able checker was appointed the relief man, since he was required to perform the tasks of observing both the hook cycle and the hatch cycle. The next most demanding job was that of the hook cycle observer. This task involves moving from the corner of the hatch opening on the deck to the dockside edge of the ship (in order to observe the hook both in the hatch and on the apron), and therefore keeps the observer quite busy. The scheduling of relief was generally left up to the men themselves, with either a 15 minute break per hour or a 30 minute break each two hours suggested; the latter alternative was generally preferred.

The time measurements were made using a wrist watch with a sweep second hand. The watch was wired to a fibreboard square which in turn was fastened to the right hand corner of a standard clipboard. Measurements were required only to the nearest tenth of a minute. For this purpose a circular paper disc divided into ten sections and extending out beyond the circumference of the watch was glued to the fibreboard square. In addition, checkers were supplied with flashlights having swivel heads and attachment clips for data-taking at night. At the beginning of the day, the watches for the team were synchronized as much as possible, and the remaining differences relative to the hook watch noted. Whenever the boards were handled such as for meal breaks (every 4 hours) the drift in the watches was recorded. The three watches of each set were observed in advance of data taking and chosen so as to be well matched in running rates. By this process the drift between watches in a set could be restricted to less than 30 seconds in 4 hours. Perfect synchronization was not required since time intervals were never measured from one data sheet to another.

The checkers were indoctrinated as observers by providing first a briefing session on the pier for about an hour, and then by explaining the procedures on the vessel while observing actual operations for about a day. During the briefing sessions, safety was emphasized. Since the quality of the data depended in large measure on the interest of the observers, it was necessary during the training period to establish whether or not checker replacements would be required. The motivation of the checkers varied a great deal; some just wanted to do a good job, some felt that the job was different and therefore interesting, and others felt that the work would be useful. At noon, and at the end of each day the data sheets were turned in by the observers to the members of the research team. The data were checked for errors and the next morning were discussed with the checkers. The major sources of errors consisted either of misreading the minutes or establishing incorrectly the time at which the draft arrived in the hold (i.e., the hatch observer's data would not agree with the hook observer). A less frequent error resulted from disagreement between the hatch observers as to the number of pieces on a draft.

Prior to the start of vessel loading, the stowage plans were examined in order to select compartments. Data were obtained when possible for all cargo loaded into one compartment. This was generally desirable to insure all cargo was accounted for because many company records specify cargo stowage location only by compartment and by position forward or aft. At the beginning of actual data collection, the purpose of the checkers was explained to the hatch foreman for the gangs being observed. It was found to be advantageous for the MCTC research members to wear distinguishing clothing in order that any questions be directed to them, rather than to the checkers.

Description of Forms

The Hook Sheet. Figure A-1 is a sample of the form used to collect data on the hook cycle by the observer stationed on the deck of the vessel. The reverse side of this form contains a detailed list of instructions. The following is a description of the break-point definitions used and of the observations noted:

Time Leave Apron (1). This column refers to the time the draft finally leaves the apron on its way to the hold. If the draft made a false start because of a package dropping off, and had to return to the apron, then the time recorded would be the second time that the vertical motion of the draft began.

Delay (2). This column refers to delays encountered by the draft after it leaves the apron and before it arrives in the hold. If the delay was incurred because the hold was not yet ready to receive the draft, the sub-column headed Hold was checked. Any other delays due to causes such as winch breakdown, rigging, etc., were noted by checking the sub-column headed Other and the cause noted in the Remarks column. (No. 10.)

Time Arrive Hold (3). This is the time that the draft is either first grasped or is in a position to be controlled, by members of the hold gang. This event is recorded also by the hatch observers, and is used to correlate the two data records.

Delay (4). This column refers to delays encountered by the hook after it leaves the hold and before it arrives back on the apron. If it was delayed in transit because there was no cargo waiting on the apron, then the sub-column headed Apron was checked. Other sources of delay were indicated by checking the sub-column Other and the reasons noted in the Remarks column.

Time Arrive Apron (5). This is the time the hook is either first grasped, or is in a position to be touched, by the hookmen.

Delay (6). This column refers to delays encountered by the hook after it arrives on the apron and before it leaves the apron. If the hook was delayed because no cargo was available, the sub-column Apron was checked. Other sources of delay were indicated by a check in the Other sub-column and the reason noted in the Remarks column.

Commodity (7). This column provides a description of the commodity loaded. Succeeding drafts of the same commodity were indicated with a check mark.

LOADING OBSERVATION
HOOK CYCLE

SHIP .... OBSERVER .... WATCH .... SHEET ....

HATCH .... RIG .... DATE .... WATCH CORR. ....

(1) Time Leave Apron	(2) Delay		(3) Time Arrive Hold	(4) Delay		(5) Time Arrive Apron	(6) Delay		(7) Commodity	(8) Gear Type	(9) Gear Out		(10) Remarks
	Hold	Other		Apron	Other		Apron	Other			Pallet	Other	

INSTRUCTIONS

(1) Observed time draft is lifted off the apron for movement to hold.

(2) Check proper column if an operational delay occurs between leave apron time and arrive hold time. If delay is due to inability of hold gang to receive draft, check "hold" delay column. For all other delays check "other" column *and in the remarks column enter cause of delay.* Examples of other delays: (a) Winch breakdown (b) Rigging, etc.

(3) Observed time draft arrives in the hold in position for hold gang to touch it.

(4) Check proper column if an operational delay occurs between leave hold time and arrive apron time. If delay is due to no cargo at apron, check "apron" delay column. For all other delays check "other" column *and in the remarks column enter cause of delay.* Examples of other delays on the apron are: (a) Winch breakdown (b) Rigging (c) Congestion.

(5) Observed time hook arrives at the apron in position for hookmen to touch it.

(6) Check proper column if an operational delay occurs between arrive apron time and leave apron time. If delay is due to no cargo at apron, check "apron" delay column. For all other delays check "other" column *and in the remarks column enter cause of delay.* Examples of other delays on the apron are: (a) Winch breakdown (b) Change of gear (c) Bringing gear into hold such as a fork lift, etc.

(7) Description of commodity loaded.

(8) Type of gear used to accommodate draft to hold such as: 1. Wire sling, 2. Rope sling, 3. Net, 4. Pallet sling, 5. Cargo tray, 6. Bridle, 7. Bridle hooks, 8. Spreader, 9. Chime hooks, 10. Clamps or tongs.

(9) Check proper "gear out" column when hook takes any type of stevedore gear out of the hold. If pallet boards are taken out, merely check "pallet" column. When any other gear is removed from the hold check "other" column *and in the remarks column enter type of gear removed* such as fork lift truck, water bucket, hand tools, roller conveyor, etc.

(10) In addition to specified instructions for use of "remarks" column note any additional information that affects the loading operation. For example, injury to a member of the longshore gang; changes in weather condition; changes in operational methods, such as the introduction of mechanical handling equipment in the hold; dunnaging; restowing spilled cargo; cleaning hatch, etc. Indicate time change or event occurred and length of time equipment is used or operations halted or slowed down.

FIGURE A-1

Gear Type (8). This column indicates the type of gear used to transport the draft to hold (see Instructions).

Gear Out (9). This column was used to record instances in which the hook unloaded gear from the hold. If the unloaded gear consisted of empty pallets the sub-column Pallets was checked. Removal of other gear from the hold was indicated by a check in the Other sub-column and a description was recorded in the Remarks column.

The Hatch Sheet. Figure A2 is a sample of the form used for the collection of hatch cycle data. The reverse side contains a list of instructions. The following is a description of the data which is called for:

Draft No. (1). This column is primarily for the convenience of the observers, in order to facilitate their keeping track of the drafts. Successive drafts were numbered consecutively. Since each observer followed one team, the draft numbers for one sheet increased in steps of 2 for each recorded draft as long as the teams were fed alternately by the hook.

Draft Arrives Hold (2). This is the time at which the draft was capable of being grasped by members of the hold gang and coincides with item (3) of the Hook Sheets.

Hook Leaves Hold (3). This is the final time at which the vertical motion of the hook out of the hold began.

Stow Begins (4). This is the time at which

LOADING OBSERVATION
HATCH CYCLE

SHIP________ OBSERVER________ WATCH NO.________ SHEET NO.________

HATCH________ RIG________ DATE________ WATCH CORR.________

(1) Draft No.	(2) Draft Arrives Hold	(3) Hook Leaves Hold	(4) Stow Begins	(5) Stow Ends	(6) Commod-ity	(7) Pkg. Type	(8) No. Men	(9) No. Units	(10) Stow Area WG	SQ.	(11) Remarks:

EXPLANATION OF COLUMNS

(1) Consecutive draft number. Each checker should follow activities of *one team.* So, normally, one checker will use odd numbers and the other will use even numbers. If several drafts in succession go to one team, or are stowed by the entire gang working as one team, one checker should time them and record the data. Be careful not to omit numbers, or to give two drafts the same number.
(2) Observed time at which draft arrives in hold and is under control of hatch men.
(3) Observed time when hook leaves hold.
(4) Observed time when first unit of cargo is removed from draft (or, if palletized or containerized, when forklift picks up unit).
(5) Observed time when last unit of cargo is stowed. If part of the team has already started stowing the next draft, enter a dash (—) here (*not* a check mark, √).
(6) Description of commodity.
(7) Type of packaging (carton, bag, palletized carton, transporter, etc.)
(8) Number of men actually engaged in physically handling cargo. Do not include men resting, foremen, men laying dunnage, etc.
(9) Number of units contained in each draft. Record 1 for transporters or for goods unitized on pallets (strapped or glued).
(10) Indicate area of stowage by check mark; WG = Wings, SQ = Hatch Square.
(11) Explain any delays observed. Indicate number of men dunnaging or similar activities. Record number and type of MHE and other gear used in hold.

FIGURE A-2

the first unit of cargo was removed from the draft or the time at which the fork lift first picked up a unit.

Stow Ends (5). This is the time when the last unit of cargo was stowed.

Commodity (6).

Package Type (7). See Instructions. Local checker terminology was used and translated later to a standard list.

Number of Men (8). The number of men actually engaged physically in handling cargo in the hold.

Number of units (9). The number of separable units on a draft.

Stow Area (10). Stowage area was indicated by a check in the sub-column headed Wing or Square, or both. Initially it was attempted to regard the Wing as consisting of two regions, a near and a far area, but this procedure did not prove satisfactory. If the stowage procedure consisted of "blocking out" (i.e., lifting cargo and stowing it by sections rather than by stowing it in horizontal layers across the entire hold) it was so indicated in the Remarks column.

Remarks (11). See Instructions.

Cargo Data

Time data provided a measure of the effort required to perform elements of the cargo loading operation. This measure of effort must be related to the characteristics of the cargo being handled. The major pertinent cargo characteristics are:

1. Commodity Type
2. Package Type
3. Number of Units
4. Weight
5. Volume

Of these, the latter two, weight and volume, cannot be obtained conveniently by observers at the scene of operations, and it was necessary to refer to company documents which describe the cargo. Sometimes commodity types were badly mixed and not available from data sheets. In such cases, only over-all averages from company documents could be used.

The procedure for relating cargo characteristics to corresponding time data varied widely from company to company, since it depended completely on the particular company's accounting system. Documents serving similar functions had a variety of nomenclatures, but the documents which were found generally useful may be listed roughly as:

1. Bills of Lading.
2. Dock Receipts.
3. Hatch Reports—generally original documents prepared by checkers on the dock.
4. Manifests—generally IBM tab.
5. The Hatch List—generally prepared as a discharge guide for the Ships' Officers.
6. The Stowage Plan.
7. Cargo Index Books—primary information from which stowage plans are made.

During the process of obtaining the weight and cube of cargo stowage in the compartment under study, it was possible to obtain data on number of units stowed, package type, and commodity type, and to check data from these sources with that obtained directly by the observers.

Editing the Time Data

Prior to transcribing the raw data from the original documents (see Figures A-1 and A-2), the forms were checked over for errors and edited. The editing was done with a red pencil in order to retain the identity of the original data. The order of editing was generally as follows:

1. The hook cycle and hold cycle data sheets were first correlated with respect to draft numbers. At the same time errors in the minute readings were picked up and corrected.

2. The blocks of consecutive drafts or identical commodity and gear were segregated by horizontal marks.

3. The hook wait-for-hold and hook wait-for-apron delays were computed and entered in red above the checks in columns (2), (4), and (6) of the Hook Sheet. The hook delay computation was done as follows: The average interval between the time the hook left the apron (column I) and the time the hook arrived in the hold (column 3) was computed for those drafts of the same commodity and gear for which no delay (column 3) was recorded. Delays were computed by subtracting this average difference from the corresponding intervals which were noted as having exhibited a delay. The computation of hook delays at the apron as a result of no available cargo (or for other reasons) was computed in a similar fash-

ion: The average interval between the time the hook arrived on the apron (column 5) and the time the hook left the apron (column 1 for the succeeding draft) was computed for drafts of identical cargo and gear for which no delay was recorded. The average difference at apron was subtracted from intervals recorded as experiencing a delay in order to provide a measure of the delay and the result put in red above the checks. Analysis of the delays checked as Other was made from noting the comments in the Remarks column. These delays were classified appropriately as either apron or hold delays or DGH (see below) and treated accordingly.

4. Certain delays in the loading of cargo were not conveniently assignable to any single commodity, but were considered as chargeable on a prorated basis. Delays of this type included laying dunnage, changing or moving gear, closing hatches, etc. and were referred to D.G.H. Based primarily on the Remarks column, those delays attributable to DGH were singled out by encircling and identified.

Appendix III

ACCURACY AND PRECISION OF DATA

Testing the accuracy or precision of an estimate of an average cycle time interval or average rate of loading for a given sample of data is complicated by the problem of establishing the parameter confines of the population to which the sample is considered to belong. The operation of handling cargo with men and equipment is subject to the effect of many more parameters than the most detailed practical data taking system can encompass. Because of the large number of parameters, many of which are unaccounted for, and the fact that observers have no control over the operation observed, there has been little or no opportunity to test the reproducibility of the samples obtained. The decision to assign a sample to one population or another so as to avoid fixed errors has been largely a subjective one.

For the above reason, while routine statistical quantities have in most cases been computed and in some cases presented, there is little confidence in their use as a measure of the reproducibility of the results presented. In view of this, although sample size information is always presented, standard deviations and confidence intervals have not been generally listed.

Nonetheless, certain statistical standards have been maintained throughout the analysis. No sample size for which averages have been presented is smaller than 15 drafts of cargo. Analysis of many samples has shown that the standard deviation of cycle time data seldom if ever exceeds 40 percent of the mean. On this basis, the 90 percent confidence interval of the estimate of a mean from a sample of 15 drafts is no more than ± 20 percent of the mean. Most samples utilized have more than 15 drafts and might be considered to yield more precise time averages. However, it is doubtful that even the largest samples are more reproducible than ± 10 percent at the 90 percent confidence level in view of neglected factors which bear on both hook and hold performances such as temperature and humidity conditions, gang incentive, gang experience, etc.

While there is no way of measuring the accuracy of commodity information in terms of weight and volume, it is considered to exceed greatly the level of confidence of time information particularly in the case of single commodity samples. Thus the confidence in average rates whether in terms of drafts per hour, long tons per hour, or measurement tons per hour is estimated to be significantly affected only by the confidence in time information.

Regression analysis has been carried out in the studies of hold gang fatigue in Section IV. In these cases the square of the correlation coefficient is indicated by the percent figure given. In calculation of the simple correlation coefficient for a group of samples, each sample has been weighted by its corresponding number of drafts. Some simple regression work has been done in other portions of the study, but the need for multiple regression analysis has become most apparent. Unfortunately, the lack of control over the range of samples collected has precluded an adequate group sample size for satisfactory results with multiple regression techniques.

The validity of many conclusions drawn depends not only on direct correlation statistics shown, but on their consistency with conclusions from other phases of the analysis. Thus in the study of loading rate versus draft size, there is substantiation of the conclusion that larger drafts will bring about higher loading rates from the hook cycle studies and from the hold gang fatigue studies. A larger draft is likely to increase productivity only if the hook is the bottleneck as indicated in the cycle studies. Similarly a larger draft can be profitable only if the hold gang has the capacity to do more work as indicated in the hold gang fatigue studies.

Appendix IV

FACILITIES DESCRIPTIONS AND DATA OBTAINED

Introduction

This section contains a detailed listing of the characteristics of each facility where data were taken. In addition, it contains a detailed listing of the reduced data taken at each port with a description of the special nature of the loading operation at each facility. The presentation of data also includes sample distributions of hook and hold work cycles for some typical commodities.

Table A-1 is an explanation of the time column headings for the detailed listings of reduced data presented in this section for each port. The table indicates the method used to reduce the raw time data as obtained from the hook and hold data collection sheets shown in Appendix II. It also serves as a definition of time terms as they are used throughout the study.

The purpose of presenting the detailed data is to invite further research in the field. Undoubtedly more can be done than has been done with data obtained. In addition if more data is taken by others it may be carefully compared with that presented. The hook and hold work cycle samples should be of particular interest to operations research people and statisticians. The development of an adequate statistical concept for prediction of hook wait-for-hold and hold wait-for-hook time averages awaits a subtle application of queueing techniques. While the solution of this problem has not

TABLE A-1

Explanation of Time Columns in Detailed Data Listings

Column 6—Net Operating time. Obtained from the time difference between hook time arrive apron (column 5 of hook cycle data sheet) for first draft of sample group and time the hook arrives at apron after the last draft of the sample. Estimation of hook time of arrival at apron is sometimes required. Time for dunnaging, gear changing, and house keeping (DGH time as determined for column 7) and lunch breaks is subtracted when occurring within period considered.

Column 7—DGH time, time required for gear changing and house keeping chores. Group total of red figures marked DGH on hook cycle sheet.

Column 10—Time at apron (%).[1] Group total of differences obtained by substracting time hook arrives at apron (column 5 on hook sheet) from time hook leaves apron (column 1 on hook sheet).

Column 11—Time in hold (%).[1] Group total of differences obtained by subtracting the time draft arrives hold (column 2 of hatch sheet) from the time hook leaves hold (column 3 of hatch sheet).

Column 12—Time in transit (%).[1] Column 10 plus column 11 subtracted from 100 percent.

Column 13—Hook wait for apron (%).[1] Group total of red figures over checks in delay at apron (columns 4a and 6a on hook sheet).

Column 14—Hook wait for hold (%).[1] Group total of red figures over checks in hold delay (column 2a on hook sheet).

Column 17—Hold work (%).[1] Group total of time differences obtained by subtracting the time draft arrives hold (column 2 on hatch sheet) from the time stow ends (column 5 on hatch sheet). When 2 teams are working, this total must be divided by 2.

Column 18—Hold wait (%). Column 17 subtracted from 100 percent.

Column 19—L. T. per hour. Group total of long tons from column 2 (generally obtained from ship manifest or hatch list) divided by net operating time (column 6 above) converted into hours.

Column 20—M. T. per hour. Group total of measurement tons from column 3 (generally obtained from ship manifest or hatch list data) divided by net operating time (column 6 above) converted into hours.

[1]Percent is obtained by dividing the indicated total by net operating time. (Column 6 above.)

been considered essential to the purpose of this study, it is well worth further work for a complete understanding of the conventional loading operation.

FACILITIES DESCRIPTION

New Orleans Commercial I

Wharf Type	Quay
Construction	Open pile shore wharf, concrete deck
Dimensions	
Length	896 feet
Useable berthing space	896 feet
Apron width	18-19 feet
Transit Shed Construction	One, 1-story steel frame, metal covered.
Dimensions	
Length & width	880x140 feet
Height inside	——
Floor area for cargo	123,000 square feet
Cargo doors	(shipside) 26, 20 feet wide
House falls	None
Railway connections	Depressed track running length of 30 feet wide loading platform, land side of shed.
Truck facilities	Truck access to shed via 30 feet rear platform roadway

Ship Type: C-3

No cargo was received at this terminal during the loading operation. Cargo loaded at this terminal was sulphur in paper multi-wall bags, which were stored on 4'x7' pallets in the transit shed. Two fork lifts, carrying two pallets per trip, were used to feed each hook at No. 3 hatch. In the hold, two dollies were being used at the after rig to roll each draft into the wings.

FACILITIES DESCRIPTION

New Orleans Commercial II

Wharf Type	Quay
Construction	Open pile shore wharf, part concrete and part timber deck.
Dimensions	
Length	1300 feet
Useable berthing space	1300 feet
Apron width	14-23 feet
Transit Shed Construction	One 1-story steel frame, metal covered.
Dimensions	
Length and width	1300x164 feet
Height inside	——
Floor area for cargo	200,800 square feet
Cargo doors	(Shipside) 60, 20 feet wide
House Falls	None
Railway Connections	Depressed track running length of 30-ft. wide concrete rear apron roadway.
Truck facilities	Truck access to shed via ramp and 30 ft. wide rear apron roadway.

Ship Type: C-1B; C-2

Receipt of Cargo

The major portion of the cargo received at this terminal during the loading operation was by rail delivery via the depressed track running the length of a 30-ft. wide apron on the inland side of the transit shed. Carefully coordinated rail movement had the cars positioned as close as possible to the storage bay in which the cargo was to be stored. Cars were spotted and ready, with doors open before 8 a.m. and 1 p.m. daily. Movement to storage bays was by hand truck or wagons. In the storage bay, the cargo was loaded on pallets which had been pre-positioned on the floor. Fork lifts on an opportunity basis would stack loaded pallets and deliver empty pallets for loading in each bay.

Truck delivery, which accounted for roughly 20 percent of the cargo received during the survey at this terminal, was accomplished by driving the trucks into the transit shed and unloading in the bay reserved for the cargo. The unloading was done onto pallets which had been pre-positioned on the floor in the bay. Again, no fork lifts were assigned specifically to any cargo receipt operation, but pallets were stacked by fork lifts on an opportunity basis.

A unique method of unloading bags and cartons onto pallets was observed in this terminal. Loaded semi-trailers would straddle a line of pre-positioned pallets and move down the line as each pallet was loaded. This offset the disadvantage of not having a fork lift assigned to remove loaded pallets.

Barges delivered drums and cotton seed meal directly to the ship.

Quay Conditions

Cargo on the quay was well laid out; there was no congestion; receipt of cargo did not interfere with the loading operation.

Stevedore Equipment

4'x7' pallets were standard in the loading operation, and empties were stacked in the hold for removal after about six were accumulated.

4'x10' trays, fitted with projecting eyes at each corner, were used for loading hides. Since the eyes interfered with stacking, a tray was removed from the hold after each draft was brought in.

Drums were loaded from barges and from the apron with drum-clamps, a special clamping device which lifted six steel drums per draft, removing the drums on end from a pallet, and delivering them standing up, in the hold. Since the drums were stored in the transit shed six to a pallet, use of this clamping device made it unnecessary to handle the drums at the apron other than to space them on the pallet so that the drum-clamps could be fitted over the drum ends.

Two fork-lifts were used to feed each hook except when lumber was being loaded, in which case one tractor with two trailers was used per hook.

Although two winch operators were assigned only one manned the two winches at any one time.

