Layouts and Work Methods for Wool Warehouses

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PREFACE

This report provides data and guidelines for use in designing layouts for wool warehouses of various sizes. It also provides data on the relative efficiency of different methods and equipment used in handling and storing wool. This is the second of two reports on handling operations in wool warehouses. The first was Marketing Research Report No. 575, "Reducing Costs of Grading Wool in Warehouses."

Acknowledgment is made to the warehouse operators who made their facilities available for study.

The study was conducted under the general supervision of the late George E. Turner, marketing research analyst, Transportation and Facilities Research Division.

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CONTENTS

SUMMARY

Operators of wool warehouses can reduce the costs of receiving, grading, packaging, and loading out wool by replacing manual methods and equipment with the more mechanized methods and equipment described in this report. Layouts were developed around the mechanized methods and equipment to provide for the most efficient performance of warehouse operations.

Operations are analyzed and layouts developed for warehouses with capacities of 500,000, 1 million, and 2 million pounds of wool. One turnover per year is assumed in each case. In a warehouse handling 2 million pounds of wool annually, the analysis shows performance of operations by the commonly used manual methods (represented by the handtruck) cost $16,760 annually, compared to $12,040 by the mechanized methods (represented by the clamp truck). The reduction in costs amounts to about 28 percent. The comparable reduction in a warehouse handling 1 million pounds of wool annually is about 22 percent, and in a warehouse handling 500,000 pounds, about 10 percent. The greater reduction at the larger volumes reflects better utilization of equipment.

In the mechanized methods and equipment discussed, one clamp truck is used for all handling operations in the warehouse and one portable scale for all weighing, in contrast to five handtrucks and three installed scales in the manual methods and equipment. Bags of wool may be transported two at a time by clamp truck, but only one at a time by handtruck. Other equipment used in the mechanized methods is a conveyor to carry fleeces to the grading table and a machine to package graded wool in bales. The manual methods use an electric hoist to dump fleeces near the grading table and a machine that packages graded wool in bags.

The layouts show the arrangement of the various storage areas, work areas, and equipment for minimum travel distances and congestion for workers and vehicles in moving wool into, through, and out of the warehouse. Each layout provides for future expansion without disrupting the flow pattern or affecting the efficiency with which warehouse operations are performed.

Layouts and Work Methods for Wool Warehouses

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INTRODUCTION

In 1963 there were about 238 million pounds of wool shorn from approximately 27.8 million sheep in this country. The sales value of this wool is estimated at $115 million. Approximately 190 warehouses throughout the country handle this wool.

Most wool producers do not have facilities to store their wool for long periods. Wool warehouses provide this service, and many warehouses also buy and sell wool. Wool is generally received in bags. Whether the wool is warehouse owned or consigned, the individual fleeces usually are removed from the bags and graded, and then packaged in bales or bags prior to shipment. The warehouse must provide space to store the ungraded bagged wool, the graded fleeces, and the bagged or baled graded wool. It must also provide facilities for grading the wool and for receiving and loading out wool.

Many wool warehouses are outmoded multistory buildings, originally constructed for other purposes. Few were planned and constructed with the benefit of technical assistance. As a result, the arrangement of storage and work areas in most warehouses does not provide for a direct flow of wool into, through, and out of the warehouse, with a minimum of handling.

Because of the poor layout of many warehouses, and the variability in size and shape of the bags and bales used, operations in wool warehouses for many years have been primarily performed by manual methods.

Research was undertaken to measure the relative efficiency of these primarily manual methods and of more mechanized methods, and to develop a layout for wool warehouses that would provide for the most efficient operations and lowest cost handling methods.

Preliminary observations and studies were made in 17 warehouses in Ohio, Indiana, Minnesota, Iowa, South Dakota, Montana, Wyoming, Colorado, and Missouri. Time studies were made in 12 warehouses selected as representative of the methods and equipment used to perform operations. The size of the warehouses studied ranged from less than 10,000 square feet to more than 100,000.

The operations analyzed in this report and the layouts developed are based on warehouses of three sizes: One with a capacity of 500,000 pounds of wool, one with a capacity of 1 million pounds, and one with a capacity of 2 million pounds of wool. The capacity of a warehouse, as used in this report, includes all bagged ungraded wool, loose graded fleeces, and graded wool packaged in bags or bales. One capacity turnover per year was assumed, although some warehouses handle less than their capacity during a year and others may handle several times their capacity.