FACILITIES DESCRIPTION

New Orleans Commercial III

Wharf Type	Quay
Construction	Open pile shore wharf, timber deck
Dimensions	
Length	4,730 feet
Useable berthing space	4,730 feet
Apron width	20 feet
Transit Shed Construction	One 1-story, lower end steel frame, metal covered, upper end all wood
Dimensions	
Length and width	4,330x140-150 feet
Height inside	16 feet
Floor area for cargo	614,800 square feet
Cargo doors	——
House Falls	None
Railway Connections	2 surface tracks on apron, total length 920 feet; 2 depressed tracks running length of shed at rear.
Truck Facilities	——

Ship Type: C-2

Cargo loaded at this terminal consisted of bagged ammonium sulphate fertilizer exclusively. Ammonium sulphate was received in bulk by rail and bagged mechanically in the transit shed.

Dock workers removed bags from the cargo pile at the output end of the bagger, and loaded 4′x10′ trays which had been placed on trailers, one tray per trailer. One tractor and three sets of three trailers each were assigned to a hook. Normally, three trailers were at the apron, three at the cargo pile, and three in transit.

Initially, 32 bags were loaded on each tray, however union delegates held that 32 bags constituted too great a load, and the draft size was subsequently reduced to 24 bags.

Trays were not stacked in the hold since the metal eyes at the corners interfered with stacking. An empty tray was removed by the hook after each draft was delivered to the hold.

FACILITIES DESCRIPTION

Baltimore

Wharf Type	Pier
Construction	Concrete retaining walls, solid fill, with timber pile, timber-decked outer section and side aprons.
Dimensions	
Length and width	928 feet (east side); 514 feet (west side)
Useable berthing space	928 feet (east side); 514 feet (west side)
Apron width	14 feet (east side); 7 feet (west side)
Transit Shed Construction	One 2-story, steel frame, metal covered, 1st floor composition block; 2nd floor wood.
Dimensions	
Length and width	941x138 feet
Height inside	1st floor 18 ft.; 2nd 12-16 ft.
Floor area for cargo	205,800 sq. ft.
Cargo doors	(shipside) lower: 29 doors 17′ w x 12′ h; one door 20′ w x 16′ h; one door 12′x12′ upper: 31 doors 18′ w x 12′ h. Five 5-ton movable loading platforms on 2nd floor level 18′ w x 8′ (apx)
Railway connections	One 915′ surface track on east apron; 2 depressed tracks inside shed.
Truck facilities	Pier is not accessible to trucks. One 50-foot open and one 60-foot covered truck loading platform at shore end of shed. 300 foot covered platform along west side of shed.

Ship Type: C-2

Receipt of Cargo

Cargo was received at the pier by rail and truck. With the exception of special cargoes (heavy lifts and outsized commodities) which were delivered to ship-side via the apron truck, all rail cargo was unloaded onto 4′x6′ pallets from railcars spotted along depressed tracks within the transit shed. Unloading was done both directly to the hook, and to storage bays. The location of railcars was such that considerable fork lift cross-traffic to and from railcars occurred and fork lifts often had to travel long distances from hook or storage bay to the rail car. Instances were observed in which railcars on the west track were being unloaded to storage bays on the east side of the transit shed so that the fork lifts were required to travel considerable distances to drawbridges crossing the depressed tracks.

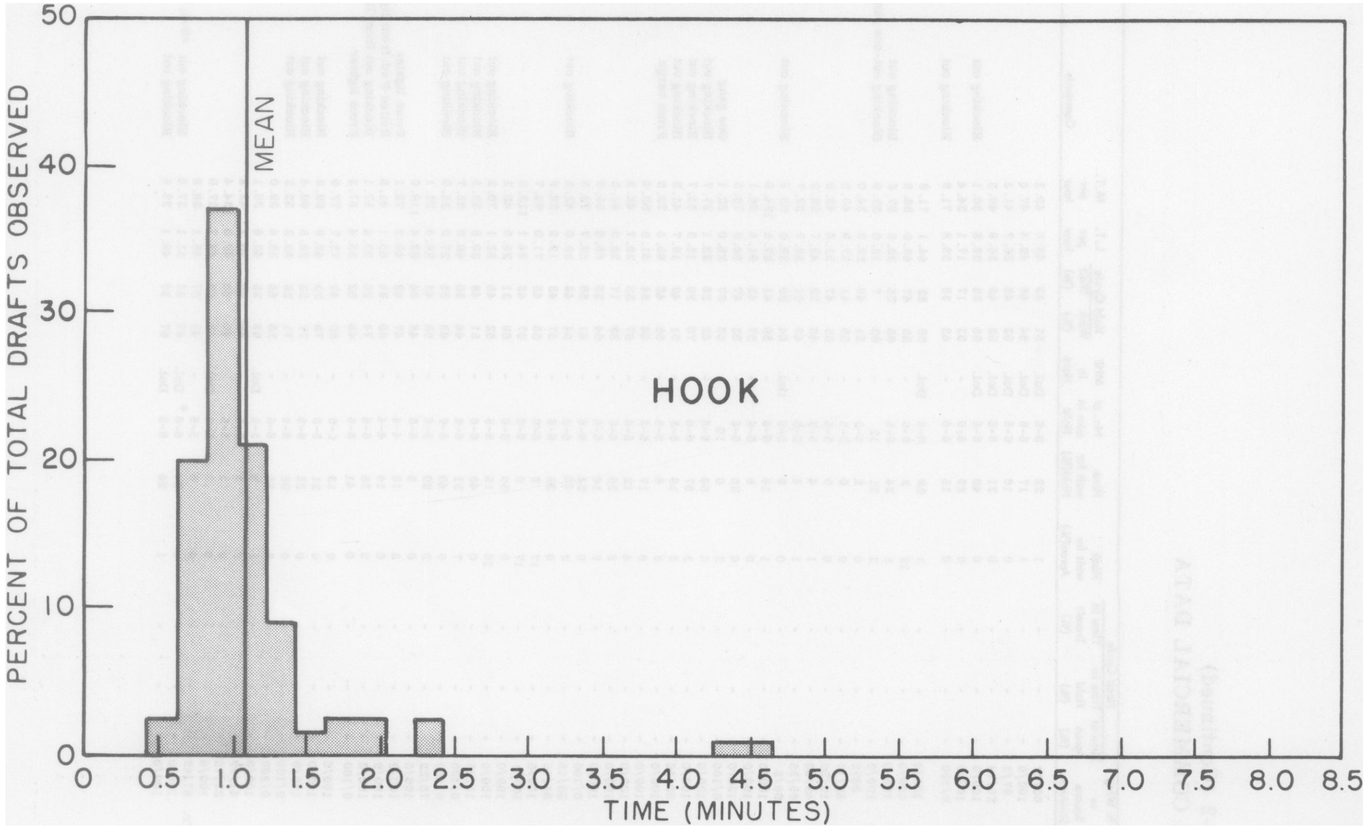
TABLE A-2
NEW ORLEANS COMMERCIAL DATA

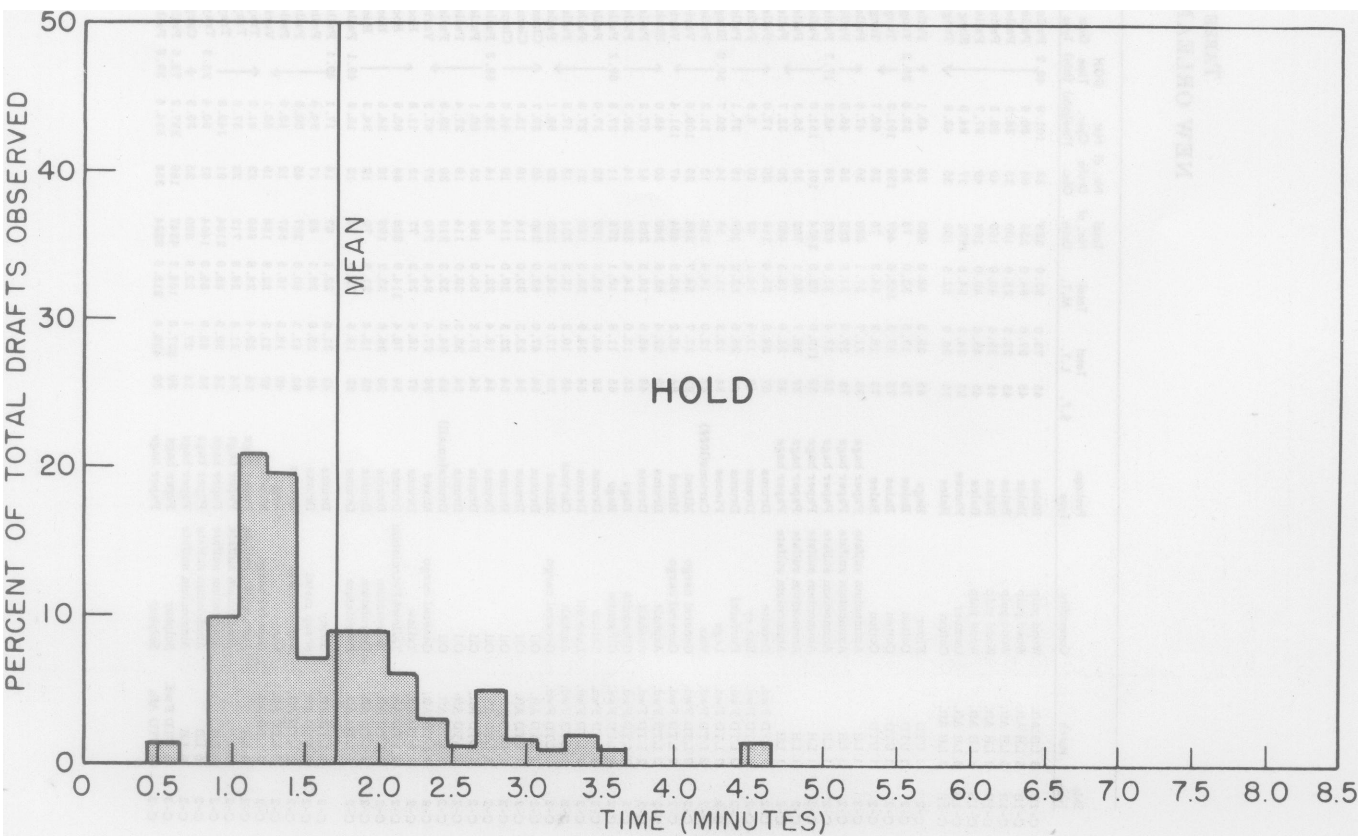
Ship Type	Hatch	Commodity	Package Type	S. F.	Total L. T.	Total M. T.	Total No. of Units	No. of Drafts Obs.	Net. Oper. Time (Min.)	DGH Time (Min.)	Gear Type	% Wing to Square Stowage	Hook Cycle: Time at Apron (%)	Hook Cycle: Time in Hold (%)	Hook Cycle: Time in Transit (%)	Hook wait for Apron(%)	Hook wait for Hold(%)	No. of men in Hold	MHE in Hold	Hold Cycle: Work (%)	Hold Cycle: Wait (%)	L. T. per hour	M. T. per hour	Comments
G-1B	1 UTD	Carbon black	Bags	170	10.9	46.2	947	21	30.0		Pallets	100/0	-	-	-	6	11	6-6	-	63	37	21.8	92.4	25-pound bags
C-1B	1 UTD	Carbon black	Bags	88	35.8	78.4	1568	49	71.2		Pallets	100/0	-	-	-	2	14	6-6	-	65	35	30.2	66.1	
C-1B	1 UTD	Carbon black	Bags	87	25.5	55.7	1120	35	50.1		Pallets	100/0	-	-	-	0	7	6-6	-	70	30	30.5	66.7	
C-1B	1 UTD	Carbon black	Bags	85	19.8	42.1	759	33	44.4	18.0	Pallets	100/0	-	-	-	0	10	6-6	-	57	43	26.8	56.9	
C-1B	1 UTD	Carbon black	Bags	85	15.0	31.9	575	25	34.8		Pallets	92/8	-	-	-	0	19	6-6	-	58	42	25.9	55.0	
C-1B	1 UTD	Carbon black	Bags	85	6.0	12.8	240	10	14.2		Pallets	0/100	-	-	-	0	20	6-6	-	68	32	25.3	54.1	
C-1B	1 UTD	Rice bran	Bags	65	71.7	115.9	1608	67	103.0		Pallets	3/97	-	-	-	0	17	6-6	-	54	46	41.8	67.5	
C-1B	1 LTD	Corn	Sacks	55	17.3	23.8	364	13	20.9		Pallets	100/0	-	-	-	0	13	6-6	-	64	36	49.7	68.3	
C-1B	1 LTD	Corn	Sacks	55	111.7	153.7	2352	84	107.3		Pallets	0/100	-	-	-	2	15	6-6	-	63	37	62.5	85.9	
C-1B	1 LTD	Corn	Sacks	55	62.5	86.0	1316	47	86.7	30.7	Pallets	98/2	-	-	-	0	29	6-6	Dol.	68	32	43.3	59.5	Blocking out
C-1B	1 LTD	Corn	Sacks	55	58.5	80.5	1232	44	62.4		Pallets	100/0	-	-	-	4	27	6-6	Dol.	66	34	56.2	77.4	Blocking out
C-1B	1 LTD	Petroleum	Drums	65	21.0	34.1	105	21	24.7		Pallets	100/0	-	-	-	2	14	6-6	-	45	55	51.0	82.8	
C-1B	1 LTD	Tobacco	Hogshead	134	10.2	34.2	17	17	18.3		Sling	100/0	-	-	-	2	10	6-6	-	35	65	33.4	112.1	
C-1B	1 LTD	Clay	Bags	28	116.7	82.9	2548	93	139.2		Pallets	100/0	-	-	-	0	26	6-6	-	60	40	50.3	35.7	
C-1B	1 LTD	Petrolatum	Drums	64	38.4	61.0	201	34	35.8		Clamps	100/0	-	-	-	0	0	6-6	-	31	69	64.4	102.0	
C-1B	1 LTD	Naptha-Petrolatum	Drums	69	27.1	47.0	156	27	33.2		Clamps	84/16	-	-	-	9	8	6-6	-	39	61	49.0	84.9	
C-1B	1 LTD	Naptha	Drums	71	28.1	49.8	164	29	50.0		Clamps	62/38	-	-	-	6	41	6-6	-	47	53	33.7	59.8	
C-1B	1 LTD	Naptha	Drums	71	28.1	49.8	164	29	45.0	136.6	Clamps	0/100	-	-	-	7	11	6-6	-	42	58	37.5	66.4	
C-1B	1 LTD	Billets	Bundles	91	16.8	38.4	704	44	49.1		Pallets	80/20	-	-	-	1	39	6-6	-	70	30	20.5	46.9	Blocking out
C-1B	1 LTD	Billets	Bundles	91	20.0	45.6	836	44	40.7		Pallets	0/100	-	-	-	3	21	6-6	-	63	37	29.5	67.2	
C-1B	1 LTD	Empty Ethyl Drums	Drums	413	3.2	33.0	100	17	25.4		Pallets	24/76	-	-	-	0	11	6-6	-	36	64	7.6	77.9	
C-1B	1 LH	Corn	Bags	55	71.8	98.8	1458	54	78.8		Pallets	99/1	-	-	-	7	13	6-6	Dol.	59	41	54.7	75.2	Blocking out
C-1B	1 LH	Corn	Bags	55	18.6	25.6	378	14	20.7		Pallets	90/10	-	-	-	3	6	6-6	Dol.	51	49	53.9	74.2	
C-1B	1 LH	Corn	Bags	55	29.3	40.3	594	22	27.9		Pallets	41/59	-	-	-	0	10	6-6	-	53	47	63.0	86.7	
C-1B	1 LH	Corn	Bags	55	63.8	87.8	1296	48	78.6	7.9	Pallets	87/13	-	-	-	1	15	6-6	-	52	48	48.7	67.0	Blocking out
C-1B	1 LH	Corn	Bags	55	62.5	86.0	1269	47	69.1		Pallets	0/100	-	-	-	1	16	6-6	-	62	38	54.3	74.7	
C-1B	2 UTD Aft.	Liquid foam	Pails(5 gal.)	42	51.3	54.0	2133	45	76.5		Pallets	100/0	-	-	-	2	33	5-5	Dol.	58	42	40.2	42.3	Blocking out
C-1B	2 UTD Aft.	Liquid foam	Pails(5 gal.)	42	20.5	21.6	853	18	31.9		Pallets	100/0	-	-	-	0	32	5-5	Dol.	63	37	38.6	40.6	
C-1B	2 UTD Aft.	Liquid foam	Pails(5 gal.)	42	85.5	90.0	3555	75	118.7	12.9	Pallets	100/0	-	-	-	1	27	5-5	Dol.	62	38	43.2	45.5	Blocking out
C-1B	2 UTD Aft.	Aluminum foil	Boxes	68	18.2	30.8	165	14	30.3		Pallets	59/41	-	-	-	3	26	5-5	-	47	53	36.0	61.0	Blocking out
C-1B	2 UTD Aft.	Aluminum foil	Boxes	68	16.9	28.6	153	13	26.0		Pallets	100/0	-	-	-	0	37	5-5	Dol.	54	46	39.0	66.0	Blocking out
C-1B	2 UTD Aft.	Paint	Pails & cartons	51	12.1	15.4	627	11	18.0	12.9	Pallets	100/0	-	-	-	4	26	5-5	-	67	33	40.3	51.3	Blocking out
C-1B	2 UTD Aft.	Household goods	Boxes	231	8.1	46.8	18	18	57.9		Pallets	40/60	-	-	-	0	35	5-5	-	29	71	8.4	48.5	
C-1B	2 UTD Aft.	General cargo	Boxes	112	6.7	18.0	146	13	27.0		Pallets	23/77	-	-	-	3	17	5-5	-	52	48	14.9	40.0	
C-1B	2 UTD Fwd.	Household goods	Boxes	231	14.4	83.2	34	32	47.8		Pallets	100/0	-	-	-	1	13	5-5	Dol.	41	59	18.1	104.4	
C-1B	2 UTD Fwd.	Household goods	Boxes	230	11.3	65.0	27	25	41.8		Pallets	100/0	-	-	-	0	14	5-5	-	34	66	16.2	93.3	
C-1B	2 UTD Fwd.	Household goods	Boxes	231	19.4	111.8	46	43	87.5	15.3	Pallets	22/78	-	-	-	0	5	5-5	Dol.	25	75	13.3	76.7	Blocking out
C-1B	2 UTD Fwd.	General cargo	Mixed	86	40.0	86.1	748	87	115.7		Pallets	89/11	-	-	-	1	23	5-5	-	55	45	20.7	44.6	
C-1B	2 UTD Fwd.	General cargo	Mixed	86	11.5	24.8	215	25	34.3		Pallets	100/0	-	-	-	1	18	5-5	-	53	47	20.1	43.4	Blocking out
C-1B	2 LTD Fwd.	Earth	Bags	52	36.8	48.0	1601	69	93.1		Pallets	100/0	-	-	-	0	20	6-6	Dol.	49	51	23.7	30.9	Blocking out
C-1B	2 LTD Fwd.	Earth	Bags	52	16.1	20.9	696	30	36.1		Pallets	100/0	-	-	-	0	16	6-6	Dol.	47	53	26.8	34.7	Blocking out
C-1B	2 LTD Fwd.	Earth	Bags	52	31.1	40.4	1346	58	67.4	65.5	Pallets	0/100	-	-	-	0	15	6-6	Dol.	48	52	27.7	36.0	Blocking out
C-1B	2 LTD Fwd.	Sheet steel	-	8	40.9	8.0	16	16	34.0		Sling	0/100	-	-	-	0	0	10	-	48	52	72.2	14.1	2 gangs together
C-1B	2 LTD Aft.	Corn starch	Bags	58	201.3	290.1	3530	181	253.8		Pallets	100/0	-	-	-	0	23	6-6	Wag.	65	35	47.6	68.6	
C-1B	2 LTD Aft.	Earth	Bags	52	9.1	11.8	394	17	29.4	27.7	Pallets	50/50	-	-	-	7	21	6-6	-	34	66	18.6	24.1	
C-1B	2 LTD Aft.	Cotton	Bales	77	32.7	63.3	147	49	74.6		Tongs	0/100	-	-	-	6	10	6-6	-	44	56	26.3	50.9	Blocking out
C-1B	2 LH Fwd.	Cotton	Bales	85	41.6	88.8	178	60	66.2		Tongs	80/20	-	-	-	10	8	6-6	-	39	61	38.1	81.4	Blocking out
C-1B	2 LH Fwd.	Cotton	Bales	86	67.1	143.6	287	97	110.7	5.5	Tongs	69/31	-	-	-	4	7	6-6	-	46	54	36.4	77.8	Blocking out
C-1B	2 LH Fwd.	Cotton	Bales	85	47.8	102.1	204	69	72.0		Tongs	100/0	-	-	-	1	9	6-6	-	70	30	39.8	85.1	Blocking out
C-1B	2 LH Fwd.	Cotton	Bales	85	21.5	45.8	92	31	47.4		Tongs	16/84	-	-	-	3	20	6-6	-	46	54	27.2	58.0	Blocking out & Beam stow
C-1B	2 LH Aft.	Rosin	Drums	50	26.9	33.9	114	23	20.9		Pallets	100/0	-	-	-	0	8	6-6	-	59	41	77.2	97.3	
C-1B	2 LH Aft.	Rosin	Drums	50	23.9	30.0	99	20	21.8		Pallets	100/0	-	-	-	0	15	6-6	-	42	58	65.8	82.6	
C-1B	2 LH Aft.	Cotton	Bales	86	40.4	86.5	172	58	55.6		Tongs	100/0	-	-	-	2	3	6-6	-	64	36	43.6	93.3	Blocking out
C-1B	2 LH Aft.	Cotton	Bales	86	49.4	106.0	213	72	81.8	38.1	Tongs	60/40	-	-	-	0	6	6-6	-	48	52	36.2	77.7	Blocking out
C-1B	2 LH Aft.	Cotton	Bales	86	34.7	74.5	148	50	64.0		Tongs	74/26	-	-	-	1	20	6-6	-	63	37	32.5	69.8	Blocking out
C-1B	2 LH Aft.	General cargo	Mixed	80	11.3	22.7	323	15	37.3		Pallets	40/60	-	-	-	1	22	6-6	-	53	47	18.2	36.5	
C-1B	3 LH Fwd.	Wood pulp	Bales	45	52.5	59.0	236	59	84.9		Pallets	86/14	-	-	-	2	5	6-6	-	48	52	37.1	41.7	
C-1B	3 LH Fwd.	Wood pulp	Bales	45	147.8	166.0	664	166	237.4		Pallets	77/23	-	-	-	0	11	6-6	-	46	54	37.3	41.9	
C-1B	3 LH Fwd.	Pulp	Bales	45	27.6	31.0	124	31	65.6		Pallets	81/9	-	-	-	0	31	6-6	Dol.	75	25	25.2	28.3	
C-1B	3 LH Fwd.	Lumber, Hickory, Stock, Handles	Mixed	63	28.2	44.5	1725	23	97.2		Pallets	100/0	-	-	-	0	28	6-6	-	73	27	17.4	27.5	
C-1B	3 LH Fwd.	Cotton	Bales	81	37.0	75.0	150	50	60.8		Tongs	48/52	-	-	-	0	1	6-6	-	41	59	36.5	74.0	

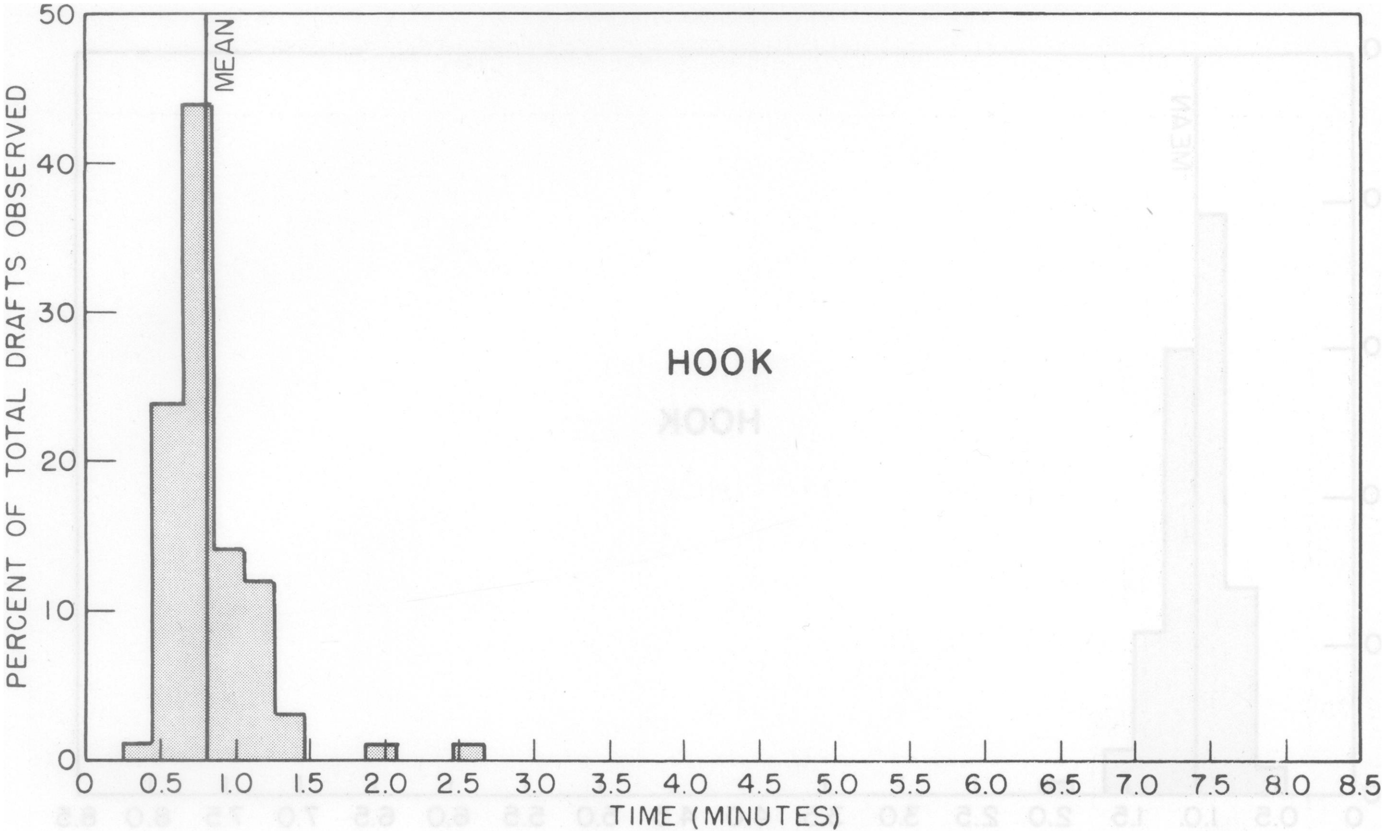
TABLE A-2 (Continued)
NEW ORLEANS COMMERCIAL DATA

Ship Type	Hatch	Commodity	Package Type	S.F.	Total L.T.	Total M.T.	Total No. of Units	No. of Drafts Obs.	Net Oper. Time(min)	DGH Time (min)	Gear Type	% Wing to Square Stowage	Hook Cycle: Time at Apron (%)	Hook Cycle: Time in Hold (%)	Hook Cycle: Time in Transit (%)	Hook wait for Apron(%)	Hook wait for Hold(%)	No. of men in Hold	MHE in Hold	Hold Cycle: Work (%)	Hold Cycle: Wait (%)	L.T. per hour	M.T. per hour	Comments
C-1B	3 LH Aft.	Wood pulp	Bales	45	73.0	82.0	328	82	101.9	40.2	Pallets	68/32	-	-	-	1	22	6-6	Dol.	51	49	43.0	48.3	
C-1B	3 LH Aft.	Wood pulp	Bales	45	57.0	64.0	256	64	80.6		Pallets	100/0	-	-	-	1	17	6-6	Dol.	54	46	42.4	47.6	
C-1B	3 LH Aft.	Wood pulp	Bales	45	22.2	25.0	100	25	36.3		Pallets	97/3	-	-	-	0	16	6-6	Dol.	52	48	36.7	41.3	
C-1B	3 LH Aft.	Wood pulp	Bales	45	35.6	40.0	160	40	59.5		Pallets	26/74	-	-	-	0	21	6-6	Dol.	52	48	35.9	40.3	
C-1B	3 LH Aft.	Wood pulp	Bales	45	43.6	49.0	196	49	97.7		Pallets	100/0	-	-	-	0	40	6-6	Dol.	65	35	26.8	30.1	Blocking out
C-1B	3 LH Aft.	Lumber	Pieces	57	24.2	34.5	1292	17	84.8		Sling	100/0	-	-	-	0	29	6-6	-	83	17	17.1	24.4	
C-1B	3 LH Aft.	Cotton	Bales	78	26.9	52.5	105	35	43.8	↓	Tongs	0/100	-	-	-	0	15	6-6	-	42	58	36.8	71.9	Blocking out
C-2	1 UTD	Flour	Bags	65	29.5	48.0	600	25	40.1	↑	Pallets	100/0	-	-	-	3	29	6-6	Dol.	68	32	44.1	71.8	
C-2	1 UTD	Cotton	Bales	75	17.5	33.0	73	25	22.8	35.2	Tongs	100/0	-	-	-	12	2	6-6	-	53	47	46.0	86.8	
C-2	1 UTD	Cotton	Bales	75	97.3	183.6	407	139	191.2		Tongs	100.0	-	-	-	5	24	6-6	-	65	35	30.5	57.6	Blocking out
C-2	1 UTD	Cotton	Bales	75	18.2	34.3	76	26	60.7	↓	Tongs	100/0	-	-	-	2	31	12	-	93	7	18.0	33.9	Blocking out-one gang
C-2	1 LH	Ammonium sulfate	Paper bags	38	31.7	27.1	690	30	47.8	↑	Pallets	98/2	-	-	-	0	2	5-5	-	51	49	39.8	34.0	
C-2	1 LH	Ammonium sulfate	Paper bags	38	37.4	31.6	832	26	46.8		Pallets	83/17	-	-	-	0	0	5-5	-	59	41	47.9	40.5	
C-2	1 LH	Ammonium sulfate	Paper bags	38	37.4	31.6	832	26	43.3	17.7	Pallets	10/90	-	-	-	0	0	5-5	-	53	47	51.8	43.8	
C-2	1 LH	Ammonium sulfate	Paper bags	38	110.0	92.8	2424	101	151.0		Pallets	42/58	-	-	-	1	4	5-3	-	48	52	43.7	36.9	
C-2	1 LH	Ammonium sulfate	Paper bags	38	35.7	30.1	792	33	55.3		Pallets	65/35	-	-	-	1	4	5-5	-	49	51	38.7	32.7	
C-2	1 LH	Ammonium sulfate	Paper bags	38	21.6	18.3	480	20	32.7	↓	Pallets	98/2	-	-	-	0	9	5-5	Dol.	64	36	39.6	33.6	Blocking out
C-2	2 LTD Fwd.	Dronite	Drums	57	24.8	35.4	116	20	17.0	↑	Pallets	100/0	-	-	-	1	16	6-6	-	59	41	87.5	124.9	
C-2	2 LTD Fwd.	Hon ey	Drums	42	13.4	14.1	43	10	8.8		Pallets	100/0	-	-	-	0	9	6-6	-	57	43	91.4	96.1	
C-2	2 LTD Fwd.	Furfural	Drums	50	26.6	33.2	108	19	27.1		Pallets	100/0	-	-	-	0	25	6-6	-	53	47	58.9	73.5	
C-2	2 LTD Fwd.	Logs	Pieces	34	13.3	11.3	56	14	30.7	39.8	Slings	0/100	-	-	-	2	0	10	-	63	37	26.0	22.1	One gang
C-2	2 LTD Fwd.	Wax	Cartons(108#)	48	12.0	14.4	240	12	31.2		Pallets	100/0	-	-	-	0	56	6-6	-	62	38	23.1	27.7	Blocking out
C-2	2 LTD Fwd.	General cargo	Mixed	93	27.7	64.7	238	29	108.6		Various	100/0	-	-	-	3	57	6-6	-	70	30	15.3	35.7	Blocking out
C-2	2 LTD Fwd.	General cargo	Mixed	84	43.2	90.3	484	47	131.4	↓	Various	50/50	-	-	-	3	18	5-5	-	51	49	19.7	41.2	Blocking out
C-2	2 LTD Fwd.	Asphalt	Drums	49	52.4	63.6	240	40	48.0	↑	Hooks	100/0	-	-	-	3	6	5-5	-	55	45	65.5	79.5	From barge
C-2	2 LTD Fwd.	Asphalt	Drums	48	46.6	56.5	205	41	67.2		Pallets	100/0	-	-	-	9	17	6-6	-	46	54	41.6	50.4	
C-2	2 LTD Fwd.	Gibsonite	Bags	65	15.0	24.4	350	14	30.3		Pallets	100/0	-	-	-	4	12	6-6	-	67	33	29.7	48.3	
C-2	2 LTD Fwd.	Gibsonite	Bags	65	11.8	19.1	275	11	27.8	89.2	Pallets	100/0	-	-	-	5	26	6-6	-	83	17	25.5	41.2	
C-2	2 LTD Fwd.	Tallow	Drums	58	40.6	58.6	192	32	37.0		Pallets	100/0	-	-	-	0	14	6-6	-	64	36	65.8	95.0	
C-2	2 LTD Fwd.	Lube oil	Drums	54	24.9	33.5	126	21	27.8		Pallets	0/100	-	-	-	0	24	6-6	-	41	59	53.7	72.3	
C-2	2 LTD Fwd.	Asphalt	Cartons	48	10.2	12.3	221	13	17.5		Pallets	85/15	-	-	-	2	22	6-6	-	54	46	35.0	42.2	Blocking out
C-2	2 LTD Fwd.	General cargo	Mixed	55	17.9	24.7	286	22	55.1	↓	Pallets	84/16	-	-	-	0	26	6-6	-	57	43	19.5	26.9	
C-2	2 LTD Aft.	Oil	Drums	54	47.0	63.0	240	40	39.7	↑	Clamps	100/0	-	-	-	17	2	6-6	-	55	45	71.0	95.7	
C-2	2 LTD Aft.	Oil	Drums	54	22.3	30.0	114	19	15.9		Clamps	100/0	-	-	-	17	0	6-6	-	57	43	84.1	113.2	
C-2	2 LTD Aft.	Oil	Drums	54	22.3	30.0	114	19	44.8		Clamps	100/0	-	-	-	0	50	6-6	-	69	31	29.9	40.2	
C-2	2 LTD Aft.	Oil	Drums	54	16.4	22.1	84	14	18.9	58.3	Pallets	100/0	-	-	-	16	16	6-6	-	52	48	52.1	70.2	Blocking out
C-2	2 LTD Aft.	Oil	Drums	54	37.2	50.0	198	33	56.1		Pallets	15/85	-	-	-	0	48	6-6	-	51	49	39.8	53.5	Blocking out
C-2	2 LTD Aft.	Oil	Drums	54	22.3	30.0	114	19	27.4		Pallets	0/100	-	-	-	7	31	6-6	-	44	56	48.8	65.7	Blocking out
C-2	2 LTD Aft.	Oil	Drums(small)	53	24.3	32.3	210	30	53.9		Pallets	0/100	-	-	-	6	40	6-6	-	65	35	27.0	35.9	Blocking out
C-2	2 LTD Aft.	General cargo	Mixed	36	27.4	24.8	270	27	67.3	↓	Various	78/22	-	-	-	2	30	6-6	-	58	42	24.4	22.1	
C-2	2 LTD Aft.	Tallow	Drums	57	16.4	23.2	77	13	11.8	↑	Hooks	100/0	-	-	-	0	5	6-6	-	46	54	83.4	118.0	
C-2	2 LTD Aft.	Tallow&Petrolatum	Drums	59	78.4	114.9	380	64	95.6		Hooks	100/0	-	-	-	3	15	4-4	-	47	53	49.2	72.1	From lighter
C-2	2 LTD Aft.	Petrolatum	Drums	50	26.6	33.2	108	18	24.5		Hooks	100/0	-	-	-	0	14	4-4	-	69	31	65.1	81.3	Rolled Fwd. from lighter
C-2	2 LTD Aft.	Petrolatum	Drums	63	13.4	21.2	70	12	34.3		Hooks	100/0	-	-	-	0	38	6-6	-	74	26	23.4	37.1	Blocking out from lighter
C-2	2 LTD Aft.	Petrolatum	Drums	63	14.6	23.0	75	13	15.8	49.1	Pallets	0/100	-	-	-	0	41	6-6	-	48	52	55.4	87.3	From lighter
C-2	2 LTD Aft.	Honey	Drums	42	21.0	22.1	67	14	17.1	49.1	Pallets	100/0	-	-	-	0	13	C-6	-	58	42	73.7	77.5	
C-2	2 LTD Aft.	Scrap metal	Drums	45	25.8	29.1	85	17	34.4		Pallets	100/0	-	-	-	0	21	5-5	-	75	25	45.0	50.8	Blocking out
C-2	2 LTD Aft.	Paraffin Wax	Drums	63	51.3	80.5	267	45	80.0		Pallets	100/0	-	-	-	0	32	6-5	-	77	23	38.5	60.4	Blocking out
C-2	2 LTD Aft.	Clay	Bags	40	16.5	16.5	547	12	18.6		Pallets	0/100	-	-	-	0	28	6-6	-	71	29	53.2	53.2	Blocking out
C-2	2 LTD Aft.	General cargo	Mixed	62	21.2	32.6	158	19	50.1	↓	Various	0/100	-	-	-	8	35	6-6	-	38	62	25.4	39.0	
C-2	5 LH	Ammonium sulfate	Paper bags	34	29.4	24.8	660	22	41.2	↑	Trays	100/0	-	-	-	1	8	5-5	Dol.	65	35	42.8	36.1	
C-2	5 LH	Ammonium sulfate	Paper bags	34	31.8	26.8	713	23	37.6		Trays	41/59	-	-	-	0	5	5-5	-	45	55	50.7	42.8	
C-2	5 LH	Ammonium sulfate	Paper bags	34	99.9	85.9	2184	91	149.8		Trays	22/78	-	-	-	0	5	5-5	-	40	60	40.0	34.4	
C-2	5 LH	Ammonium sulfate	Paper bags	34	65.9	55.8	1464	61	90.4	25.3	Trays	100/0	-	-	-	0	16	5-5	Dol.	46	54	43.7	37.0	
C-2	5 LH	Ammonium sulfate	Paper bags	34	27.1	22.9	600	25	35.3	↓	Cargo Tr.	57/43	-	-	-	0	0	5-5	-	43	57	46.1	38.9	
C-3	3 UTD Fwd.	Sulphur	Paper bags	30	227.8	168.3	4347	189	267.2	73.6	Pallets	100/0	-	-	-	2	24	6-6*	Dol.	67	33	51.1	37.8	Blocking out *6-6; 6-4
C-3	3 UTD Aft.	Sulphur	Paper bags	30	429.6	318.5	8234	358	524.4	39.8	Pallets	100/0	-	-	-	1	26	6-6	Dol.	67	33	49.1	36.4	Blocking out

FIGURE A-3
Hook and Hold Work Cycle Distributions for New Orleans Commercial Sample
120 Drafts of Drums on Pallets To 2 LTD







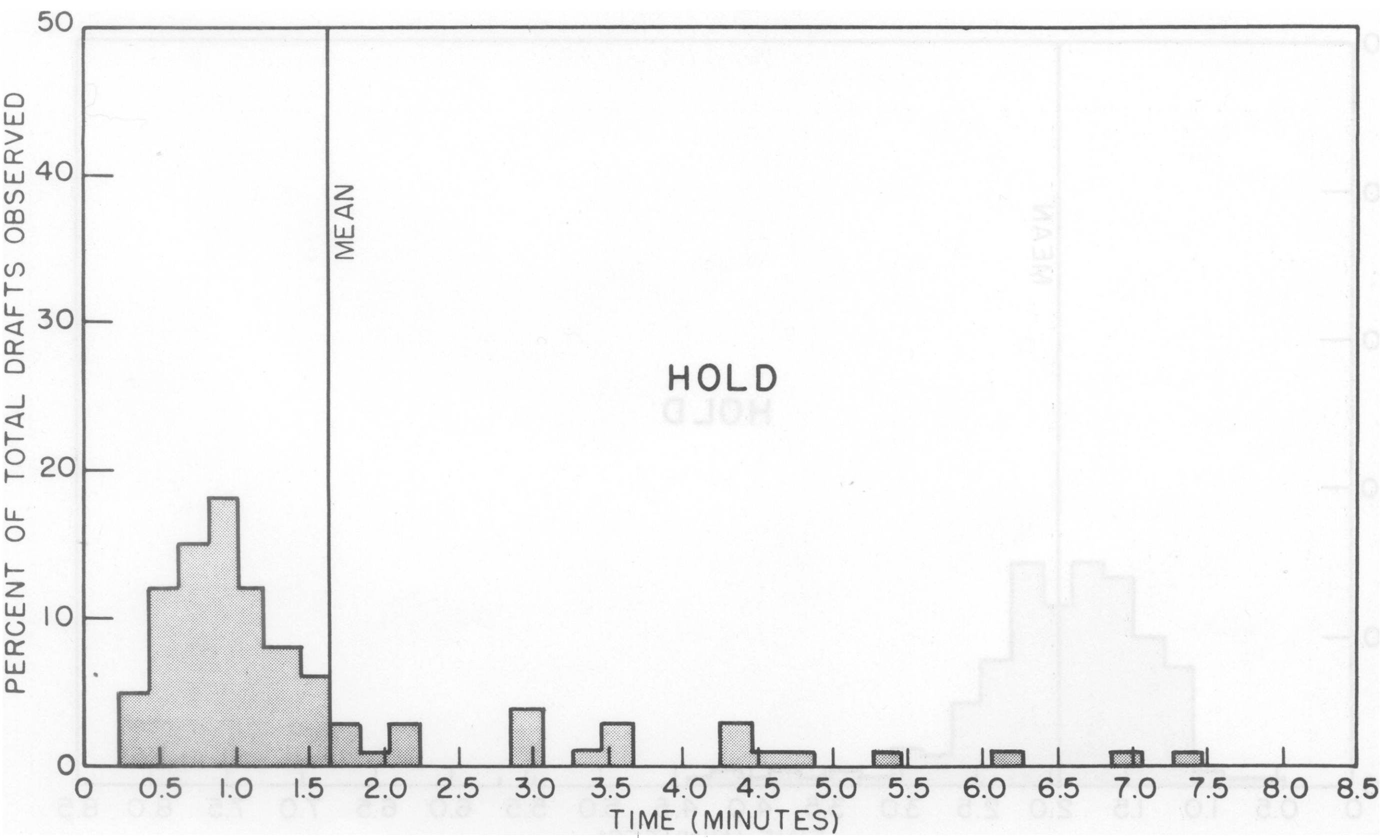
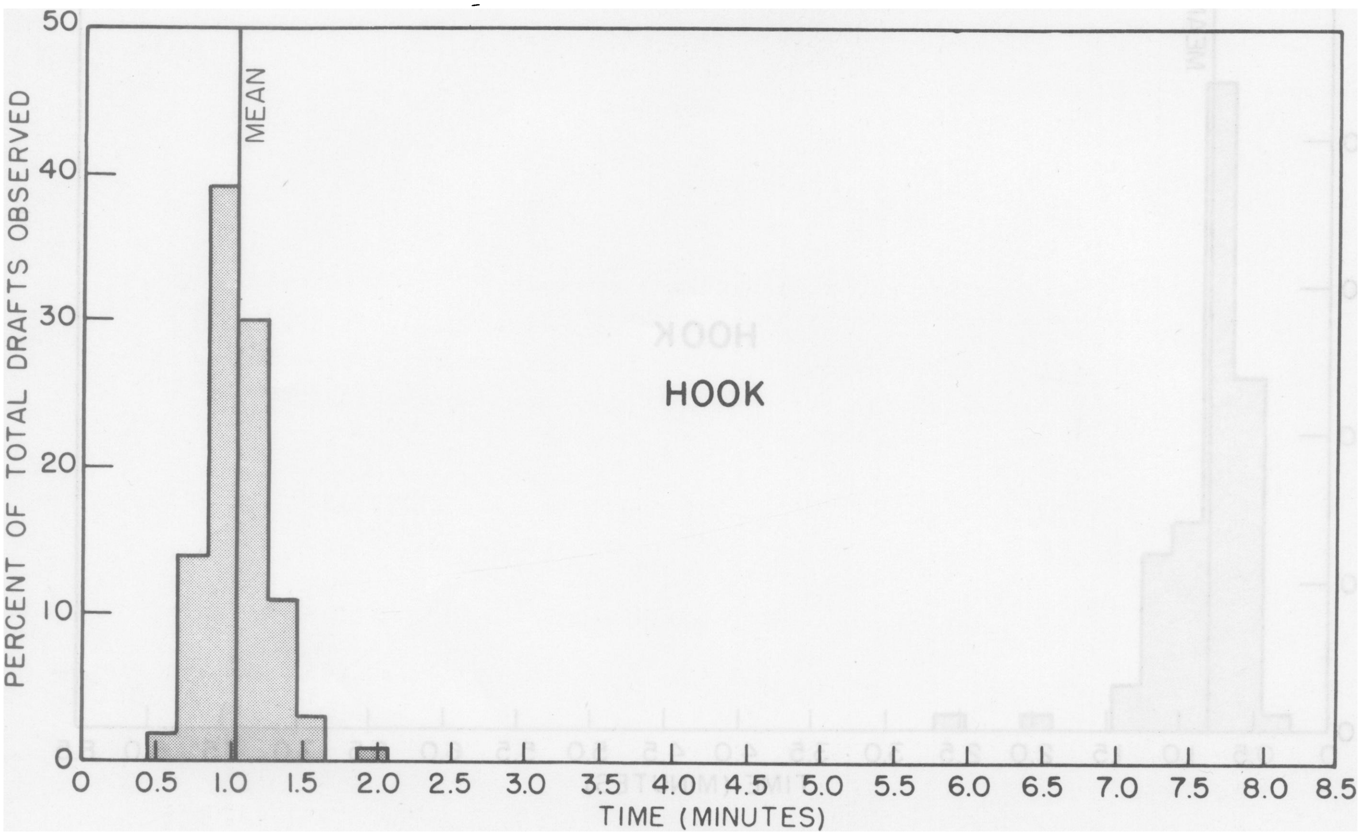


FIGURE A-4
Hook and Hold Work Cycle Distributions for New Orleans Commercial Sample
78 Drafts of Drums Handled with Drum Clamps to 2 LTD