Cost Determinations

Labor costs are based on the productive labor required for the operation plus the amount of idle time inherent in the method. "Wait time," in this report, is always job regulated. Equipment costs are allocated to each method on the basis of the elapsed time for the method for all equipment except the clamp truck. This truck is usually used part time for other work while any specific operation is being performed. Thus, the cost of the clamp truck is allocated on the basis of the time actually used in the particular transporting job. Labor and equipment requirements and costs per 1,000 pounds are computed for warehouses grading 500,000, 1 million, and 2 million pounds annually.

A wage rate of $1.25 per hour is assumed as the average rate for unskilled labor in a wool warehouse. Skilled labor is computed on the basis of $2 per hour. The wool grader is considered a skilled worker; all other workers are classified unskilled.

Data on equipment costs were obtained from manufacturers, dealers, and warehouse operators and are based on average factory prices for 1962 and 1963. Total equipment cost is the sum of ownership and operating costs; they are computed on an annual basis.

Ownership costs are considered to be fixed and include depreciation, interest, taxes, and insurance. Interest on the average investment is calculated at 6 percent, and 4 percent of the initial investment is allowed for insurance and taxes.

Operating costs include fuel, power, and maintenance. Operating-cost computations are based on representative costs in wool warehouses.

Description of Wool Warehouses and Defects Noted

Receiving and Loading Out Wool

Wool is received and loaded out both by truck and by rail car. Warehouses covered in this study received a large percentage of their wool from trucks. Most warehouses also have rail facilities and may receive wool from rail cars. Warehouse operators indicated that wool shipments are about equally divided between truck and rail.

Most wool warehouses have truck docks, although some unload wool from trucks backed up to a warehouse door. There appeared to be little conformity as to number, size, or design of truck docks. Several warehouses in the study had two or more truck receiving docks. Docks ranged from small wooden platforms to concrete platforms as large as 50 feet deep and 100 feet long.

The truck dock was often located far from the storage areas for ungraded bagged wool. This involves long transport distances in placing wool bags in storage, increases labor and equipment costs for receiving wool, and, during the peak season, may cause trucks to wait in line to be unloaded.

Some warehouses have a rail dock to receive a portion of their wool but many do not. Those not having a dock have a rail siding and use a bridgeplate to connect the floor of the rail car to the floor of the warehouse.

Many of the older warehouses were designed for rail receipts. In recent years, storage areas for bagged wool were often relocated to be more convenient to the increased truck receipts. This resulted in long transport distances and poor flow of rail receipts.

Generally, wool is weighed as a part of the receiving operation. Many of the older warehouses have a small platform scale built into the warehouse floor. Often this scale is not located in the general flow pattern, and wool receipts cannot flow in the shortest, most direct route from the dock to the storage area. Location of the installed platform scale near the receiving dock limits its use to the receiving operation, resulting in low utilization and high ownership and operating costs.

Some warehouses use a portable platform scale for weighing wool in the receiving operation. This scale can be positioned at any desired point en route from the dock to the storage area. A portable platform scale can be used for other operations besides receiving; often all weight determinations made in a warehouse are made with one portable scale. Occasionally, there may be a delay in one operation because another operation is using the portable scale; however, the waiting period is generally short. Greater utilization of the scale and lower per-unit weighing costs offset the occasional delays incurred.

Ungraded-Wool Storage Area

Most of the ungraded wool is stored in the bag in which it is received. The bags of wool are generally stored upright in blocks. A block may range in size from 500 to 3,000 square feet. Aisles between the blocks provide access for the handtrucks or clamp truck to place bags in storage and to transport them to the next operation. The aisles vary from about 5 to about 12 feet wide.

In some warehouses, the blocks of ungraded bagged wool were so small and aisles between blocks occupied so much of the floor, that valuable space that could have been used for storage was lost. In other warehouses, efforts to make maximum use of storage space, with large blocks and narrow aisles, brought on other problems: Long transport distances in moving bags of wool to and from a substantial portion of the storage area, and lost time due to poor maneuverability of workers and transporting equipment in the narrow aisles.

Wool Grading Area

The grading area consists of a grading table, an electric hoist to empty fleeces from bags onto the floor or a short conveyor attached to the grading table, wool carts positioned around three sides of the grading table, and an installed or portable scale for weighing graded wool fleeces en route to the storage bins.

The proper location of the grading area in relation to the ungraded-wool storage area and to the graded-wool storage bins is essential for overall efficiency of warehouse operations. Some warehouses place the grading table within the ungraded-wool storage area. This permits fast movement of ungraded wool to the grading table. However, it may result in workers having to transport graded wool such a long distance to the storage bins that they cannot keep pace with the other workers in the grading crew. Location of the grading table in or very near the graded-wool storage bins and a relatively long distance from the ungraded-wool storage area has the same general delaying effect.