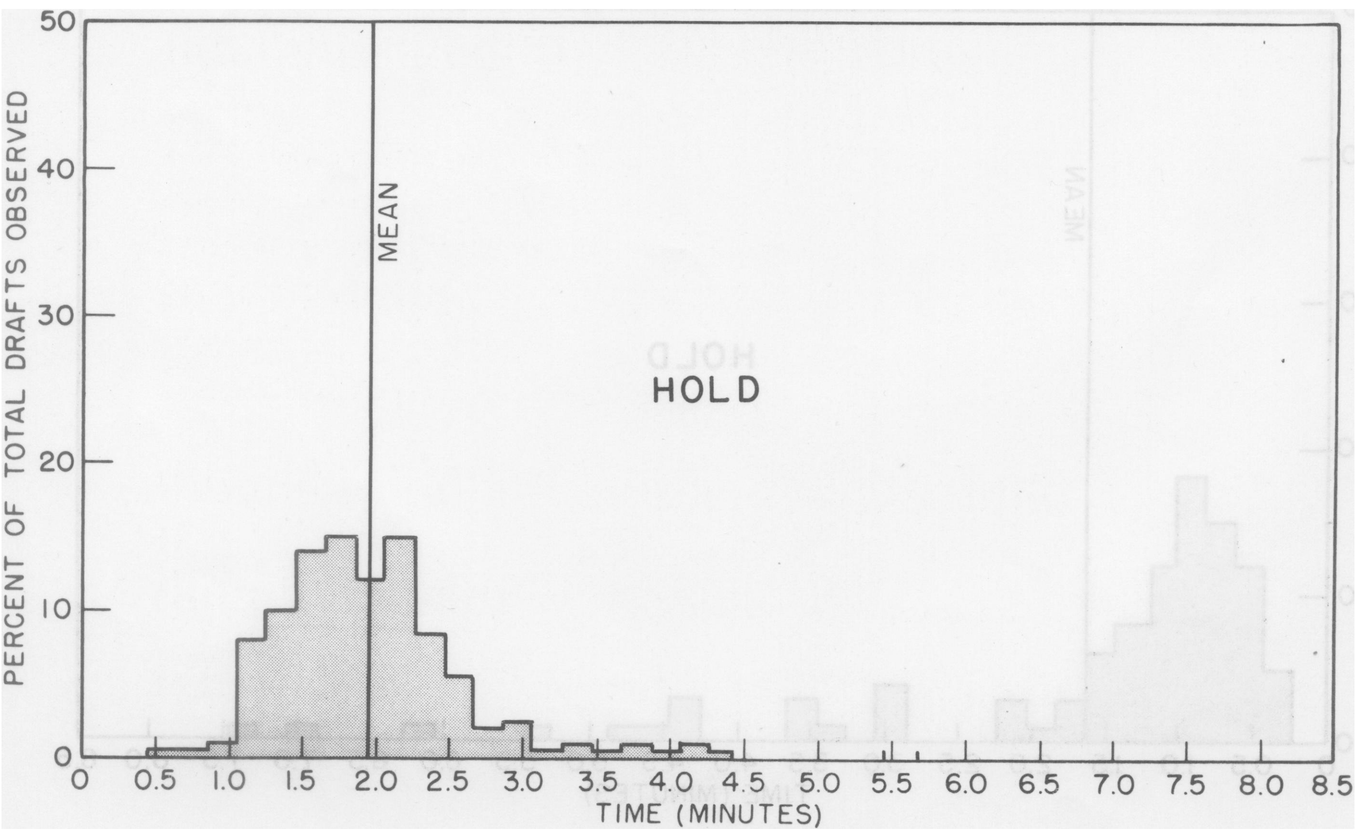


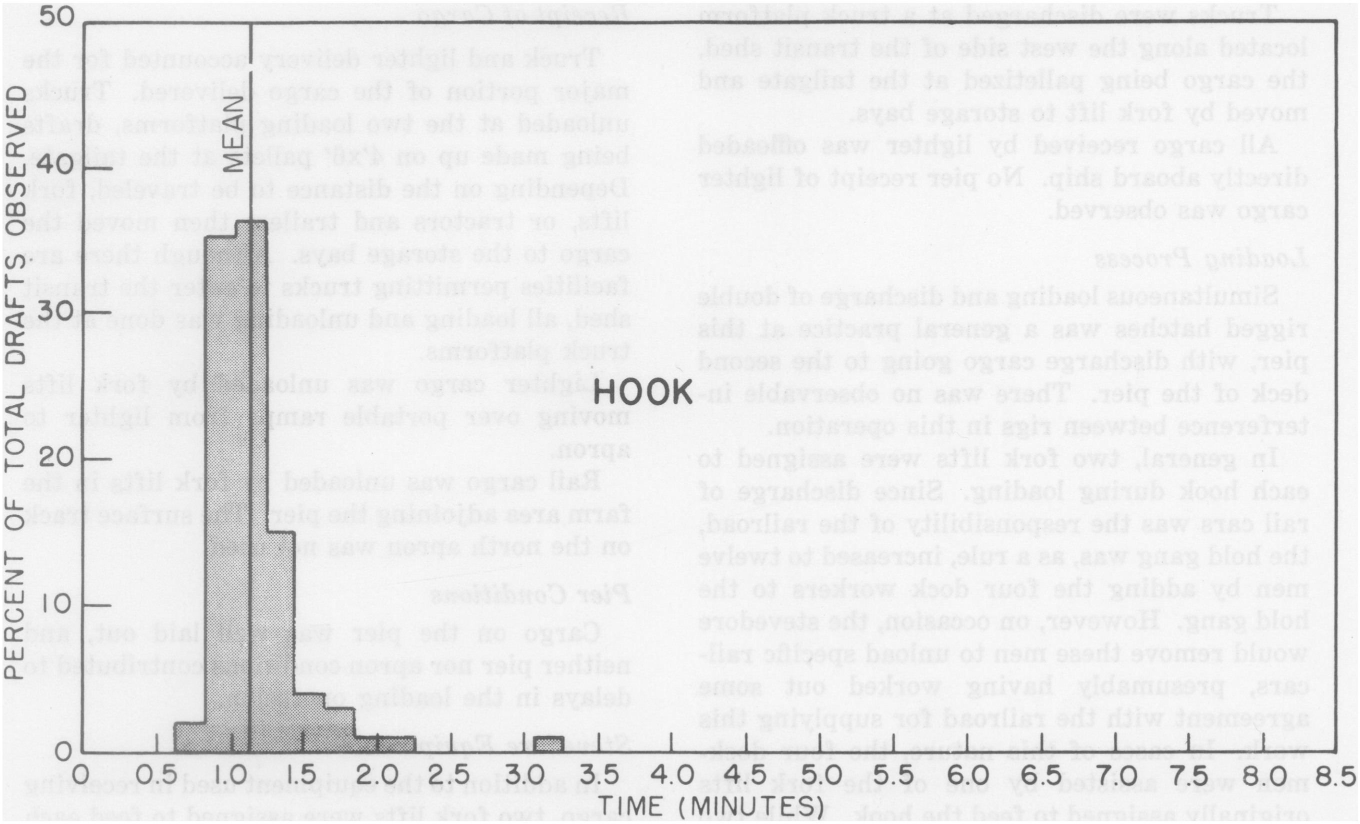
FIGURE A-5
Hook and Hold Work Cycle Distributions for New Orleans Commercial Sample 355 Drafts of Bags of Sulfur to 3 UTD (Wings with Wagons)

TABLE A-3
Baltimore Commercial Data

Ship Type	Hatch	Commodity	Package type	S.F	Total L.T.	Total M.T.	Total no. of units	No. of Drafts Obs.	Net Oper. Time (Min.)	DGH Time (Min.)	Gear Type	% Wing to Square Stowage	Hook Cycle: Time at Apron (%)	Hook Cycle: Time in Hold (%)	Hook Cycle: Time in Transit (%)	Hook wait for Apron(%)	Hook wait for Hold(%)	No. of men in Hold	MHE in Hold	Hold Cycle: Work (%)	Hold Cycle: Wait (%)	L.T. per hour	M.T. per hour	Comments
C-2	1 UTD	Autos	Unboxed	411	16.7	171.4	12	12	55.3	0	Sling	67/33	28	25	46	0	26	8	-	66	34	18.0	186 0	1 team
C-2	1 LTD	Ammo. Sulf.	Bags	49	21.7	26.5	240	20	36.6	0	Pallets	100/0	34	11	55	14	14	4-4	-	35	65	35.6	43.4	
C-2	1 LTD	Ammo. Sulf.	Bags	49	68.5	83.9	763	64	92.7	0	Pallets	47/53	30	8	61	8	2	4-4	-	41	59	44.3	54.3	
C-2	1 LTD	General cargo	Mixed	48	12.1	14.5	544	14	30.8	7.4	Pallets	100/0	22	32	46	5	33	6-6	-	56	44	24.0	28.7	
C-2	1 LH	Steel bars	Bundles	15	118.0	44.1	57	33	134.6	2.1	Sling	48/52	33	47	19	10	0	6	-	38	62	52.6	19 7	1 team
C-2	1 LH	Pipe	Bundles	31	51.0	39.8	17	17	84.1	13.1	Sling	50/50	30	50	20	12	0	8	-	43	57	36.4	28 4	1 team
C-2	1 LH	Pipe	Bundles	30	28.0	21.0	21	10	47.9	17.8	Sling	50/50	31	48	29	0	0	8	-	50	50	35.1	26.3	1 team
C-2	1 LH	General	Ctns., boxes	100	50.0	125.0	1893	119	215.2	4.3	Pallets	79/21	24	29	48	3	2	4-4	-	48	52	13.9	34.9	
C-2	2 LTD Fwd.	-	Containers	157	20.7	81.0	13	13	37.9	13.4	Hooks	92/8	27	23	50	5	9	6	-	60	40	32 7	128.0	1 team
C-2	2 LTD Fwd.	General cargo	Mixed	100	15.9	39.7	362	22	37.0	5.9	Pallets	41/59	30	15	55	4	14	4-4	-	64	36	25.8	64.3	
C-2	2 LTD Aft.	-	Containers	156	9.6	37.5	6	6	26.1	6.0	Hooks	100/0	15	36	48	25	20	6	-	66	34	22.1	86.3	1 team
C-2	2 LH Aft.	Beer	Cartons	58	31.9	45.9	2000	31	48.6	0	Pallets	100/0	35	14	51	0	3	6-6	-	77	23	39.2	56.5	
C-2	2 LH Aft.	Canned corn	Cartons	48	46.8	56.4	3384	36	64.1	0	Pallets	100/0	29	12	59	5	3	6-6	-	76	24	44.0	53.0	
C-2	2 LH Aft.	Canned puree	Cartons	51	55.8	71.5	2451	37	74.8	1.8	Pallets	72/28	36	19	45	0	3	6-6	-	80	20	44.6	57.2	
C-2	2 LH Aft.	Canned beans	Cartons	41	67.8	69.0	4050	43	74.2	0	Pallets	43/57	30	13	56	0	8	6-6	-	76	24	54.9	55.9	
C-2	2 LH Aft.	K/D cans	Cartons	53	65.6	87.6	2266	39	99.2	0	Pallets	50/50	35	19	46	4	20	6-6	-	69	31	39.4	52.6	
C-2	2 LH Aft.	Bottles(empty)	Cartons	164	18.0	74.1	2964	33	81.1	2.6	Pallets	100/0	41	15	45	11	11	6-6	-	65	35	13.3	54.8	
C-2	2 LH Aft.	Bottles(empty)	Cartons	75	42.5	79.2	2193	54	101.3	0	Pallets	69/31	31	20	48	3	11	6-6	-	58	42	25.1	46.7	
C-2	2 LH Aft.	Pails, tubs	Bundles	192	15.3	73.5	356	41	84.8	.5	Pallets	100/0	52	15	33	13	0	4-4	-	41	59	10.9	52.2	
C-2	2 LH Aft.	K/D Ctns.	Bundles	88	12.7	27.8	580	11	35.1	0	Pallets	100/0	33	24	43	18	32	5-5	-	72	38	21.7	47.5	
C-2	2 LH Aft.	Feed	Bags	61	11.8	18.0	240	12	19.9	0	Pallets	83/17	42	16	42	11	0	6-6	-	57	43	35.6	54.4	
C-2	2 LH Fwd.	Feed	Bags	67	40.4	67.5	900	45	73.1	4.8	Pallets	96/4	28	21	51	10	4	6-6	-	41	59	33.1	55.4	
C-2	2 LH Fwd.	Feed	Bags	67	36.0	60.0	800	40	54.4	.5	Pallets	30/70	29	18	53	9	5	6-6	-	38	62	39.6	66.0	
C-2	2 LH Fwd.	Feed	Bags	67	107.7	180.0	2400	120	171.7	.4	Pallets	57/43	24	45	31	3	9	6-6	-	43	57	37.7	63.0	
C-2	2 LH Fwd.	General, Stoves	Mixed	100	39.9	100.0	1416	78	118.1	10.4	Pallets	97/3	26	21	53	7	7	6-6	-	48	52	20.3	51.1	
C-2	2 LH Fwd.	Glass ware	Cartons	166	5.8	24.0	1084	13	20.3	0	Pallets	100/0	32	29	40	6	6	6-6	-	75	25	17.2	71.0	
C-2	2 LH Fwd.	Crackers	Cartons	208	11.2	58.3	1000	28	40.8	0	Pallets	100/0	31	23	46	4	3	6-6	-	54	46	16.5	85.7	
C-2	2 LH Fwd.	Bottles	Cartons	73	28.7	52.6	1485	27	43.4	0	Pallets	52/46	28	21	52	7	13	6-6	-	54	46	39.6	72.6	
C-2	4 UTD Fwd.	Malt	Bags	60	15.0	22.5	300	15	23.3	2.6	Pallets	100/0	38	12	50	3	7	4-4	Wag.	79	21	38.7	58.1	
C-2	4 UTD Fwd.	Feed	Bags	67	13.4	22.5	300	10	25.1	0	Trays	100/0	45	18	37	7	0	4-4	Wag.	71	29	32.0	53.8	Loaded from lighter
C-2	4 UTD Fwd.	Feed	Bags	64	30.7	48.8	725	31	59.3	0	Pallets	100/0	45	12	43	23	16	6-5	Wag.	70	30	31.0	49.3	
C-2	4 Utd Fwd.	Earthenware	Cartons	71	9.1	16.1	826	10	32.8	4.7	Trays	100/0	22	20	59	2	10	4-4	Wag.	67	33	16.7	29.4	Loaded from lighter
C-2	4 UTD Fwd.	K/D cans	Cartons	55	59.8	82.4	2305	45	87.2	0	Pallets	37/63	40	19	41	18	12	6-6	-	54	46	41.3	56 9	
C-2	4 UTD Fwd.	Can. spaghetti	Cartons	48	6.0	7.2	350	8	26.2	0	Pallets	31/69	66	10	24	53	2	6-6	-	52	48	13.7	16.5	
C-2	4 UTD Fwd.	Matches	Cartons	126	12.9	40.5	1940	34	56.1	0	Pallets	6/94	42	20	38	11	19	6-6	-	45	55	13.8	43.3	
C-2	4 UTD Fwd.	-	Containers	207	12.1	62.5	10	10	26.0	2.4	Pallets	100/0	19	26	55	0	51	8	-	80	20	28.0	144.4	1 team
C-2	4 UTD Fwd.	Feed	Bags	67	27.9	46.5	620	31	39.8	3.9	Pallets	100/0	31	13	56	8	16	6-6	-	71	29	42.1	70.2	
C-2	4 UTD Fwd.	General cargo	Mixed	110	16.6	45.5	853	38	54.6	0	Pallets	68/32	33	18	49	10	17	6-6	-	60	40	18.3	50.0	
C-2	4 UTD Fwd.	Candy	Cartons	83	10.0	20.7	693	19	24.8	2.8	Pallets	100/0	33	17	49	8	8	6-6	-	73	27	24.2	50.1	
C-2	4 UTD Fwd.	TV sets	Cartons	254	6.5	41.2	145	22	29.7	1.4	Pallets	36/64	27	17	56	6	11	6-6	-	61	39	13.1	83.2	Single team, 12 men for 1/2 operation
C-2	4 UTD Aft.	Malt	Bags	60	99.0	148.5	1980	99	170.1	1.7	Pallets	100/0	31	19	50	10	20	6-6	-	70	30	34.7	52.0	
C-2	4 UTD Aft.	Malt	Containers	158	9.5	37.5	6	6	14.5	4.7	Hooks	0/100	23	60	17	0	0	10	-	60	40	39.3	155.3	1 team
C-2	4 UTD Aft.	Feed	Bags	67	27.0	45.0	600	30	49.2	0	Pallets	42/58	38	21	41	12	3	6-6	-	66	34	32.9	54.9	
C-2	4 UTD	Matches	Cartons	125	3.9	12.2	575	10	19.1	0	Pallets	0/100	42	19	38	21	19	6-6	-	57	43	12.2	38.3	
C-2	4 UTD Aft.	Caustic soda	Drums	54	37.9	50.7	201	33	65.1	0	Trays	100/0	22	40	38	0	1	4-4	-	62	38	35.0	46.8	Loaded from lighter
C-2	4 UTD Aft.	General	Mixed	100	13.6	33.9	720	30	60.0	10.6	Pallets	86/14	39	18	44	4	9	6-6	-	62	38	13.6	33.9	
C-2	4 UTD Aft.	Feed	Bags	68	60.1	101.7	1447	69	101.8	0	Pallets	83/17	34	16	49	8	11	6-6	-	66	34	35.5	59.9	
C-2	4 UTD Aft.	Candy	Cartons	82	17.1	35.1	1211	33	55.1	3.5	Pallets	91/9	33	18	49	0	13	6-6	-	65	35	18.6	38.2	
C-2	4 UTD Aft.	TV sets	Cartons	280	3.2	22.4	69	12	21.2	0	Pallets	0/100	26	12	62	0	4	8-6	-	42	58	9.1	63.4	
C-2	4 UTD Aft;Fwd.	Bottled beer	Cases	57	31.9	45.8	1999	31	48.1	0	Pallets	100/0	35	19	46	15	8	6-6	-	63	37	39.8	57.1	
C-2	4 UTD Aft;Fwd.	Mixed general	Mixed	97	58.3	141.1	1096	83	129.3	12.4	Pallets	62/38	32	29	39	8	10	6-6	-	60	40	27.0	65.5	
C-2	4 UTD Aft;Fwd.	Feed	Bags	67	80.8	135.0	1800	90	123.6	17.9	Pallets	100/0	31	26	43	8	11	6-6	-	57	43	39.2	65.5	
C-2	4 UTD Aft;Fwd.	Feed	Bags	67	53.8	90.0	1200	60	120.9	0	Pallets	100/0	46	23	30	28	10	4-4	-	57	43	26.7	44.7	
C-2	4 UTD Aft;Fwd.	Feed	Bags	67	32.3	54.0	720	36	62.7	0	Pallets	0/100	43	26	31	26	11	6-5	-	48	52	31.0	51.7	
C-2	4 LTD Aft.	General cargo	Mixed	161	7.3	29.4	377	26	39.2	6.1	Pallets	100/0	34	21	45	9	12	6-6	-	82	18	11.2	45.0	
C-2	4 LTD Aft.	Beer	Cartons	59	11.0	16.1	704	11	17.8	0	Pallets	100/0	30	21	49	11	20	6-6	Wag.	76	24	37.1	54.3	
C-2	4 LTD Aft.	Beer	Cartons	57	36.9	52.7	2296	37	90.8	2.4	Pallets	100/0	39	16	44	21	27	4-4	Wag.	67	33	24.4	34.8	
C-2	4 LTD Aft.	Refrigerators	Cartons	252	12.2	76.9	98	50	65.1	4.7	Pallets	64/36	36	18	45	12	1	6-6	-	45	55	11.2	70.7	
C-2	4 LTD Aft.	General cargo	Mixed	88	26.6	58.5	465	38	98.2	8.0	Pallets	18/82	45	22	34	27	15	6-6	-	45	55	16.2	35.7	

TABLE A-3—(Continued)
Baltimore Commercial Data

Ship Type	Hatch	Commodity	Package type	S.F.	Total L.T.	Total M.T.	Total no. of units	No. of Drafts Obs.	Net Oper. Time (Min.)	DGH Time (Min.)	Gear Type	% Wing to Square Stowage	Hook Cycle: Time at Apron (%)	Hook Cycle: Time in Hold (%)	Hook Cycle: Time in Transit (%)	Hook wait for Apron (%)	Hook wait for Hold (%)	No. of men in Hold	MHE in Hold	Hold Cycle: Work (%)	Hold Cycle: Wait (%)	L.T. per hour	M.T. per hour	Comments
C-2	4 L1D Fwd.	General cargo	Mixed	84	9.5	19.9	462	29	44.6	0	Pallets	100/0	27	17	56	1	12	4-4	-	66	34	12.8	26.9	
C-2	4 L1D Fwd.	Pails, tubs	Bundles	173	13.4	57.9	303	38	78.7	1.3	Pallets	100/0	47	16	37	20	3	6-6	-	44	56	10.2	44.0	
C-2	4 LTD Fwd.	Canned goods	Cartons	45	16.5	18.7	1050	19	30.1	0	Pallets	100/0	40	19	42	11	1	6-6	-	69	31	32.8	37.2	
C-2	4 LTD Fwd.	Empty cans	Cartons	276	14.8	102.3	871	37	60.3	0	Pallets	100/0	40	22	34	12	2	6-6	-	48	52	14.8	102.3	
C-2	4 LH Fwd.	General cargo	Mixed	72	32.8	58.8	1485	38	99.4	0	Pallets	86/14	31	23	47	10	21	6-6	-	66	34	19.7	35.5	
C-2	4 LH Fwd.	TV sets	Cartons	302	8.8	66.4	231	23	61.6	9.0	Trays	100/0	31	24	45	0	6	4-4	-	50	50	8.6	64.7	Loaded from lighter
C-2	4 LH Fwd.	Bottles(empty)	Cartons	108	16.9	45.8	905	29	48.3	0	Pallets	100/0	28	25	47	2	6	6-6	-	61	39	21.0	56.9	
C-2	4 LH Fwd.	Malt	Bags	60	31.6	47.5	633	31	78.7	0	Pallets	48/52	55	15	30	36	1	4-4	-	31	69	24.0	36.2	
C-2	4 LH Fwd.	Feed	Bags	67	31.5	52.5	700	34	43.5	5.1	Pallets	50/50	27	22	51	3	4	6-6	-	56	44	43.4	72.4	
C-2	4 LH Fwd.	Malt, feed	Bags	62	170.2	264.0	3520	176	255.8	0	Pallets	92/8	34	27	40	1	1	6-6	-	58	42	39.1	60.7	
C-2	4 LH Fwd.	Feed	Bags	65	49.5	80.9	1080	55	98.7	0	Pallets	91/9	29	22	49	2	2	4-4	-	57	43	30.2	49.3	
C-2	4 LH Fwd.	General cargo	Mixed	100	55.0	137.5	2937	123	228.0	29.8	Pallets	95/5	36	26	38	6	5	5-5	-	60	40	14.3	35.8	
C-2	4 LH Fwd.	Feed	Bags	67	63.3	106.3	1409	70	160.5	0	Pallets	35/65	57	12	31	28	0	4-4	-	35	65	23.4	39.3	
C-2	4 LH Aft.	General cargo	Mixed	94	31.5	73.6	785	62	117.2	0	Pallets	92/8	26	32	42	7	24	6-6	-	61	39	16.1	37.7	
C-2	4 LH Aft.	Corn flakes	Cartons	226	15.7	88.5	2576	45	91.8	.5	Pallets	96/4	27	24	49	9	14	6-6	-	70	30	10.3	57.8	
C-2	4 LH Aft.	Cans Edible Oil	Cartons	47	28.1	32.7	1675	24	50.2	0	Pallets	29/71	24	27	49	2	30	6-6	-	69	31	33.6	39.1	
C-2	4 LH Aft.	Feed	Bags	67	81.4	135.7	1809	91	178.3	4.2	Pallets	38/62	31	25	45	14	12	4-4	-	48	52	27.4	45.7	
C-2	4 LH Aft.	Malt	Bags	60	48.6	73.0	973	49	124.3	0	Pallets	15/85	44	16	40	29	11	4-4	-	35	65	23.5	35.2	
C-2	4 LH Aft.	Feed	Bags	67	26.9	45.0	600	30	33.9	0	Pallets	100/0	30	17	53	0	0	6-6	-	58	42	47.6	79.7	
C-2	4 LH Aft.	General cargo	Mixed	100	16.2	40.5	339	40	54.5	1.9	Pallets	82/18	23	23	55	1	4	6-6	-	52	48	17.8	44.6	
C-2	4 LH Aft.	Bottles	Cartons	167	19.3	80.6	2178	53	83.7	0	Pallets	60/40	27	22	51	7	11	6-6	-	60	40	13.9	58.0	
C-2	4 LH Aft.	Refrig;Stoves	Cartons	295	6.8	48.5	82	26	42.8	12.3	Pallets	100/0	24	22	54	6	7	6-6	-	58	42	9.5	67.9	
C-2	4 LH Aft.	Can parts	Cartons	74	43.2	80.1	1763	31	71.9	2.5	Pallets	71/29	28	27	45	13	14	6-6	-	62	38	35.9	66.5	
C-2	5 TD	Candy	Cartons	116	14.1	40.9	931	16	21.5	0	Pallets	44/56	38	16	46	0	0	4-4	-	72	28	39.3	114.1	
C-2	5 TD	General cargo	Mixed	100	39.7	99.0	1428	53	81.2	3.3	Pallets	49/51	43	20	36	1	4	7-6	-	56	44	29.3	73.2	
C-2	5 TD	Lard	Cartons	53	11.3	14.9	648	9	22.3	0	Pallets	100/0	43	26	30	13	22	7-7	-	71	29	30.4	40.1	
C-2	5 TD	Crackers	Cartons	176	10.0	44.0	687	22	33.4	0	Pallets	100/0	48	16	37	0	0	6-6	-	51	49	18.0	79.0	
C-2	5 TD	General cargo	Mixed	100	18.4	46.0	669	52	76.7	2.2	Pallets	75/25	32	17	51	8	9	6-5	-	55	45	14.4	36.0	(Night work)
C-2	5 TD	General cargo	Mixed	106	68.0	181.0	1627	96	158.5	4.3	Pallets	92/8	33	18	48	15	15	7-6	-	52	48	25.7	68.5	
C-2	5 LH	Hams	Boxes	68	11.7	19.9	234	13	23.3	0	Pallets	92/8	35	12	54	1	10	4-4	-	75	25	30.1	51.2	
C-2	5 LH	Lard	Cartons	67	22.6	37.9	1201	19	39.1	0	Pallets	70/30	29	16	55	3	20	4-4	-	57	43	34.7	58.2	
C-2	5 LH	Pork	Barrels	63	24.8	39.4	499	36	64.1	2.5	Pallets	11/89	42	21	37	0	0	4-4	-	54	46	23.2	36.9	
C-2	5 LH	Hams	Boxes	76	13.1	25.0	330	17	36.0	0	Pallets	35/65	43	15	42	0	2	4-4	-	46	54	21.8	41.7	
C-2	5 LH	Meat	Barrles	60	43.7	65.5	909	71	119.2	1.7	Pallets	68/32	31	22	46	9	6	6-6	-	47	53	22.0	33.0	
C-2	5 LH	Lard	Cans, cartons	53	61.7	82.8	3450	72	195.0	6.1	Pallets	80/20	35	23	42	21	13	7-6	-	56	44	19.0	25.5	
C-2	5 LH	Meat, hams	Cases	68	32.4	55.6	666	39	96.2	0	Pallets	72/28	40	18	41	28	16	6-5	-	51	49	20.2	34.7	



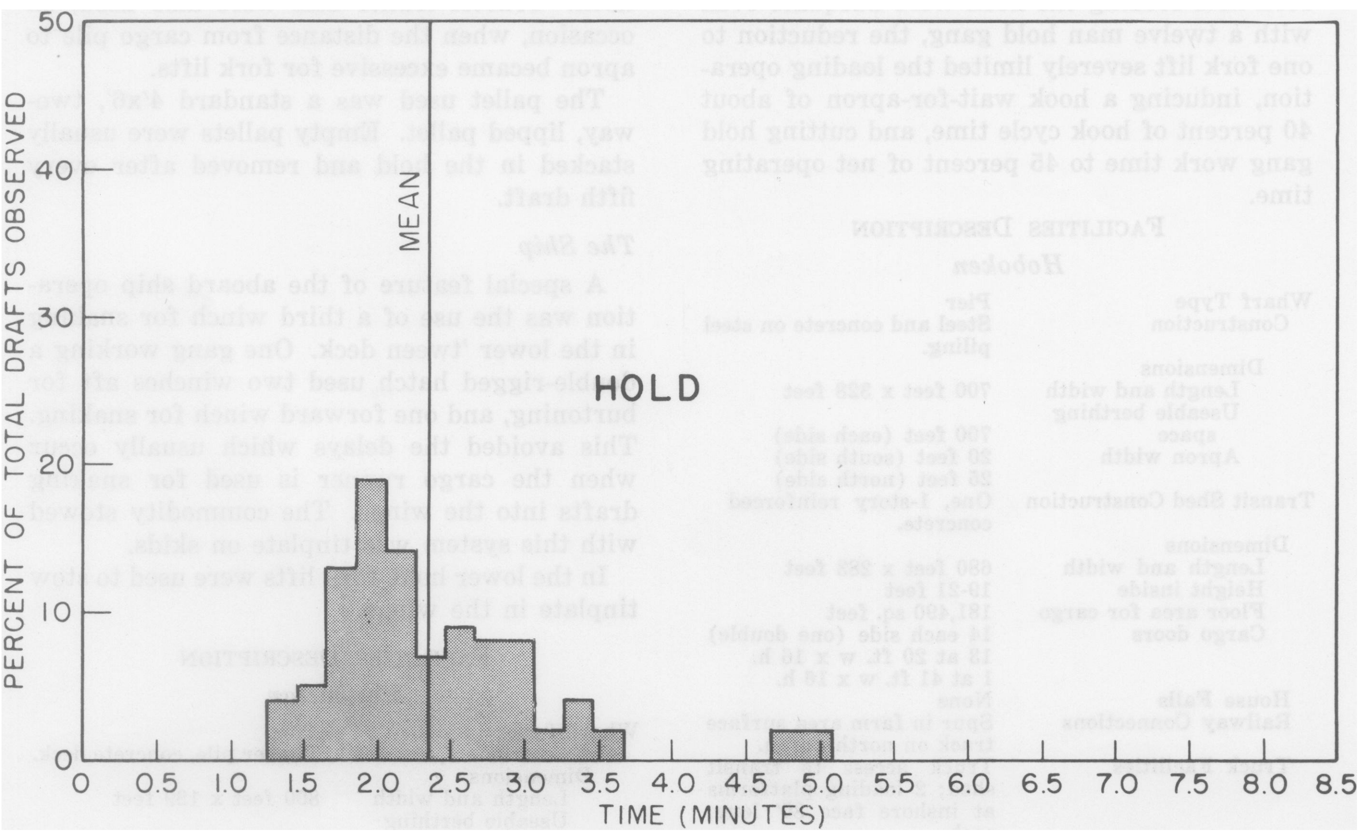


FIGURE A-6
Hook and Hold Work Cycle Distributions for Baltimore Sample 98 Drafts of Bags on Pallets to 4 UTD Aft (Wings with Wagons)

Trucks were discharged at a truck platform located along the west side of the transit shed, the cargo being palletized at the tailgate and moved by fork lift to storage bays.

All cargo received by lighter was offloaded directly aboard ship. No pier receipt of lighter cargo was observed.

Loading Process

Simultaneous loading and discharge of double rigged hatches was a general practice at this pier, with discharge cargo going to the second deck of the pier. There was no observable interference between rigs in this operation.

In general, two fork lifts were assigned to each hook during loading. Since discharge of rail cars was the responsibility of the railroad, the hold gang was, as a rule, increased to twelve men by adding the four dock workers to the hold gang. However, on occasion, the stevedore would remove these men to unload specific railcars, presumably having worked out some agreement with the railroad for supplying this work. In cases of this nature, the four dockmen were assisted by one of the fork lifts originally assigned to feed the hook. While two fork lifts feeding the hook were adequate even with a twelve man hold gang, the reduction to one fork lift severely limited the loading operation, inducing a hook wait-for-apron of about 40 percent of hook cycle time, and cutting hold gang work time to 45 percent of net operating time.

FACILITIES DESCRIPTION

Hoboken

Wharf Type	Pier
Construction	Steel and concrete on steel piling.
Dimensions	
Length and width	700 feet x 328 feet
Useable berthing space	700 feet (each side)
Apron width	20 feet (south side) 25 feet (north side)
Transit Shed Construction	One, 1-story reinforced concrete.
Dimensions	
Length and width	680 feet x 283 feet
Height inside	19-21 feet
Floor area for cargo	181,490 sq. feet
Cargo doors	14 each side (one double) 13 at 20 ft. w x 16 h. 1 at 41 ft. w x 16 h.
House Falls	None
Railway Connections	Spur in farm area surface track on north apron.
Truck Facilities	Truck access to transit shed; 2 loading platforms at inshore face 80′ long, each.

Ship Type: Modified C-3

Receipt of Cargo

Truck and lighter delivery accounted for the major portion of the cargo delivered. Trucks unloaded at the two loading platforms, drafts being made up on 4′x6′ pallets at the tailgate. Depending on the distance to be traveled, fork lifts, or tractors and trailers then moved the cargo to the storage bays. Although there are facilities permitting trucks to enter the transit shed, all loading and unloading was done at the truck platforms.

Lighter cargo was unloaded by fork lifts moving over portable ramps from lighter to apron.

Rail cargo was unloaded by fork lifts in the farm area adjoining the pier. The surface track on the north apron was not used.

Pier Conditions

Cargo on the pier was well laid out, and neither pier nor apron conditions contributed to delays in the loading operation.

Stevedore Equipment

In addition to the equipment used in receiving cargo, two fork lifts were assigned to feed each hook. Tractor-trailer sets were also used, on occasion, when the distance from cargo pile to apron became excessive for fork lifts.

The pallet used was a standard 4′x6′, two-way, lipped pallet. Empty pallets were usually stacked in the hold and removed after every fifth draft.

The Ship

A special feature of the aboard ship operation was the use of a third winch for snaking in the lower 'tween deck. One gang working a double-rigged hatch used two winches aft for burtoning, and one forward winch for snaking. This avoided the delays which usually occur when the cargo runner is used for snaking drafts into the wings. The commodity stowed with this system was tinplate on skids.

In the lower hold, fork lifts were used to stow tinplate in the wings.

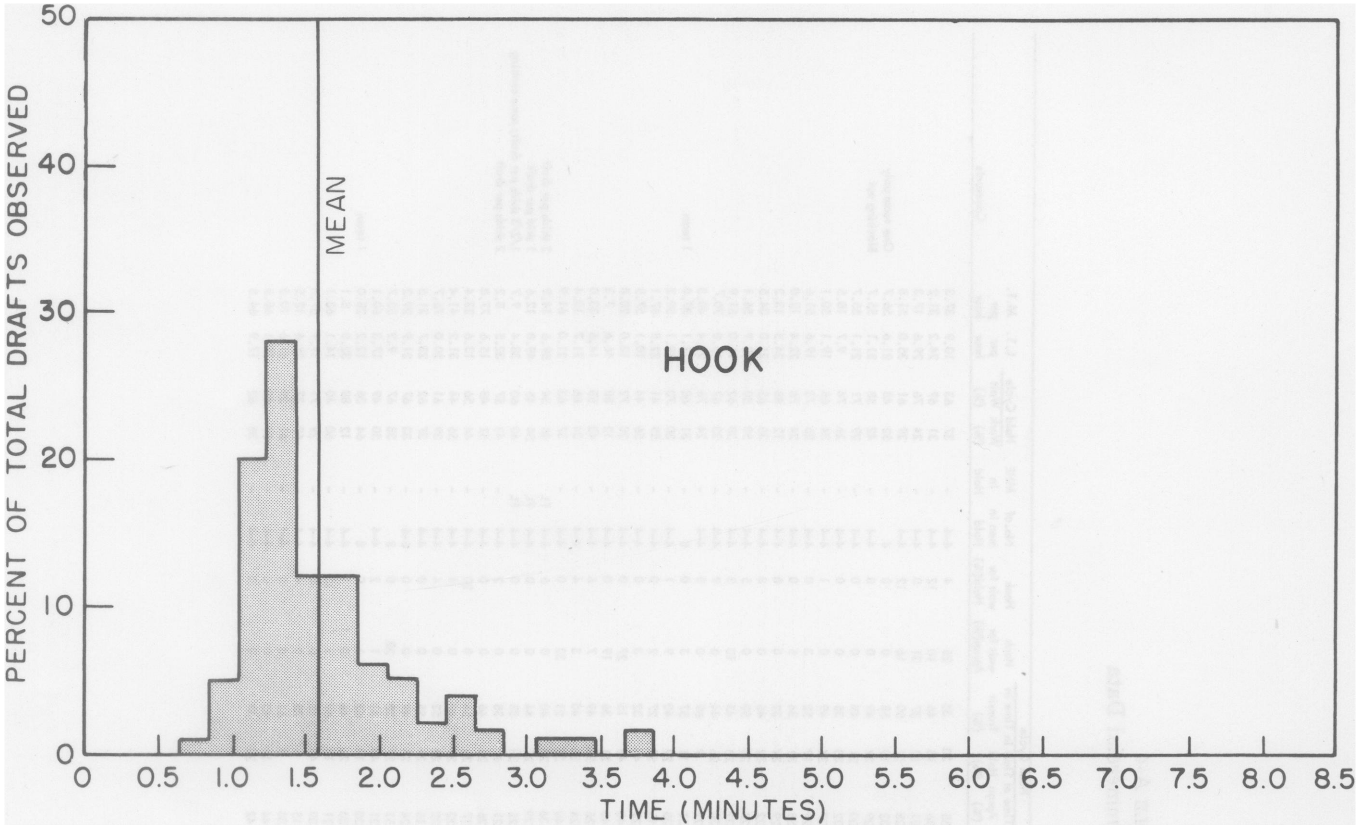
FACILITIES DESCRIPTION

Manhattan

Wharf Type	Pier
Construction	Timber pile, concrete deck.
Dimensions	
Length and width	800 feet x 129 feet
Useable berthing space	800 feet (each side)
Apron width	5 feet (each side)

TABLE A-4
Hoboken Commercial Data

Ship Type	Hatch	Commodity	Package Type	S.F.	Total L.T.	Total M.T.	Total No. of Units	No. of Drafts Obs.	Net Oper. Time (Min.)	DGH Time (Min.)	Gear Type	% Wing to Square Stowage	Hook Cycle: Time at Apron (%)	Hook Cycle: Time in Hold (%)	Hook Cycle: Time in Transit (%)	Hook wait for Apron(%)	Hook wait for Hold(%)	No. of men in Hold	MHE in Hold	Hold Cycle: Work (%)	Hold Cycle: Wait (%)	L.T. per hour	M.T. per hour	Comments
C-2(Mod.)	1 UTD	Paper	Bales	136	14.4	49.1	37	21	79.0	12.7	Sling	74/26	35	30	35	25	4	4-4	-	37	63	10.9	37.3	
C-2(Mod.)	1 UTD	Chemicals	Drums	52	36.0	46.4	165	33	89.1	10.2	Pallets	68/32	36	18	46	10	12	4-4	-	31	69	24.2	31.2	
C-2(Mod.)	1 UTD	Nickel ore	Small drums	23	26.0	15.2	101	17	52.7	0	Pallets	3/97	51	12	37	31	0	4-4	-	24	76	29.6	17.3	
C-2(Mod.)	1 UTD	General cargo	Mixed	59	35.8	53.1	695	27	61.5	0	Pallets	57/43	38	12	50	16	12	4-4	-	39	61	35.0	51.8	
C-2(Mod.)	1 UTD	DDT	Fiber drums	105	5.9	15.5	120	11	16.4	2.6	Pallets	81/18	32	10	58	0	0	4	-	52	48	21.6	56.7	One team only
C-2(Mod.)	1 UTD	DDT	Fiber drums	105	10.2	26.9	207	19	29.0	1.4	Pallets	100/0	29	22	49	0	0	4-4	-	42	58	21.1	55.7	Blocking out
C-2(Mod.)	1 UTD	DDT	Fiber drums	105	16.1	42.4	328	30	45.7	0.0	Pallets	74/26	30	21	48	0	0	4-4	-	29	71	21.1	55.7	
C-2(Mod.)	1 UTD	General cargo	Cses, Ctns.	76	6.0	11.4	47	18	37.0	13.6	Pallets	30/70	32	33	35	0	0	4-4	-	26	74	9.7	18.5	
C-2(Mod.)	1 LTD	DDT	Fiber drums	105	23.8	62.5	484	44	74.8	21.2	Pallets	17/83	27	24	49	0	1	4-4	-	34	66	19.1	50.1	
C-2(Mod.)	1 LTD	DDT	Fiber drums	105	46.5	122.3	946	86	142.3	8.0	Pallets	52/48	29	19	52	3	0	4-4	-	26	73	19.6	51.6	
C-2(Mod.)	1 LTD	Steel scrap	Drums	22	49.6	26.6	108	57	132.9	4.2	Sling	98/2	35	31	34	5	0	4-4	-	24	76	22.4	12.0	
C-2(Mod.)	1 LTD	Steel scrap	Drums	22	30.4	16.4	66	35	74.4	10.9	Sling	0/100	29	39	32	0	0	4-4	-	12	88	24.5	13.2	
C-2(Mod.)	1 LTD	Steel scrap	Wood bbls.	66	11.3	18.6	75	13	32.3	20.4	Pallets	70/30	22	32	46	0	8	4-4	-	35	65	21.0	34.5	
C-2(Mod.)	1 LTD	Alcohol	Drums	52	38.8	50.7	189	32	54.2	17.5	Ch. Hks.	72/28	27	20	53	0	5	4-4	-	50	50	42.9	56.1	
C-2(Mod.)	1 LTD	Mixed general	Mixed	129	23.0	74.5	508	36	86.2	10.6	Pallets	90/10	32	23	45	10	3	4-4	-	38	62	16.0	51.9	
C-2(Mod.)	1 LTD	Paper	Bales	168	36.7	154.3	94	49	131.0	.6	Sling	57/43	30	26	44	8	9	4-4	-	33	67	16.8	70.7	
C-2(Mod.)	1 LH	Oil	Drums	55	24.3	33.3	124	22	49.6	4.5	Pallets	73/27	22	9	69	0	0	4-4	-	24	76	29.4	40.3	
C-2(Mod.)	1 LH	DDT	Fiber drums	105	8.8	23.1	179	17	37.5	1.8	Pallets	95/05	31	11	57	3	0	8	-	31	68	14.1	37.0	1 team
C-2(Mod.)	1 LH	Paper	Bales	131	74.8	245.3	202	96	248.5	2.6	Sling	20/80	38	22	40	9	1	4-4	-	30	70	18.1	59.2	
C-2(Mod.)	3 LTD Aft.	K/D Auto	Cases	118	47.5	140.0	29	29	125.1	10.3	Sling	45/55	15	58	27	2	0	4-4	-	59	41	22.8	67.1	
C-2(Mod.)	3 LH Aft.	Household goods	Cases	227	16.3	92.5	29	29	96.5	4.1	Sling	100/0	25	42	32	3	0	4-4	-	56	44	10.1	57.5	
C-2(Mod.)	3 LH Aft.	Eng; Mach.	Skid+case	64	7.2	11.5	6	5	33.1	8.2	Sling	80/20	40	45	15	27	0	4-4	-	28	72	13.0	20.8	
C-2(Mod.)	3 LH Aft.	Steel wire	Cases	17	7.3	3.2	30	9	26.3	0	Sling	11/89	43	21	36	19	0	4-4	-	12	88	16.6	7.3	
C-2(Mod.)	3 LH Aft.	General cargo	Ctns-cses-Bls	91	39.8	90.1	799	63	163.9	35.2	Pallets	78/22	26	25	49	7	6	4-4	-	42	58	14.6	33.0	
C-2(Mod.)	3 LH Aft.	Steel circles	Drums	19	21.3	10.2	35	18	58.9	0	Sling	33/67	24	36	40	3	4	4-4	-	34	66	21.7	10.4	
C-2(Mod.)	3 LH Aft.	K/D Autos	Cases	118	31.0	91.4	19	19	88.6	11.4	Sling	63/37	40	38	21	32	0	4-4	-	37	63	21.0	61.9	
C-2(Mod.)	6 LTD Aft.	Tin plate	Skids	10	27.2	6.8	26	13	27.4	5.0	Sling	93/7	36	23	40	0	6	4-4	FL	46	54	59.6	14.9	2 skids per draft
C-2(Mod.)	6 LTD Aft.	Tin plate	Skids	10	14.6	3.7	14	14	17.6	0.0	Sling	100/0	29	27	44	0	0	4-4	FL	54	45	49.8	12.6	1 skid per draft
C-2(Mod.)	6 LTD Aft.	Tin plate	Skids	10	88.8	22.4	85	43	138.8	19.4	Sling	100/0	25	38	38	0	0	4-4	FL	40	60	38.4	9.7	1/2/3 skids per draft; some snaking
C-2(Mod.)	6 LTD Aft.	Tin plate	Skids	10	64.8	16.3	62	31	119.7	19.9	Sling	100/0	21	41	38	0	2	4-4	-	43	57	32.5	8.2	2 skids per draft
C-2(Mod.)	6 LTD Aft.	Phosphate	Fiber drums	53	18.6	24.8	114	19	43.4	3.3	Pallets	100/0	26	28	46	0	0	4-4	-	52	48	15.6	77.8	
C-2(Mod.)	6 LTD Fwd.	Milk	Fiber drums	69	10.9	18.8	96	17	48.5	18.3	Pallets	85/15	17	26	56	0	20	4-4	-	44	56	13.6	23.4	
C-2(Mod.)	6 LTD Fwd.	Tubs cheese	Tubs	53	11.9	15.8	330	10	23.9	0	Pallets	100/0	22	29	49	0	4	4-4	-	56	44	31.2	41.4	
C-2(Mod.)	6 LTD Fwd.	Cloth, Paper	Bales	153	17.8	68.3	46	23	53.4	13.1	Sling	15/85	22	26	52	0	4	4-4	-	39	61	20.0	76.7	
C-2(Mod.)	6 LH Aft.	Phosphate	Fiber drums	53	18.2	24.2	109	19	46.1	11.2	Pallets	68/32	16	29	55	0	0	4-4	-	37	62	23.7	31.5	
C-2(mod.)	6 LH Aft.	Phosphate	Fiber drums	53	19.1	25.5	120	20	52.3	4.4	Pallets	14/86	24	26	49	0	0	6-6	-	33	67	21.9	29.2	
C-2(Mod.)	6 LH Aft.	Household good	Vans	232	3.8	22.1	6	5	24.7	1.4	Sling	0/100	51	27	22	28	0	8	-	33	67	9.2	53.7	
C-2(Mod.)	6 LH Fwd.	Paper	Bales	139	86.9	302.2	186	93	301.4	33.7	Sling	100/0	21	48	31	1	2	4-4	-	50	49	17.3	60.1	
C-2(Mod:)	7 TD	Machinery	Cases	94	9.7	22.2	13	9	47.6	0	Sling	100/0	20	18	62	1	0	8	-	64	36	12.2	28.0	1 team
C-2(Mod.)	7 TD	Steel	Cases	10	45.6	11.5	78	34	85.6	6.3	Sling	0/100	30	24	46	0	1	4-4	-	12	88	32.0	8.1	
C-2(Mod.)	7 TD	General cargo	Mixed	180	11.5	51.3	290	26	48.8	5.1	Pallets	0/100	21	10	69	1	13	4-4	-	60	40	14.1	63.1	
C-2(Mod.)	7 TD	Rags	Bales	115	13.9	39.8	32	17	41.9	0	Sling	0/100	39	43	18	0	0	4-4	-	29	71	19.9	57.0	
C-2(Mod.)	7 TD	Coffee	Bags	66	17.0	28.0	246	16	35.6	0	Pallets	87/13	15	6	78	0	4	4-4	-	63	37	28.6	12.5	
C-2(Mod.)	7 TD	Cheese	Cases	53	19.7	26.2	546	17	37.4	.4	Pallets	100/0	30	8	61	0	0	4-4	-	61	39	31.6	10.5	
C-2(Mod.)	7 LH	Rags	Bales	144	11.7	42.0	42	21	36.8	7.2	Sling	95/5	44	11	45	0	0	4-4	-	60	40	19.1	68.5	
C-2(Mod.)	7 LH	Rags	Bales	144	13.6	49.0	49	25	45.6	0	Sling	4/96	42	20	38	0	0	4-4	-	38	62	17.9	64.5	