In the grading area itself, some warehouses do not allow enough space to efficiently empty wool fleeces from the bag and to fold and stack the bag.

Graded-Wool Storage Bins

In most areas of the country, five or six basic grades account for the vast majority of fleeces handled. Thus, a wool warehouse, regardless of size, should provide a minimum of six large bins for the commonly handled grades and at least six

small bins for those fleeces outside the usually handled grades.

Small warehouses frequently provide more and larger bins than are needed for the quantity of wool handled. The reverse is often true of large warehouses, where the small bins needed for grades not encountered frequently are either missing completely or are inadequate in number and size. Warehouses providing these small bins often locate them in an inconvenient area, necessitating long transporting distances.

Aisles

Some warehousemen consider the floor space allowed for aisles as wasted and attempt to limit space for this use as much as possible This often results in congestion and less efficiency in receiving and shipping wool, moving wool bags to the grading area, transporting graded fleeces to the storage bins, and moving bagged or baled graded wool to and from the weighing and core-sampling equipment.

WAREHOUSE OPERATIONS

The work performed in wool warehouses is divided into four groups of operations in this report: (1) receiving, (2) grading, (3) packaging and storing, and (4) loading out.

The methods and equipment used in warehouse operations fall into two general categories, described here as the manual (represented by the handtruck) and the mechanized (represented by the clamp truck). The choice of handling equipment affects the storage method and the type and amount of other equipment used in the warehouse. For example, when handtrucks are used, bags are transported one at a time and are generally stored upright in one layer (fig. 1). When clamp trucks are used, bags may be transported two at a time and stored in a cordwood pattern several bags high (fig. 2). Warehouses that use handtrucks usually also have three separate installed platform scales, one each for weighing wool in the receiving, grading, and loading-out operations. Warehouses that use a clamp truck usually have one portable platform scale that is used for all three operations.

Another main difference between handtruck and clamp truck methods is that transporting by clamp truck can usually be independent of other parts of the operation. Because clamp trucks can handle a larger load than handtrucks, the clamp truck operator can move from one operation to another to avoid wait time that might otherwise occur. In each of the three sizes of warehouse discussed in this report, the handling equipment consists of either one clamp truck or five handtrucks.

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FIGURE 1.—Bags of wool are transported one at a time by handtruck.

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FIGURE 2.—A clamp truck can transport two bags of wool at a time.

Other differences in method and equipment are discussed in the sections that follow.

The elements of work involved in each operation, the labor required for each element, and the average transport distances are given in the appendix (tables 9, 10, and 11). Average transport distances were determined from the layouts developed for the warehouses of the three sizes selected (see section on layouts).

Receiving Wool

Receiving wool into the warehouse includes transporting bags of wool from the truck or rail car to the scale, weighing bags and recording weight, transporting bags to the ungraded wool

storage area, and positioning the bags in the storage pattern. The warehouses studied received most of their wool in bags on trucks. The amount of wool received in containers other than bags was not sufficient to provide a basis for worthwhile analysis. Average weight of a bag of ungraded wool in this report is assumed to be 120 pounds. Some bags were only partially filled, and observed weights ranged from less than 50 pounds to more than 300 pounds. A full bag is about 30 inches wide, 18 inches thick, and 72 to 90 inches long.

Analysis of the wool-receiving operation showed only minor variations in labor and equipment requirements and costs between truck and rail receipts. Therefore, the analysis of the receiving operation is limited to bagged wool arriving by motortruck.

A four-man crew is generally used when wool is received by handtrucks. One worker is on the motor truck to break out and position the bags for loading onto handtrucks. Two workers transport the bags on handtrucks from the truck to the installed platform scale, and then from the scale to the storage area. They place the bags upright in the storage block. The fourth worker weighs the bags, marks the bags with the weight and lot number, and maintains the receiving records.

Only one worker is used when receiving is done by clamp truck. He transports two bags per trip and weighs the bags on a portable platform scale. The bags are stored in a cordwood pattern eight high (fig. 3).

The labor requirements for both methods include time to place a bridgeplate to connect the truck and the dock and to remove the bridgeplate.