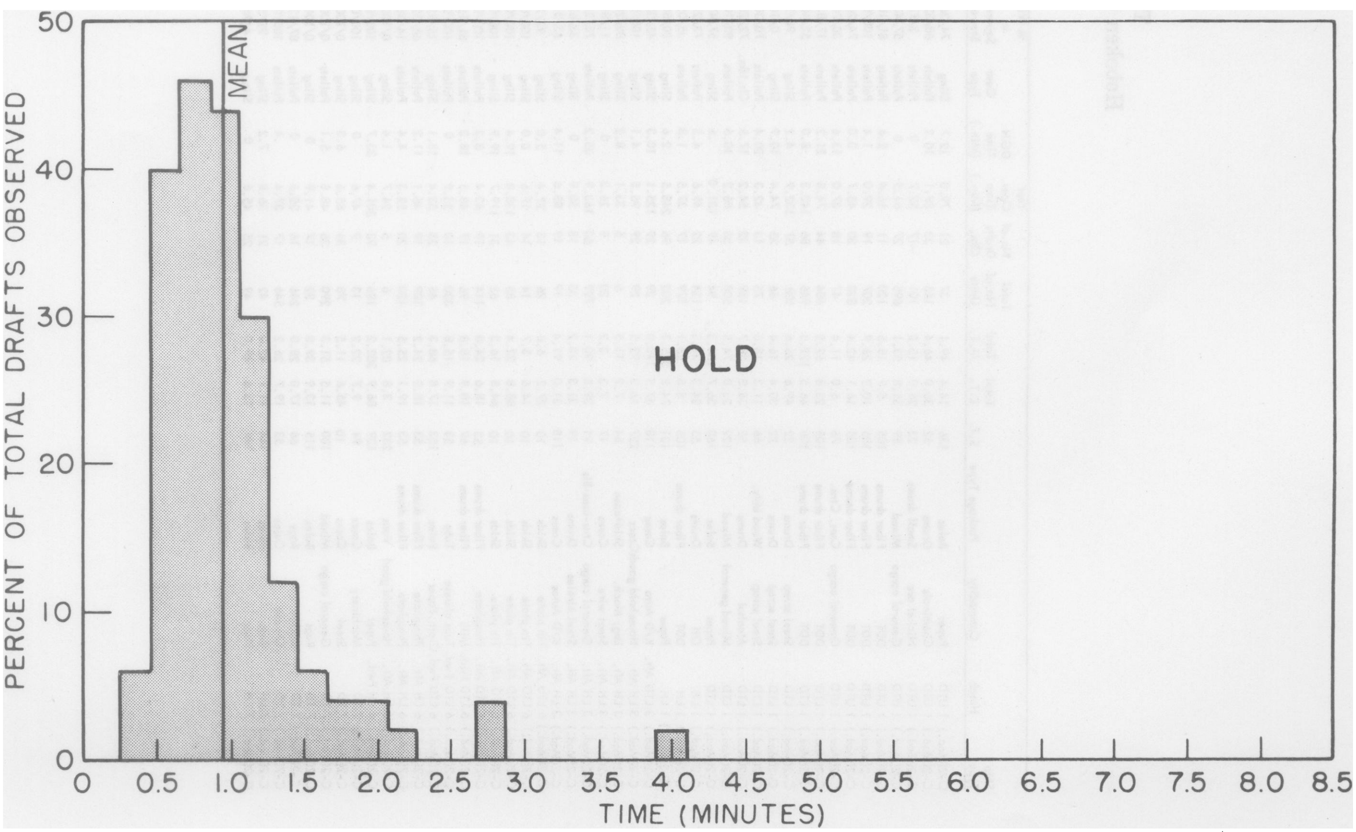


FIGURE A-7
Hook and Hold Work Cycle Distributions for Hoboken Sample 130 Drafts of Fiber Drums on Pallets to 1 LTD

TABLE A-5
MANHATTAN COMMERCIAL DATA

Ship Type	Hatch	Commodity	Package Type	S. F.	Total L. T.	Total M. T.	Total No. of Units	No. of Drafts Obs.	Net Oper. Time (Min.)	DGH Time (Min.)	Gear Type	% Wing to Square Stowage	Hook Cycle: Time at Apron (%)	Hook Cycle: Time in Hold (%)	Hook Cycle: Time in Transit (%)	Hook wait for Apron(%)	Hook wait for Hold(%)	No. of men in Hold	MHE in Hold	Hold Cycle: Work (%)	Hold Cycle: Wait (%)	L. T. per hour	M. T. per hour	Comments
C-2	2 UTD Fwd.	Lard	Cases	49	55.4	68.5	2024	46	98.3	10.4	Pallets	100/0	23	24	53	3	13	4-4	Dol.	69	31	33.8	41.8	
C-2	2 UTD Fwd.	Lard	Cases&cartons	46	39.2	45.1	1660	23	57.5	15.4	Pallets	100/0	16	22	61	0	33	4-4	Dol.	60	40	40.9	46.9	
C-2	2 UTD Fwd.	Lard	Cases	49	39.9	49.2	1452	33	66.1	3.8	Pallets	100/0	20	24	56	0	24	4-4	Dol.	73	27	36.2	44.7	
C-2	2 UTD	Lard	Cartons	45	49.1	55.6	2132	39	105.2	9.6	Pallets	100/0	24	14	62	0	23	4-4	Dol.	57	43	28.0	31.7	
C-2	2 UTD Aft.	Lard	Boxes	50	33.4	42.1	1188	27	71.3	3.8	Pallets	100/0	22	10	68	4	10	2-2	Rol.	68	32	28.1	35.4	
C-2	2 UTD Aft.	Lard	Cartons	47	20.3	24.1	1382	17	63.1	6.2	Pallets	100/0	10	11	78	6	30	2-2	Rol.	70	30	19.3	22.9	
C-2	2 UTD Aft.	Mail	Bags	199	9.2	45.8	360	14	34.7	4.3	Carg. nets	100/0	53	2	44	0	0	4-4	-	35	65	15.9	79.2	
C-2	2 UTD Aft.	Mail	Bags	199	19.8	98.5	776	30	69.8	3.4	Carg. nets	37/63	48	11	40	0	0	4-4	-	13	87	17.0	84.7	
C-2	2 LTD Single	Lard	Cases	45	55.5	62.6	2004	46	116.8	8.5	Pallets	0/100	23	11	65	6	27	-	-	42	58	28.5	32.1	
C-2	2 LTD Single	Lard	Cartons	40	23.3	23.1	845	15	36.1	6.0	Pallets	0/100	30	11	59	2	19	-	-	46	54	38.7	38.4	
C-2	3 LH Fwd.	Hydrocarbons	Drums	53	69.2	91.8	322	57	143.2	10.6	Pallets	90/10	32	18	49	3	1	4-4	-	31	69	29.0	38.5	Interference from after rig
C-2	3 LH Fwd.	Mixed general	Cases, bales, drums	70	28.4	49.7	152	33	95.4	29.5	Pallets	94/6	25	18	57	1	4	4-4	-	33	67	17.9	31.3	Interference from after rig
C-2	3 LH Fwd.	Lamp black	Bags	69	32.4	56.0	671	28	76.3	2.4	Pallets	62/38	25	22	53	1	14	4-4	-	44	56	25.5	44.0	Interference from after rig
C-2	5 TD Fwd.	Lard	Cases	50	78.2	98.4	2780	64	133.6	7.0	Pallets	100/0	35	17	48	0	5	4-4	-	72	28	35.1	44.2	No. 5 hatch was worked
C-2	5 TD Fwd.	Lard	Cases	50	26.0	32.7	924	21	46.3	2.4	Pallets	48/52	35	17	47	0	2	4-4	-	56	44	33.7	42.4	double-rigged by marrying
C-2	5 TD Fwd.	Machinery	--	158	3.5	13.8	33	10	23.6	7.8	Sling	100/0	30	52	19	0	0	4-4	-	48	52	8.9	35.1	a cargo runner from each
C-2	5 TD Fwd.	Lard	Cases	50	19.8	24.9	704	16	42.3	4.3	Pallets	0/100	26	13	61	3	22	4-4	-	50	50	28.1	35.3	ship's boom to house-falls
C-2	5 TD Fwd.	Sticks	Bundles	71	18.2	32.1	1090	25	74.6	0	Pallets	0/100	23	13	64	0	25	4-4	-	43	57	14.6	25.8	
C-2	5 LH Aft.	Candle wax	Bags	43	10/0	10/7	125	11	29.8	8.3	Pallets	0/100	27	15	58	0	8	2-2	-	15	85	20.1	21.5	

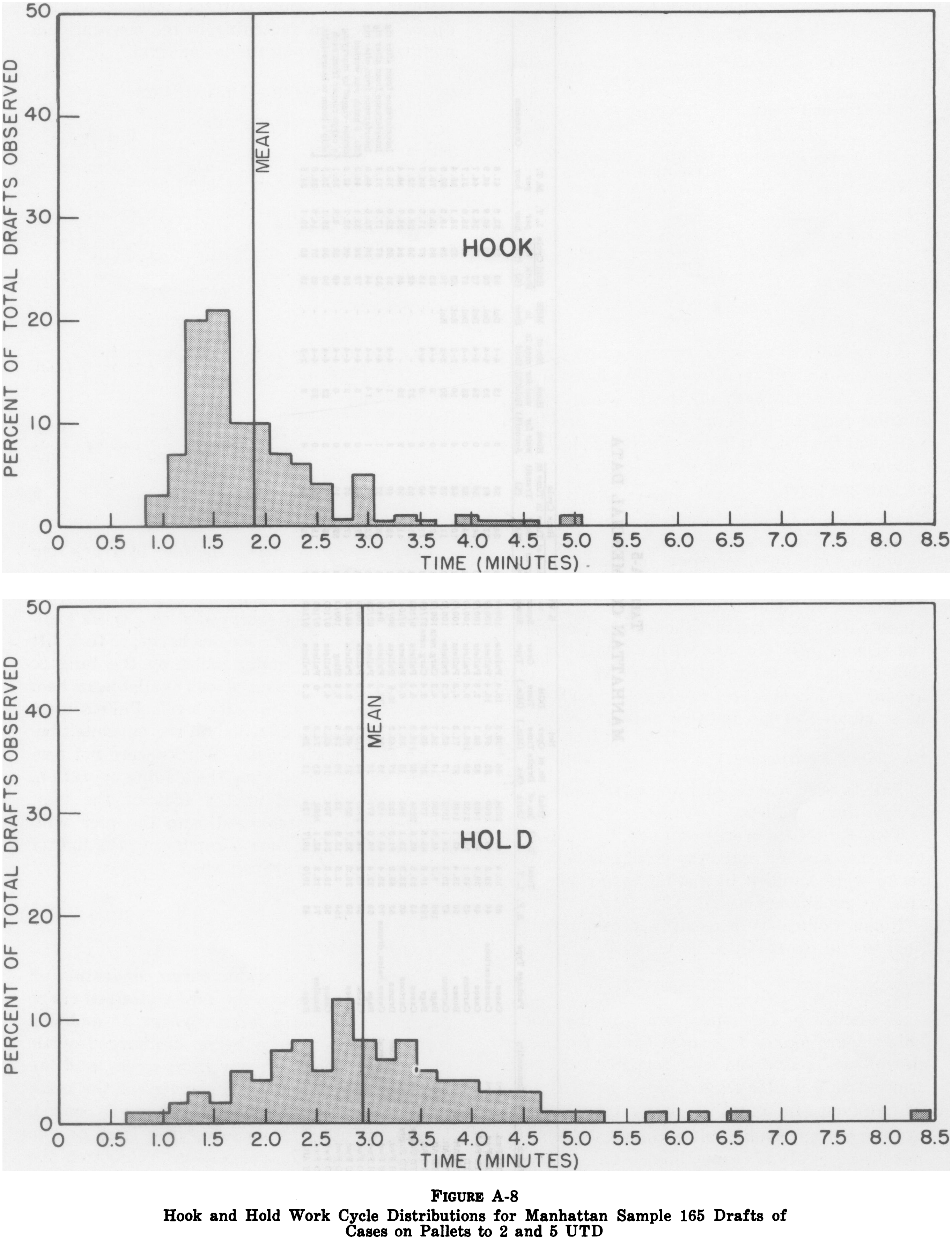


FIGURE A-8
Hook and Hold Work Cycle Distributions for Manhattan Sample 165 Drafts of Cases on Pallets to 2 and 5 UTD

FACILITIES DESCRIPTION—*Contd.*

Manhattan—Contd.

Transit Shed Construction	One 2-story steel frame, metal covered, wood floor.
Dimensions	
Length and width	762x119 feet—1st floor 724x119 feet 2nd floor
Height inside	22 feet
Floor area for cargo	176,596 square feet.
Cargo doors	Continuous, all 15 feet
House Falls	Continuous cargo beams; steam winches on 2nd floor
Railway Connections	None
Truck Facilities	Truck access to transit shed; no loading platforms.

Ship Type: C-2

Receipt of Cargo

All cargo was received by truck and lighter. There are no rail facilities at this installation. Trucks unloaded both on the pier and at the inshore face, cargo being made into drafts on pallets at the truck tailgate. Portable platforms (horses) were observed in use to hold pallets at tailgate level.

Pier Conditions

There were no indications of cargo congestion on the pier. Cargo was loaded from both decks. Cargo beams run the length of the pier (both sides) and steam winches are located on the second deck for use with house falls. Although this pier is equipped with a very narrow apron, no delays were observable which could be attributed to the five-foot apron.

Stevedore Equipment

Pallets used at this pier were standard 4′x6′ 2-way, lipped pallets.

Two fork lifts were assigned to feed each hook except when mail was being loaded. Mail sacks were handled in manila cargo nets carried by mobile cranes.

Roller dollies were used on occasion in the hold to roll drafts into the wings.

The Ship

A feature of this operation was the use of ship's gear married to house-falls for added flexibility. No. 5 hatch, for instance, was worked as a double-rigged hatch, with the use of two house-falls and the ship's gear.

Intermittent loading off both pier levels without the necessity of respotting the onshore boom was also possible by marrying the ship's cargo runner to the house-fall for loading off the upper deck, and switching to the conventional method for cargo on the lower level.

FACILITIES DESCRIPTION

Brooklyn Commercial

Wharf Type	Pier
Construction	Timber pile, concrete deck, asphalt paved.
Dimensions	
Length and width	1,199 feet x 80 feet
Useable berthing space	1,199 feet (each side)
Apron width	4 feet (each side)
Transit Shed Construction	One 1-story steel frame, metal covered.
Dimensions	
Length	1,175x72 feet
Height inside	25 feet
Floor area for cargo	84,600 square feet
Cargo doors	25, 14 w x 16 ft. h (each side)
House Falls	None
Railway Connections	None
Truck Facilities	Truck access to transit shed; no loading platforms.

Ship Type: C-2

Receipt of Cargo

Cargo was received at the pier by truck and lighter, made into drafts on pallets, and stored on the pier.

The pier was not equipped with a truck loading platform. For truck discharge, a fork lift either placed an empty pallet on the tailgate and truck bed when space was available, or held an empty pallet at tailgate level. Pallets were also observed being loaded on the pavement beneath the truck tailgate. Trucks were not permitted on the pier during the loading operation, but were unloaded at the foot of the pier. Lighters were discharged onto the pier with fork lifts running over a ramp onto the lighter directly from the transit shed.

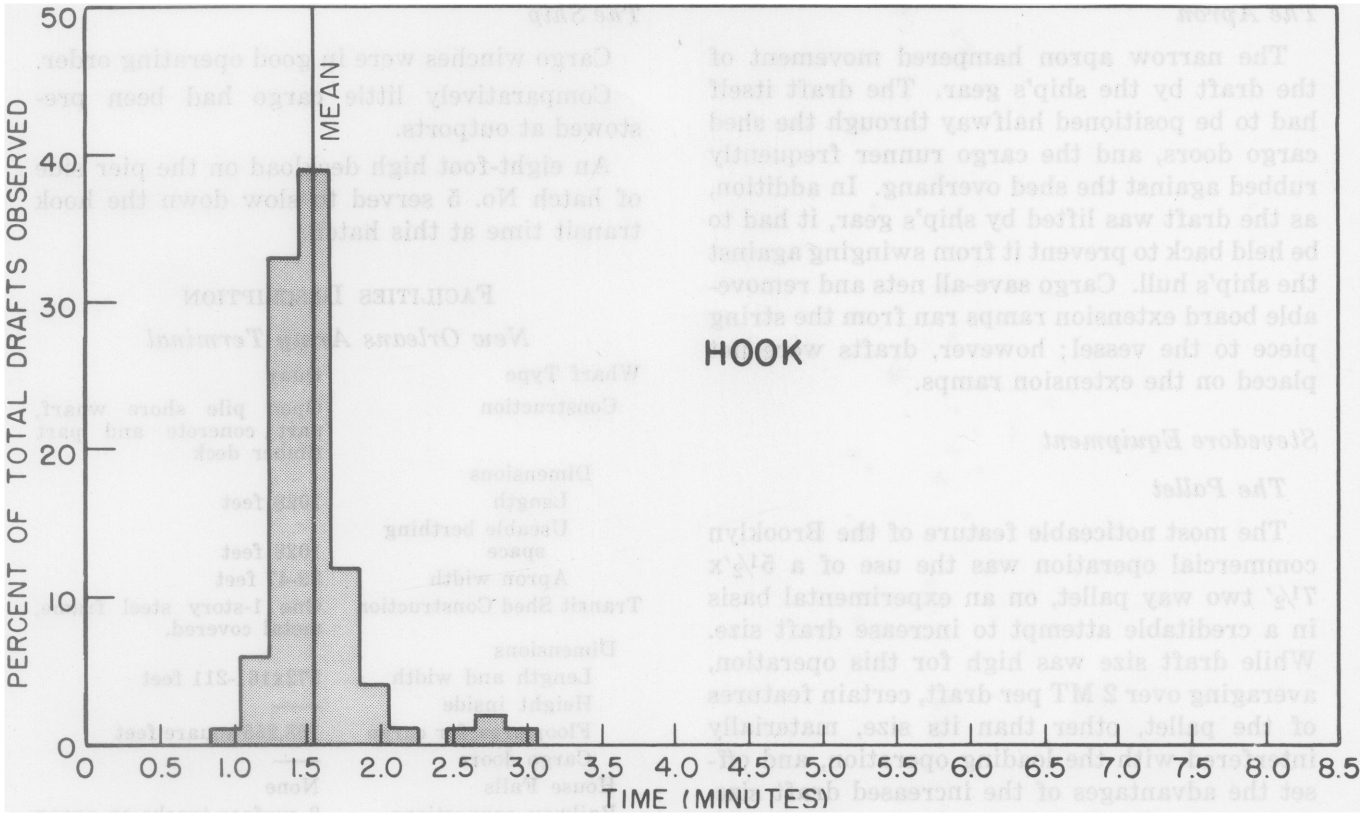
Pier Condition

Cargo Space

There was considerable cargo congestion on the narrow pier since the shed contained cargo for both this and a later voyage. In addition certain hatches were being discharged while the loading operation was in progress, and the discharge operation was dependent on the space made available as outbound cargo was loaded. Maximum use was made of free time on the lighters to ease the congestion problem on the pier.

TABLE A-6
BROOKLYN COMMERCIAL DATA

Ship Type	Hatch	Commodity	Package Type	S. F.	Total L. T.	Total M. T.	Total No. of Units	No. of Drafts Obs.	Net Oper. Time (Min.)	DGH Time (Min.)	Gear Type	% Wing to Square Stowage	Hook Cycle: Time at Apron (%)	Hook Cycle: Time in Hold (%)	Hook Cycle: Time in Transit (%)	Hook wait for Apron(%)	Hook wait for Hold(%)	No. of men in Hold	MHE in Hold	Hold Cycle: Work (%)	Hold Cycle: Wait (%)	L. T. per hour	M. T. per hour	Comments
C-2	2 L T/D Fwd.	K/D Trucks	Case	165	13.0	53.6	6	6	55.2	0	Sling	100/0	21	39	40	0	0	4-4	-	37	63	14.1	58.3	
C-2	2 L T/D Fwd.	Looms	Case	109	30.0	82.0	15	15	100.9	6.6	Sling	100/0	15	70	16	1	3	8	Rlrs.	81	19	17.8	48.8	Snaking; one team
C-2	2 Deep Tanks Fwd.	General	Mixed	141	18.7	65.9	210	38	125.0	0.8	Pallets	100/0	39	38	24	8	0	4-4	-	39	61	9.0	31.6	
C-2	2 Deep Tanks Fwd.	Gas ranges	Cases	250	17.4	108.6	220	39	110.3	3.1	Pallets	94/6	35	35	29	3	0	4-4	-	38	62	9.5	59.1	
C-2	2 Deep Tanks Fwd.	Gas ranges	Cases	251	4.7	29.5	59	21	37.7	0	Pallets	57/43	33	37	30	0	0	4-4	-	41	59	7.5	47.0	
C-2	2 Deep Tanks Aft.	Tinplate	Skids	10	138.0	33.3	138	89	201.2	19.1	Sling	84/16	22	36	42	1	13	4-4	Fl*	30	70	41.1	9.9	*Forklift in one tank, hook spotting in another
C-2	3 L/H Aft.	Tinplate	Skids	9	127.0	28.2	178	92	205.6	0.8	Sling	92/8	22	15	63*	3	0	4-4	FL.	28	72	37.1	8.2	*Long loads fwd. interfered w/hook aft.
C-2	3 L/H Aft.	Tinplate	Skids	6	133.0	20.0	118	77	201.9	14.6	Sling	4/96	27	45	28	0	0	4-4	-	16	84	39.5	5.9	No forklift (square)
C-2	4 UTD Fwd.	General	Mixed	90	52.9	118.5	1863	56	204.5	0.9	Pallets	100/0	36	40	24	16	10	6-6	-	67	33	15.5	34.8	
C-2	4 DeepTanksFwd.	Oil	Drums	54	13.0	17.4	65	11	25.8	5.6	Hooks	91/9	20	8	72	0	29	4	-	81	19	30.2	40.5	Single team(one tank only)
C-2	4 Deep Tanks Fwd.	Oil	Drums	54	224.5	302.3	1124	190	297.4	33.6	Hooks	91/9	30	9	61	1	1	4-4	-	47	53	45.3	61.0	
C-2	4 Deep Tanks Fwd.	Oil	Drums	54	35.5	47.7	177	30	47.2	14.5	Hooks	13/87	27	16	57	0	0	4-4	-	48	52	45.1	60.6	
C-2	4 Deep Tanks Aft.	Tin plate	Skid	9	157.1	36.1	146	125	250.6	11.3	Sling	88/12	25	15	60	8	16	3	Fl.	63	37	37.6	8.6	1 team of 3 (one-tank)
C-2	4 Deep Tanks Aft.	Tin plate	Skid	10	37.9	9.4	73	33	72.1	1.4	Sling	3/97	24	29	47	1	0	4-4	-	24	76	31.5	7.8	
C-2	4 Deep Tanks Aft.	Steel sheet	Skid	9	71.0	16.3	133	49	219.7	17.4	Sling	12/88	18	39	43	2	0	4-4	-	21	79	19.4	4.4	
C-2	4 Deep Tanks Aft.	Paint	Drums	40	24.4	24.6	87	15	35.3	21.9	Hooks	100/0	25	24	51	3	0	4-4	-	54	46	41.5	41.8	
C-2	4 Deep Tanks Aft.	Lg. Crates& K/Ds	Cses& Crts	231	16.3	94.0	16	14	63.9	5.3	Sling	86/14	22	36	42	5	4	4-4	-	30	70	15.3	88.3	
C-2	4 Deep Tanks Aft.	Mixed general	Mixed	56	38.2	53.6	1510	37	175.6	53.4	Pallets	82/18	24	31	44	4	2	5-4	-	35	65	13.0	18.3	4-4; 6-4 men
C-2	4 Deep Tanks Aft.	Mixed general	Mixed	49	31.8	38.6	330	26	98.6	0.7	Pallets	75/25	17	38	44	0	0	6-6	-	53	47	19.3	23.5	
C-2	4 Deep Tanks Aft.	Mixed general	Mixed	53	76.4	100.8	1071	62	249.1	36.8	Pallets	73/27	20	35	45	1	1	4-4	-	46	54	18.4	24.3	
C-2	4 Deep Tanks Aft.	Ice cans	Loose	104	12.0	31.2	72	23	59.9	1.0	Pallets	16/84	28	25	47	4	0	3-3	-	27	73	12.0	31.2	
C-2	5 L. H.	Oil	Drums	51	34.7	44.5	174	29	55.9	2.9	Hooks	100/0	35	16	48	14	6	4-4	-	56	44	37.2	47.8	
C-2	5 L. H.	Oil	Drums	51	19.1	24.5	96	20	33.0	7.3	Hooks	35/65	28	22	51	0	11	4-4	-	57	43	34.7	44.5	
C-2	5 L. H.	Wire	Rolls	36	17.0	15.5	224	13	46.5	0.2	Sling	100/0	46	22	32	21	0	4-4	-	63	37	21.9	20.0	
C-2	5 L. H.	Knockdown Autos	Cases	130	25.8	83.8	10	10	143.7	12.2	Sling	100/0	8	67	24	2	0	4-4 *	-	56	44	10.8	35.0	Snaking * 4-4; 6-0; 8-0



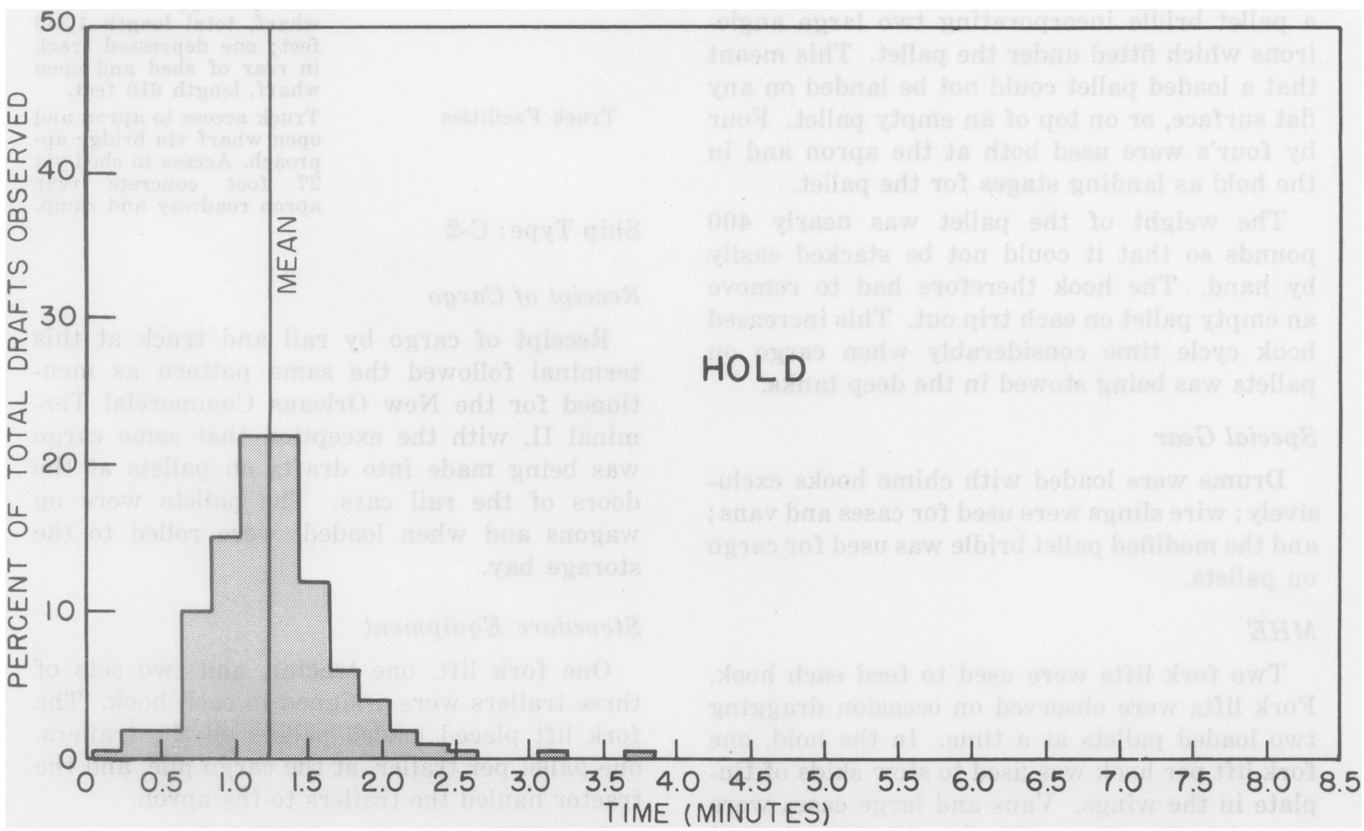


FIGURE A-9

Hook and Hold Work Cycle Distributions for Brooklyn Commercial Sample
189 Drafts of Drums Handled with Chime Hooks to 4 Deep Tanks

The Apron

The narrow apron hampered movement of the draft by the ship's gear. The draft itself had to be positioned halfway through the shed cargo doors, and the cargo runner frequently rubbed against the shed overhang. In addition, as the draft was lifted by ship's gear, it had to be held back to prevent it from swinging against the ship's hull. Cargo save-all nets and removeable board extension ramps ran from the string piece to the vessel; however, drafts were not placed on the extension ramps.

Stevedore Equipment

The Pallet

The most noticeable feature of the Brooklyn commercial operation was the use of a 5½'x 7½' two way pallet, on an experimental basis in a creditable attempt to increase draft size. While draft size was high for this operation, averaging over 2 MT per draft, certain features of the pallet, other than its size, materially interfered with the loading operation, and offset the advantages of the increased draft size. Since the pallet had no lips, it was lifted with a pallet bridle incorporating two large angle-irons which fitted under the pallet. This meant that a loaded pallet could not be landed on any flat surface, or on top of an empty pallet. Four by four's were used both at the apron and in the hold as landing stages for the pallet.

The weight of the pallet was nearly 400 pounds so that it could not be stacked easily by hand. The hook therefore had to remove an empty pallet on each trip out. This increased hook cycle time considerably when cargo on pallets was being stowed in the deep tanks.

Special Gear

Drums were loaded with chime hooks exclusively; wire slings were used for cases and vans; and the modified pallet bridle was used for cargo on pallets.

MHE

Two fork lifts were used to feed each hook. Fork lifts were observed on occasion dragging two loaded pallets at a time. In the hold, one fork lift per hook was used to stow skids of tinplate in the wings. Vans and large cases were stowed in the wings with the aid of hard wood rollers.

The Ship

Cargo winches were in good operating order.

Comparatively little cargo had been prestowed at outports.

An eight-foot high deckload on the pier side of hatch No. 5 served to slow down the hook transit time at this hatch.

FACILITIES DESCRIPTION

New Orleans Army Terminal

Wharf Type	Quay
Construction	Open pile shore wharf, part concrete and part timber deck
Dimensions	
Length	1028 feet
Useable berthing space	1028 feet
Apron width	39-47 feet
Transit Shed Construction	One 1-story steel frame, metal covered.
Dimensions	
Length and width	572x161-211 feet
Height inside	——
Floor area for cargo	108,255 square feet
Cargo doors	——
House Falls	None
Railway connections	2 surface tracks on apron and open upper section of wharf, total length 1,340 feet; one depressed track in rear of shed and open wharf, length 610 feet.
Truck Facilities	Truck access to apron and open wharf via bridge approach. Access to shed via 27 foot concrete rear apron roadway and ramp.

Ship Type: C-2

Receipt of Cargo

Receipt of cargo by rail and truck at this terminal followed the same pattern as mentioned for the New Orleans Commercial Terminal II, with the exception that some cargo was being made into drafts on pallets at the doors of the rail cars. The pallets were on wagons and when loaded, were rolled to the storage bay.

Stevedore Equipment

One fork lift, one tractor, and two sets of three trailers were assigned to each hook. The fork lift placed loaded pallets on the trailers, one pallet per trailer, at the cargo pile, and the tractor hauled the trailers to the apron.

In addition to pallet bridles for cargo on pallets, slings were used for vans and tinplate.

TABLE A-7
NEW ORLEANS ARMY TERMINAL DATA

Ship Type	Hatch	Commodity	Package Type	S. F.	Total L. T.	Total M. T.	Total No. of Units	No. of Drafts Obs.	Net. Oper. Time (Min.)	DGH Time (Min.)	Gear Type	% Wing to Square Stowage	Hook Cycle: Time at Apron %	Hook Cycle: Time in Hold %	Hook Cycle: Time in Transit %	Hook wait for Apron(%)	Hook wait for Hold(%)	No. of men in Hold	MHE in Hold	Hold Work (%)	Cycle Wait (%)	L. T. per hour	M. T. per hour	Comments
C-2	1 U. T. D.	General Cargo	Mixed	267	14.4	96.2	50	37	75.3	12.6	Pallets	8/92	-	-	-	12	9	4-4	-	19	81	11.5	76.7	
C-2	3 L. T. D. Aft.	Grease	Pails	68	16.7	28.2	956	20	34.6		Pallets	100/0	-	-	-	17	8	5-5	Dol.	47	53	29.0	48.9	
C-2	3 L. T. D. Aft.	Household goods	Boxes	238	32.5	193.6	66	60	126.6		Pal. & Sl.	84/16	-	-	--	18	2	5-5	Dol.	28	72	15.4	91.8	Blocking out
C-2	3 L. T. D. Aft.	Splint sets	Bundles	119	19.1	56.6	1424	39	53.3	68.5	Sling	100/0	-	-	-	12	8	5-5	-	51	49	21.5	63.7	Blocking out
C-2	3 L. T. D. Aft.	Bomb rings	Bundles	75	30.0	56.3	1663	36	66.6		Pallets	85/15	-	-	-	11	19	5-5	-	62	38	27.0	50.7	Blocking out
C-2	3 L. T. D. Aft.	Bomb rings	Bundles	125	8.2	25.6	255	22	33.2		Pal. & Sl.	24/76	-	-	-	9	17	5-5	-	41	59	14.8	46.3	Blocking out
C-2	3 L. T. D. Fwd.	Household goods	Boxes	238	18.3	108.9	37	34	74.3		Sling	100/0	-	-	-	5	19	5-5	Dol.	62	38	14.8	87.9	
C-2	3 L. T. D. Fwd.	Household goods	Boxes	237	13.5	80.0	28	25	36.9		Pallets	100/0	-	-	-	14	3	5-5	Dol.	58	42	22.0	130.4	Blocking out
C-2	3 L. T. D. Fwd.	Household goods	Boxes	237	10.8	64.0	22	20	40.5	11.7	Sling	100/0	-	-	--	0	16	5-5	-	42	58	16.0	94.7	
C-2	3 L. T. D. Fwd.	Household goods	Boxes	237	10.8	64.0	22	20	47.6		Sling	4/96	-	-	-	0	20	5-5	-	29	71	13.6	80.6	
C-2	3 L. T. D. Fwd.	Bomb rings	Bundles	126	22.2	69.7	696	60	103.1		Pallets	67/33	-	-	-	25	12	5-5	-	39	61	12.9	40.6	Blocking out
C-2	5 T. D.	Household goods	Boxes	223	24.7	138.0	56	49	94.3		Pal. & Sl.	100/0	-	-	-	1	15	5-5	Dol.	53	47	15.8	88.3	
C-2	5 T. D.	Household goods	Boxes	222	11.6	64.5	26	23	54.7		Slings	100/0	-	-	-	4	12	5-5	Dol.	50	50	12.7	70.7	
C-2	5 T. D.	Ice cream mix	Cartons	73	43.8	79.5	3191	43	88.6	33.8	Pallets	100/0	-	-	--	0	38	5-5	-	83	17	29.8	54.1	Blocking out
C-2	5 T. D.	Wing tanks	Crates	640	2.1	33.3	12	12	17.4		Pallets	25/75	-	-	-	0	0	5-5	-	41	59	7.2	114.9	
C-2	5 T. D.	Bomb rings	Bundles	98	14.3	35.1	581	27	45.2		Pallets	0/100	-	-	-	12	14	5-5	-	44	56	19.0	46.7	
C-2	5 T. D.	General cargo	Mixed	131	20.8	68.0	648	80	139.6		Pallets	49/51	-	-	-	8	19	5-5	-	36	64	8.9	29.2	Blocking out

The hold gang was supplied with dollies and pry-bars to assist in stowing vans and heavy cases.

FACILITIES DESCRIPTION

Hampton Roads Army Terminal

Wharf Type	Pier
Construction	Concrete retaining wall, solid fill, with open concrete pile extensions decked with concrete and timber.
Dimensions	
Length and width	1,328 feet x 300 feet
Usable berthing space	1,328 feet (each side)
Apron width	36 feet (each side)
Transit Shed Construction	One, 1-story steel frame, metal and concrete walls, concrete floor.
Dimensions	
Length and width	1,280x228 feet
Height inside	18 feet
Floor area for cargo	245,820 square feet
Cargo doors	——
Railway Connections	2 surface tracks on each apron; 3 depressed tracks inside transit shed.
Truck Facilities	Truck access to transit shed.

Ship Type: EC-2; C-2; C1-B

Receipt of Cargo

The major portion of the cargo received at this pier was delivered by railcar. Loose cargo, and cargo unitized on pallets were delivered in railcars spotted on three depressed tracks within the transit shed. Fork lifts, tractor-trailer sets, or hand trucks, based on equipment availability and commodity type, were used to unload the railcars. Army transporters were delivered on flat cars to shipside along the apron tracks, and were loaded aboard directly from the flat cars.

Truck delivery was accomplished by permitting truck access to the transit shed. A loop truck lane is maintained inside the shed to facilitate truck through-movement.

Stevedore Equipment

Two fork lifts were used to feed each hook during the loading of unitized and loose cargo. Individual flat cars with transporters were spotted in way of ship's gear by a pier tractor.

Roller conveyors were used on occasion in the hold for loose cargo. Transporters were stowed with the aid of a fork lift and a tractor. Fork lifts were also used for tiering unitized cargo.

Pallets on which subsistence was unitized were both lipped and without lips. A pallet bridle was used to load the lipped pallets, but the unlipped pallets posed a special problem. Much time was lost at the apron threading the ends of wire slings through the unlipped pallets. Later, 4x4's were located at the apron and in the hold so that the slings could be located beneath the pallets; however this caused damage to the bottom boards of the pallets. Eventually, the unlipped pallets were burtoned aboard by placing them on the regular stevedore pallet at the apron and using pallet bridles with the stevedore pallet. The lipped stevedore pallet measured 4′x6′, while the palletized units were 4′x4′, so that two units could be carried on the stevedore pallet with overhang at the lipped ends.

The Ships

The winches aboard the two Liberties observed at this terminal suffered from low steam pressure. On one occasion this severely hampered the loading of a hatch by preventing the hook from lifting a fork lift into the hold. The steam pressure to the winches of the Liberties remained low throughout the operation.

FACILITIES DESCRIPTION

Brooklyn Army Terminal

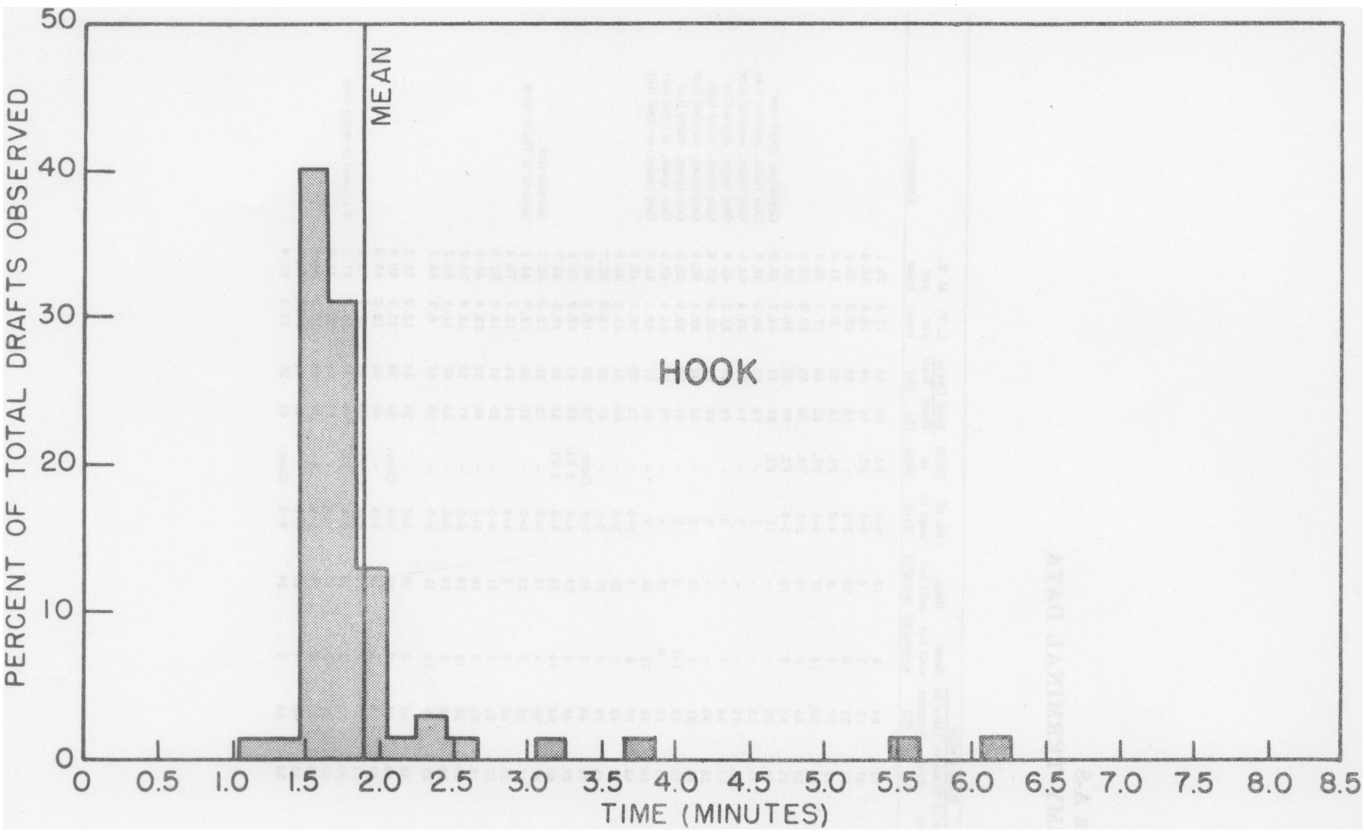
Wharf Type	Pier
Construction	Open timber pile, concrete deck, asphalt block paving.
Dimensions	
Length and width	1300 ft. x 150 ft.
Useable berthing space	1300 ft. (each side)
Apron width	5 ft. (each side)
Transit Shed Construction	2 story; steel frame, reinforced concrete. 6 cargo elevators.
Dimensions	
Length and width	1260 ft. x 140 ft.
Height inside	19-25 ft. (first floor); 14-26 ft. (second floor).
Floor Area for Cargo	330,300 sq. ft.
Cargo doors	Continuous (each side, both decks).
House Falls	Continuous cargo beam (each side)
Railway Connections	2 flush tracks within transit shed
Truck facilities	Truck access to shed; no loading platforms.

Ship Types: EC-2; C1-M-AV1; Modified C-3

NOTE: A detailed study of the loading operation, as observed at Hampton Roads Army Terminal, may be found in *The NEAC Study*, A Comparison of Conventional Versus Unitized Cargo Systems. National Academy of Sciences—National Research Council, publication 389, pp. 65-82.