Labor and equipment requirements and costs per 1,000 pounds for the two methods for the three sizes of warehouse are shown in table 1. In the warehouse handling 500,000 pounds of wool annually, the handtruck method of receiving wool is the most economical. The clamp truck is the lowest cost method for the larger warehouses. The clamp truck method reduces the receiving cost per 1,000 pounds by 14 cents (11 percent) in the 1-million-pound-capacity warehouse and by 32 cents (26 percent) in the 2-million-pound-capacity warehouse.

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FIGURE 3.—Bags of wool stored in a cordwood pattern.

For both methods, equipment cost per 1,000 pounds of wool decreases as the annual volume increases because of better utilization of the equipment. This is true for all the operations and methods discussed in this report. The labor requirements and costs per 1,000 pounds increase slightly as the size of the warehouse increases because the transport distances in the larger warehouse are greater than those in the small warehouse.

Grading

Methods of grading consigned wool and warehouse owned wool were analyzed in detail in an earlier report.[1] Results of the analysis for consigned wool are summarized here. When wool is owned by the warehouse, a system of conveyors can be used to transport graded wool directly from

[1] WEBB, TARVIN F. REDUCING COSTS OF GRADING WOOL IN WAREHOUSES. U.S. Dept. Agr. Mktg. Res. Rpt. 575, 51 pp., illus. 1963.

TABLE 1.—*Labor and equipment requirements and costs per 1,000 pounds for receiving wool, by method and warehouse size*

Method and volume handled per year	Requirements		Costs		
	Labor	Equipment	Labor	Equipment	Total
Handtruck method:	*Man-hours*	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
500,000 pounds	0.84	0.63	1.05	0.42	1.47
1 million pounds	.88	.66	1.10	.21	1.31
2 million pounds	.88	.66	1.10	.11	1.21
Clamp truck method:					
500,000 pounds	.33	.66	.41	1.30	1.71
1 million pounds	.34	.68	.43	.74	1.17
2 million pounds	.35	.70	.44	.45	.89

the grading table into storage bins. Most warehouses cannot use this system because they handle both consigned and warehouse owned wool, and consigned wool must be weighed after it is graded. Most of the warehouses studied handled a substantial part of their wool on a consignment basis. Not all warehouses grade wool, and some grade only part of the wool handled.

There are four methods of grading consigned wool—three of them essentially manual and one mechanized. The three manual methods all use the same equipment, but the number of workers and their work assignments differ. These methods use a handtruck, an electric hoist, an installed platform scale, a grading table, and 14 wool carts for the grading operation. One method uses seven workers, the second uses six, and the third uses five.

The mechanized method uses five workers and the following equipment: A clamp truck, a grading table, a short conveyor attached to the grading table, a portable platform scale, and 14 wool carts.

The differences in equipment between the mechanized method and the three manual methods, and the extent to which the jobs are coordinated to minimize wait time, determine the relative efficiency of the method.

The method using five workers, clamp truck, conveyor, and wool cart has the lowest costs for all three warehouse sizes (table 2). In this method, one worker transports bags of wool two at a time from their storage area to the grading area. (This worker also performs other transporting work, such as receiving or loading out wool, while wool is being graded; only the time actually used for the grading operation is charged to the operation). The second worker empties the bags, places fleeces on the conveyor leading to the grading table, folds and stacks the empty bags, and cleans up around the grading table after each owner's lot. The third worker grades the individual fleeces and tosses them into the appropriate wool cart (about eight carts are grouped around the table). Two workers transport the wool in carts to the scale, weigh the wool, record the information, and then take the wool to the appropriate storage bin for graded fleeces.

The worker grading fleeces paces the operation. All other workers in the crew, except the clamp truck operator, have wait time. The elapsed time for 1,000 pounds of wool is 0.42 hour.

Costs for the three manual methods increase as the number of workers used increases, although the elapsed time for the seven-worker and the six-worker methods is shorter than that for the five-worker method.

The work assignments in the method using seven workers, handtruck, hoist, and wool cart are: One worker transports bagged ungraded wool by handtruck from its storage area to the grading area. The second worker opens one end of each bag, raises the bag with the electric hoist, dumps the wool fleeces onto the floor, and folds and stacks the empty bags. The third worker places the wool fleeces on the grading table. The fourth worker grades the individual fleeces, records the grading information, and cleans up around the grading table after each owner's lot (fig. 4). After he grades a fleece, he tosses it into the appropriate wool cart. The fifth and sixth workers transport the wool carts to the scale and then to the appropriate storage bin for graded fleeces. The seventh worker weighs the fleeces and records the information (fig. 5).

The worker grading fleeces is the pace setter for the crew. The grader requires 0.44 hour per 1,000

TABLE 2.—*Labor and equipment requirements and costs per 1,000 pounds for grading wool, by method and warehouse size*

Method, and volume handled per year	Requirements		Costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Seven workers, handtruck, hoist, and wool cart:					
500,000 pounds	3.08	2.20	4.18	0.77	4.95
1 million pounds	3.08	2.20	4.18	.39	4.57
2 million pounds	3.08	2.20	4.18	.21	4.39
Six workers, handtruck, hoist, and wool cart:					
500,000 pounds	2.64	2.20	3.63	.77	4.40
1 million pounds	2.64	2.20	3.63	.39	4.02
2 million pounds	2.64	2.20	3.63	.21	3.84
Five workers, handtruck, hoist, and wool cart:					
500,000 pounds	2.45	2.45	3.43	.77	4.20
1 million pounds	2.45	2.45	3.43	.39	3.82
2 million pounds	2.45	2.45	3.43	.21	3.64
Five workers, clamp truck, conveyor, and wool cart:					
500,000 pounds	1.79	1.79	2.55	1.04	3.59
1 million pounds	1.79	1.79	2.55	.56	3.11
2 million pounds	1.79	1.79	2.55	.33	2.88

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FIGURE 4.—The worker in the center raises a bag of wool with the electric hoist, the worker at left places the fleeces on the grading table, and the grader, at right, tosses the graded fleeces into the wool carts grouped around the table.

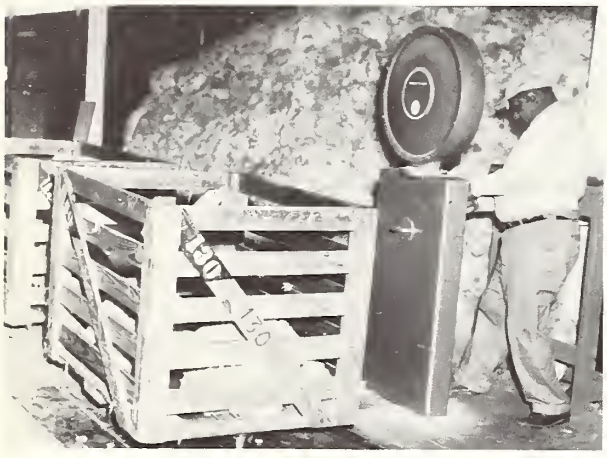

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FIGURE 5.—A worker weighs carts of graded wool on an installed platform scale.

pounds; the other six workers have varying amounts of wait time.

The worker grading fleeces is also the pace setter in the method using six workers, handtruck, hoist, and wool cart, and the elapsed time is also 0.44 hour per 1,000 pounds of wool. The five other workers have varying amounts of wait time. The main difference between this method and the seven-worker method is that the weighing is done by the two workers transporting graded wool from the grading area to the storage bins, instead of by the seventh worker.

The work assignments in the method using five workers, handtruck, hoist, and wool cart are: One worker transports bags of wool by handtruck to the grading area, opens each bag, and raises it with the electric hoist. The second worker empties the bag, places fleeces on the grading table, and folds and stacks the empty bags. The third worker grades the wool. The fourth and fifth workers transport the wool in carts to the scale, weigh the wool, and then take it to the storage bins.

The worker emptying bags and placing wool fleeces on the grading table is the pace setter, requiring 0.49 hour per 1,000 pounds of wool. The four other workers in the crew have varying amounts of wait time.

Packaging and Storing

After fleeces are graded, they are packaged either in bags or bales for shipment. Both bagging and baling are done by portable machines, which are placed in or close to the bin of loose graded wool to be packaged. Baling machines are more expensive than bagging machines (see app., table 8) but take less time to operate. After packaging is completed, a worker transports the bag or bale to the storage area for packaged graded wool. Considerable variation was observed in the weights of both bags and bales. This analysis of packaging and storing is based on bags weighing 240 pounds and bales weighing 400 pounds.

Wool is usually packaged in bags in warehouses using handtrucks and in bales in warehouses using a clamp truck. But some warehouses use handtrucks with baling machines and some use clamp trucks with bagging machines. Therefore, four methods of packaging and storing are described: Bag and handtruck, bag and clamp truck, bale and handtruck, and bale and clamp truck. All four methods use five workers. Except for operation of the bagging and baling machines, the work is essentially the same.