TABLE A-8
HAMPTON ROADS ARMY TERMINAL DATA

Ship Type	Hatch	Commodity	Package Type	S. F.	Total L. T.	Total M. T.	Total No. of Units	No. of Drafts Obs.	Net Oper. Time (Min.)	DGH Time (Min.)	Gear Type	% Wing to Square Stowage	Hook Cycle			Hook wait for Apron(%)	Hook wait for Hold(%)	No. of men in Hold	MHE in Hold	Hold Cycle		L. T. per hour	M. T. per hour	Comments
													Time at Apron (%)	Time in Hold (%)	Time in Transit (%)					Work (%)	Wait (%)			
C1-B	2 L. T. D. Fwd	Subsistence	Pallet. units	74	18.1	33.4	21	21	60.5	0	Sling	100/0	23	23	54	2	18	5-5	FL	32	68	17.9	33.1	
C1-B	2 LTD Fwd.	Subsistence	Pallet. units	74	29.2	54.1	34	34	88.8	10.8	Sling	0/100	36	47	17	3	4	5-5	FL	16	84	19.8	36.8	
C1-B	2 LTD Fwd.	Subsistence	Pallet. units	74	27.5	50.9	32	32	91.2	10.5	Sling	0/100	26	51	23	0	19	5-5	-	18	82	18.2	33.6	
C1-B	3 LH	Subsistence	Pallet. units	104	19.7	51.0	34	25	143.2	0	Sling	76/24	12	12	77	7	2	4-4	FL	14	86	8.2	21.4	
EC-2	1 LH & Deep Tank	Subsistence	Pallet. units	109	24.4	66.7	45	29	82.6	0	Sling	100/0	32	38	30	14	17	5-5	FL	42	58	17.7	48.5	
EC-2	1 LH & Deep Tank	Subsistence	Pallet. units	109	48.8	133.3	89	58	140.8	0	Sling	100/0	27	28	45	2	14	3-3	FL	45	55	20.8	56.8	
EC-2	1 LH & Deep Tank	Cement	Bags	24	96.6	57.5	2300	62	150.6	6.7	Pallets	100/0	14	31	55	2	18	5-5	FL	61	39	38.5	23.0	
EC-2	2 LH	-	Containers	79	124.2	245.7	27	27	166.1	0	Sling	100/0	22	42	36	-	-	11	FL	89	11	44.7	88.5	Oneteam, first tier
EC-2	2 LH	-	Containers	79	165.6	327.6	36	36	351.3	4.2	Sling	100/0	16	71	13	-	-	7	-	74	26	28.2	55.7	One team, second tier
EC-2	2 LH	-	Containers	79	101.2	200.2	22	22	184.9	0	Sling	41/59	11	74	15	-	-	7	-	70	30	32.4	64.1	One team, second tier
EC-2	2 LH	-	Containers	79	193.2	382.2	42	42	499.5	74.9	Sling	98/2	9	77	14	-	-	8	-	74	26	23.2	45.9	One team, third tier
EC-2	2 LH	Subsistence	Pallet. units	72	19.2	34.5	23	23	55.2	16.8	Sling	43/57	35	35	30	-	-	7	-	32	68	20.9	37.6	One team, third tier
EC-2	3 LH	-	Containers	80	138.0	273.5	29	29	245.7	0	Sling	90/10	15	65	21	5	19	8	-	58	42	33.1	65.6	One team, second tier
EC-2	3 LH	-	Containers	80	174.8	345.8	38	38	305.0	75.2	Sling	79/21	11	72	18	1/2	0	8	-	67	33	35.0	69.2	One team, third tier
EC-2	4 LH	-	Containers	81	76.5	154.7	17	17	186.9	12.3	Sling	100/0	15	75	10	0	59	8	-	76	24	24.5	49.5	One team, second tier
EC-2	4 LH	-	Containers	81	72.0	145.6	16	16	101.8	0	Sling	25/75	21	50	28	12	35	8	-	43	57	42.5	85.9	One team, second tier
C-2	4 LH Aft.	Subsistence	Pallet. units	82	27.7	56.8	44	44	70.7	0	Pallets	100/0	25	44	30	2	5	5-5	-	71	29	23.5	48.3	
C-2	4 LH Aft.	Candy & loose sub.	Cartons	61	60.2	91.2	3697	47	128.4	6.7	Pallets	94/6	26	32	42	7	23	5-5	-	69	31	28.1	42.6	
C-2	4 LH Aft.	Household goods	Cases	167	10.0	41.7	231	15	39.9	6.0	Sling	100/0	17	45	39	0	27	5-5	-	47	53	15.0	62.7	
G-2	4 LH Aft.	Cigarettes	Cartons	147	18.5	68.0	1022	29	68.9	0	Pallets	100/0	20	34	45	3	31	5-5	Conv.	70	30	16.1	59.2	
EC-2	4 LH	Subsistence	Pallet. units	81	82.0	166.4	110	62	185.0	7.7	Sling	100/0	17	39	45	3	23	4-4	2 FL	59	41	26.2	53.2	
EC-2	4 LH	Subsistence	Pallet. units	81	14.2	28.7	19	15	44.6	1.4	Sling	53/47	28	48	24	14	34	4-4	2 FL	41	59	19.2	38.7	
EC-2	5 LH	Loose subsistence	Cartons	129	26.9	86.9	1920	48	134.8	0	Pallets	0/100	20	27	53	4	16	5-5	-	72	28	12.0	38.7	Second tier
EC-2	5 LH	Loose subsistence	Cartons	129	35.8	115.8	2560	64	157.0	15.5	Pallets	100/0	20	42	38	3	23	5-5	-	68	32	13.7	44.3	Second & Third tiers
EC-2	5 LH	Foam glass	Cartons	238	47.4	282.5	3139	101	231.0	21.2	Pallets	100/0	17	35	49	4	5	4-4	-	64	36	12.3	73.4	
C-2	1 LH	Ord. supplies	Cases	83	14.0	29.0	294	21	55.0	8.5	Pallets	52/48	22	17	61	2	31	5-5	-	39	61	15.3	31.6	
C-2	1 LH	Candy	Cartons	69	21.2	36.4	1339	15	53.5	0	Pallets	0/100	18	18	64	5	18	5-5	-	68	32	23.8	40.8	
C-2	1 LH	Household goods	Cases	240	12.6	75.6	27	23	61.1	5.7	Pallets	0/100	28	45	28	10	26	5-5	-	27	73	12.4	74.2	
C-2	1 LH	Household goods	Cases	239	7.0	41.9	15	15	38.0	0	Pallets	80/20	20	32	48	3	24	4-4	-	33	67	11.1	66.2	
C-2	1 LH	Household goods	Cases	236	6.8	40.2	14	14	44.1	0	Pallets	100/0	32	29	39	16	32	5-5	-	36	64	9.2	54.7	
C-2	3 LH Fwd.	Household goods	Cases	232	30.5	176.9	61	60	141.2	8.7	Sling	82/18	27	32	41	2	19	6-6	-	34	66	13.0	75.2	
C-2	3 LH Fwd.	Cigarettes	Cartons	141	15.8	55.6	877	22	54.8	0	Pallets	100/0	18	18	64	0	26	6-6	Conv.	82	28	17.3	60.9	
C-2	3 LH Fwd.	Household goods	Cases	232	11.0	63.8	22	18	54.8	16.7	Sling	22/78	25	40	35	5	15	6-6	-	40	60	12.0	69.9	
C-2	3 LH Aft.	Cigarettes	Cartons	139	29.8	103.5	1630	41	84.7	7.1	Pallets	100/0	24	31	45	0	16	3-4	Conv.	69	31	21.1	73.3	
C-2	3 LH Aft.	Household goods	Cases	232	54.5	316.1	109	90	193.8	32.1	Sling	70/30	29	38	33	5	12	5-5	FL	46	54	16.9	97.9	FL used in wing only
C-2	4 LH Fwd.	Subsistence	Pallt. units	82	22.0	45.2	35	35	63.1	0	Sling	91/9	20	49	32	0	17	6-6	-	35	65	20.9	43.0	
C-2	4 LH Fwd.	Candy	Cartons	61	24.3	36.9	1476	19	86.8	12.9	Pallets	63/37	10	26	64	7	39	6-6	-	32	68	16.8	25.5	
C-2	4 LH Fwd.	Household goods	Cases	230	6.0	35.0	11	10	25.8	11.2	Sling	95/5	20	38	42	0	20	6-6	-	29	71	14.0	81.4	
C-2	4 LH Fwd.	Cigarettes	Cartons	147	24.4	89.5	1351	35	96.6	2.8	Pallets	91/9	19	28	54	3	34	6-6	Conv.	61	39	15.1	55.6	



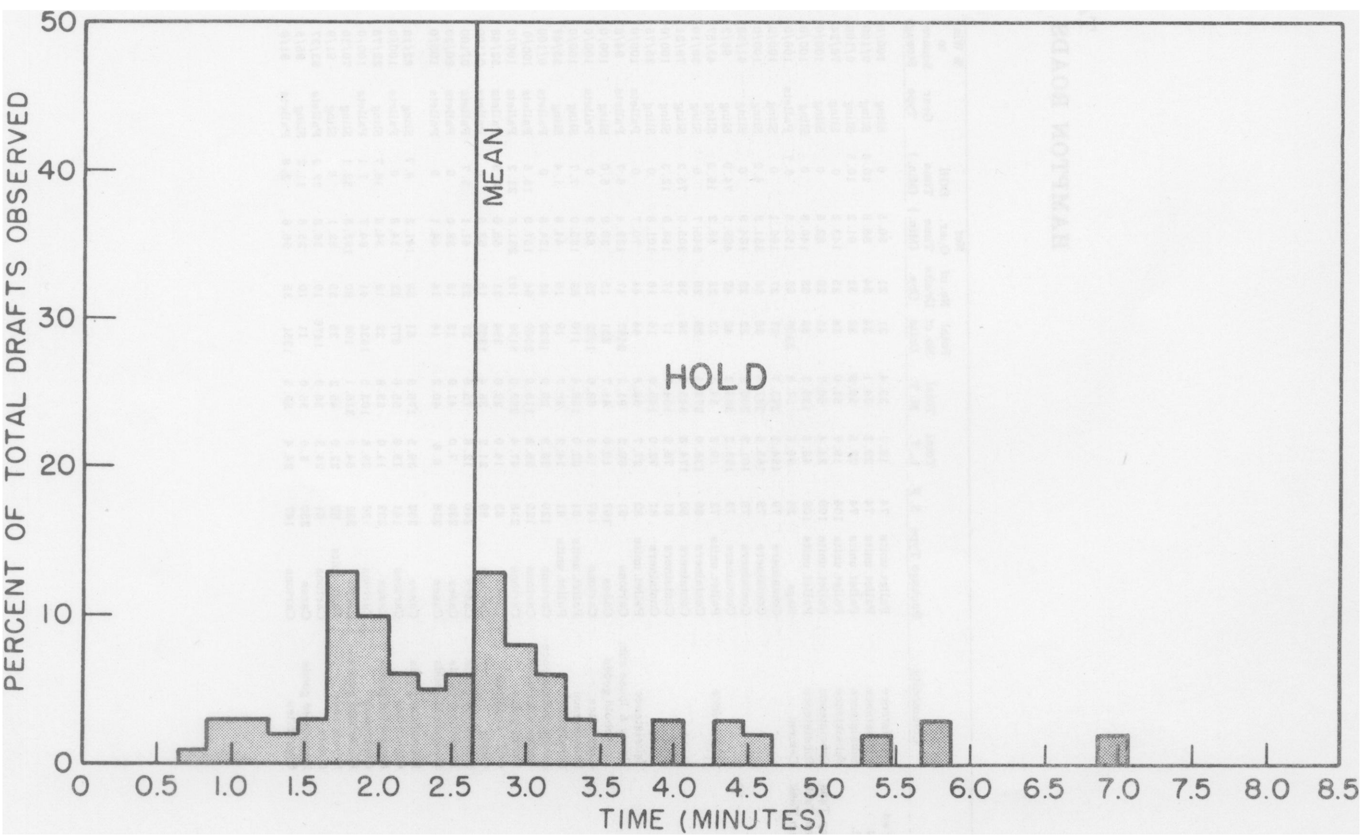


FIGURE A-10
Hook and Hold Work Cycle Distributions for Hampton Roads Army Terminal EC-2, Sample 62 Drafts of Bags of Cement on Pallets to 1 L.H. (Fork Lift Used in Hold)

TABLE A-9
BROOKLYN ARMY TERMINAL DATA

Ship Type	Hatch	Commodity	Package Type	S. F.	Total L. T.	Total M. T.	Total No. of Units	No. of Drafts Obs.	Net Oper. Time (Min.)	DGH Time (Min.)	Gear Type	% Wing to Square Stowage	Hook Cycle: Time at Apron (%)	Hook Cycle: Time in Hold (%)	Hook Cycle: Time in Transit (%)	Hook wait for Apron(%)	Hook wait for Hold(%)	No. of men in Hold	MHE in Hold	Hold Cycle: Work (%)	Hold Cycle: Wait (%)	L. T. per hour	M. T. per hour	Comments
EC-2	2 LH	General cargo	Mixed	97	28.0	67.6	446	47	89.4	8.6	Pallets	22/78	36	17	47	0	0	6-6	-	48	52	18.8	45.3	
EC-2	2 LH	Subsistence	Containers	88	53.9	118.6	13	13	101.0	14.4	Hooks	0/100	31	12	57	12	0	12	-	18	82	31.8	70.0	1 Team; loaded with floating crane
EC-2	4 TD	Subsistence	Unitized Pal.	54	37.6	50.5	33	33	57.1	1.4	Sling	100/0	53	15	31	0	15	7-7	Fl.	59	41	39.5	53.0	
EC-2	4 TD	Eng. Assemblies	Boxes	71	7.7	13.6	17	17	31.9	0	Sling	100/0	40	20	40	12	13	6-6	Fl.	36	64	14.5	25.6	
EC-2	4 TD	Eng. Assemblies	Boxes	71	6.8	12.0	15	15	25.1	0	Sling	0/100	29	33	38	5	13	6-6	-	43	57	16.3	28.7	
EC-2	4 TD	General cargo	Mixed	75	49.1	92.4	856	58	113.9	19.4	Pallets	81/19	35	27	38	7	12	6-6	RL.	47	53	26.0	49.0	
EC-2	4 TD	Tires	Loose	175	15.3	66.9	239	37	50.5	5.6	Pallets	95/5	31	31	38	0	13	6-6	-	46	54	18.2	79.6	
EC-2	4 LH	Subsistence	Pall. units	54	31.9	42.8	28	28	75.9	0	Sling	4/96	32	48	21	0	43	6-6	-	15	85	25.2	33.8	
EC-2	5 LH	Subsistence	Pall. units	57	42.7	60.7	44	44	100.4	2.1	Sling	-	28	42	30	0	7	6-6	-	22	78	25.5	36.3	Second tier; wing & square
EC-2	5 LH	General cargo	Mixed	88	48.0	106.2	900	60	116.5	17.7	Pallets	77/23	24	36	40	0	3	6-6	-	47	53	24.7	54.7	Second tier
C1-MAV-1	1 TD	Household goods	Cases	249	6.5	40.4	23	18	47.1	0	Sling	0/100	23	37	40	0	30	6-6	-	18	82	8.3	51.4	
C1-MAV-1	1 TD	Baggage	Mixed	137	4.6	15.7	143	13	24.5	1.8	Pallets	0/100	33	17	50	0	16	8-6	-	35	65	11.3	38.5	
C1-MAV-1	1 TD	Subsistence	Pall. units	77	13.4	25.8	23	23	51.5	0.6	Sling	0/100	31	49	19	1	3	8-5	-	12	88	15.5	29.9	Loaded from 2nd deck of pier with housefalls
C1-MAV-1	1 LH	Household goods	Cases	249	3.6	22.4	10	10	18.9	2.3	Sling	100/0	32	39	30	0	0	6-6	Rl.	27	73	11.4	71.0	
C1-MAV-1	1 LH	Household goods	Cases	245	4.4	26.9	21	12	35.7	0	Sling	0/100	21	47	32	0	11	6-6	-	19	81	7.4	45.2	
C1-MAV-1	2 LH	Subsistence	Containers	82	44.6	91.3	11	11	64.5	0	Hooks	100/0	32	18	50	11	0	13	Fl.	48	52	41.5	84.9	1 Team; loaded with floating crane from lighter
C1-MAV-1	2 LH	Subsistence	Pall. units	26	52.1	33.3	30	30	51.5	0	Sling	80/20	30	29	41	1	6	10	-	92	8	60.7	38.8	1 Team; loaded from 2nd deck of pier w/housefalls
C-3(Mod.)	7 LH	Rangers	Crates	126	8.1	23.0	19	19	38.1	-	Sling	0/100	20	32	38	0	0	4-4	-	24	76	12.8	40.2	
C-3(Mod.)	7 LH	General cargo	Cases, crates	139	16.6	57.5	48	24	67.3	-	Sling	79/21	22	40	38	0	0	6-5	-	48	52	14.8	51.3	
C-3(Mod.)	7 LH	General cargo	Cartons, boxes	123	9.7	29.8	230	23	38.4	-	Pallets	26/74	27	16	57	8	0	5-5	-	48	52	15.2	46.6	
C-3(Mod.)	7 LH	Tires	Loose	195	4.5	21.9	144	12	16.8	-	Pallets	100/0	31	13	55	9	0	5-5	-	39	61	16.1	78.2	
C-3(Mod.)	7 LH	General cargo	Mixed	65	11.8	19.2	68	17	30.0	-	Pallets	0/100	44	14	41	5	0	6-6	-	31	69	23.6	38.4	Beam stowage
C-3(Mod.)	7 LH	General cargo	Mixed	140	11.2	39.2	575	25	51.8	-	Sl. & Pal.	8/92	43	12	44	9	3	5-5	-	49	51	13.0	45.4	
C-3(Mod.)	7 LH	General cargo	Mixed	132	11.5	37.8	600	24	42.4	-	Pallets	50/50	25	17	58	5	8	5-5	-	57	43	16.3	53.5	
C-3(Mod.)	7 LH	Cans oil	Cartons	45	35.5	40.0	1456	26	47.4	-	Pallets	100/0	20	14	66	1	2	5-5	-	58	42	50.2	56.6	
C-3(Mod.)	7 LH	Cloth	Bags	117	48.6	142.1	792	72	102.8	-	Pallets	100/0	28	18	54	2	0	5-5	-	52	48	28.4	82.9	
C-3(Mod.)	7 LH	Shoes	Cartons	112	33.7	94.6	1428	51	82.4	-	Pallets	0/100	25	19	56	6	0	5-5	-	51	49	24.5	68.9	

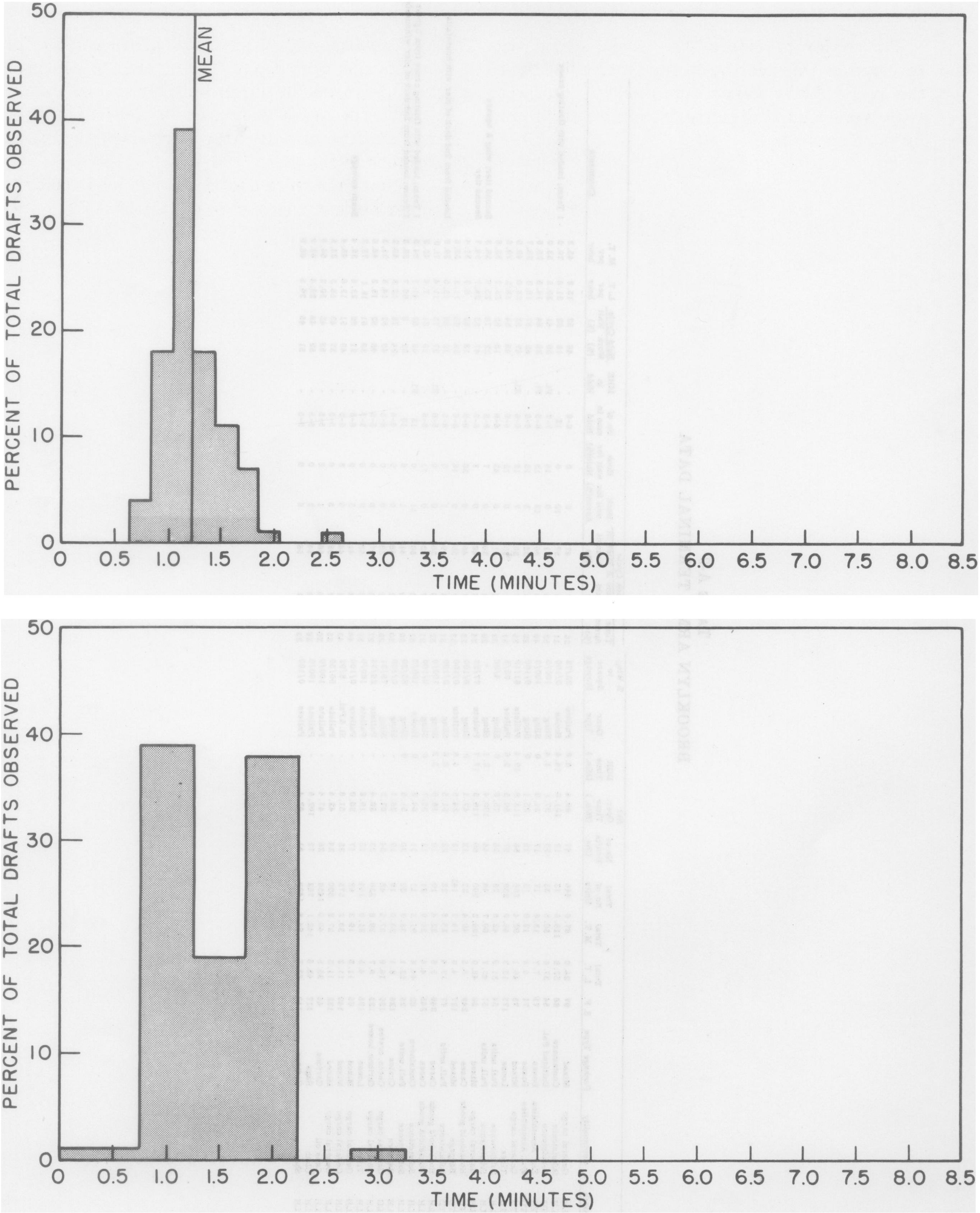


FIGURE A-11
Hook and Hold Work Cycle Distributions for Brooklyn Army Terminal Sample
72 Drafts of Bundles of Cloth on Pallets to 7 L.H.

Receipt of Cargo

The major portion of the cargo loaded was received at this pier by lighter and offloaded to the pier. Army cargo containers (transporters) were loaded directly from lighter to ship by floating cranes.

Stevedore Equipment

Standard 4′x6′ lipped pallets were used for break-bulk operations. The pallet-bridle gear was also used for cargo unitized on pallets.

Two fork lifts were used to feed each hook and additional fork lifts were used to unload lighters to the pier.

House falls were used for cargo loaded off the upper deck of the pier to the C1-M-AV1.

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The **Maritime Cargo Transportation Conference** is under the joint administrative sponsorship of the Divisions of Engineering and Industrial Research and of Physical Sciences of the Academy—Research Council. The MCTC was established in 1953 at the request of the Department of Defense and the Department of Commerce with fiscal support under a contract with the Office of Naval Research. The objectives of the Conference are to provide guidance on means and techniques leading to improvement in the sea transportation of general cargo; to determine critical factors and identify possible remedial measures in the effort to reduce current ship turn-around time; and to stimulate research and provide means for voluntary correlation of research in efforts to attain reduction in ship turn-around time.