When the bagging machine and handtruck are used, two workers carry fleeces from the storage bin and place them on the platform of the machine (fig. 6). A third worker attaches empty bags to a loading hoop, which holds the bag open, and puts the hoop and bag on the machine. The fourth worker feeds fleeces into the bag and operates the plunger that packs the fleeces in. While the bags are being filled, the third worker helps carry fleeces to the bagging machine; he also detaches filled bags from the machine and removes the loading hoop from the bags. The fifth worker sews the bag closed, transports it by handtruck to the storage area for packaged graded wool, and stacks it upright. The workers who place fleeces on the machine platform set the pace for the crew; the elapsed time for 1,000 pounds of wool is 0.30 hour. Total man-hours are 1.50.

Work assignments for the third and fifth workers differ slightly when the clamp truck is used

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FIGURE 6.—A bagging machine in front of a bin of graded wool.

with the bagging machine. In this case, the third worker sews the bags closed, in addition to his other jobs, and he has less time to help place the fleeces on the bagging machine. The two workers placing fleeces on the bagging machine pace the operation; in this method, the elapsed time is 0.33 hour per 1,000 pounds of wool. The clamp truck operator is not assigned any job except transporting so he can be free to work in other operations, and only the time actually spent in packaging and storing is charged to this operation. He transports two bags at a time. Total man-hours required for this method are 1.39.

When wool is packaged in bales, a short conveyor is used that extends from the graded-wool bin to the platform of the baling machine. Assignments of the five workers are identical whether the handling equipment used is a handtruck or a clamp truck. Two workers place fleeces on the conveyor. The third worker attaches the bale covering to the machine and, while the bales are being packed, helps place fleeces on the conveyor. The fourth worker feeds fleeces into the baler and operates the plunger that packs the fleeces (fig. 7). After a bale is packed, the third worker inserts five wires in the machine, ties them around the

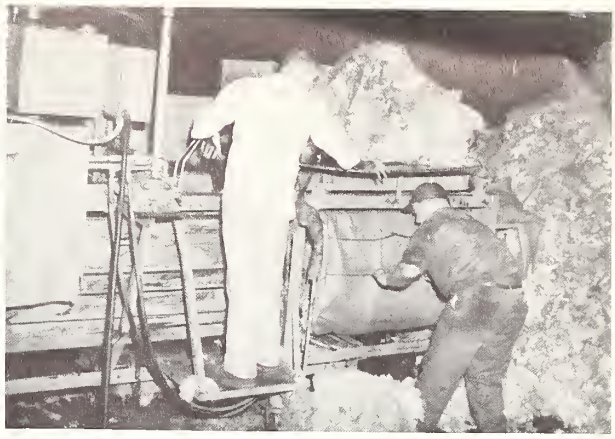

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FIGURE 7.—The worker at left operates the plunger that packs fleeces; the worker at right inserts wires around the bales.

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FIGURE 8.—Stacking bales of graded wool with a clamp truck.

bale, removes the bale from the machine and sews the end of the bale closed. The fifth worker transports one bale at a time by handtruck or clamp truck to the storage area for packaged graded wool (fig. 8).

The workers who operate the baling machine and handle the bale covers and ties set the pace for the operation; the elapsed time for 1,000 pounds of wool is 0.22 hour.

Labor requirements per 1,000 pounds for baling and storing wool are 1.10 man-hours if handtrucks are used and 0.95 man-hour if a clamp truck is used. The man-hour requirements differ because, as in other operations, only the time that the clamp truck operator actually uses for transporting bales to storage is charged to the operation. In each of the four methods, all workers other than the pace

setters and clamp truck operators have varying amounts of wait time.

Table 3 lists the labor and equipment requirements and costs per 1,000 pounds for packaging and storing by the four methods in the three warehouse sizes. The bale and clamp truck method is the least costly for the two larger warehouses, and the bag and handtruck method is the least costly for the small warehouse.

Loading Out

Loading out wool includes transporting bags or bales of graded wool from the storage area to the scales, weighing them and recording the data, taking a core sample, and transporting the bag or bale to the truck or rail car and positioning it in the car. Bags or bales are transported by handtruck or clamp truck, so there are four methods of loading out. An average time of 0.08 man-hour per 1,000 pounds of wool is used for core-sampling bags, and 0.07 for bales. Methods of obtaining core samples were not specifically studied, but these were average times in warehouses where this job was observed. Not all warehouses take core samples.

Seven workers are used to load out bags by handtruck. Two workers transport bags from the storage area to an installed platform scale, and then from the scale to the truck or rail car. The third worker weighs the bags and records data. The fourth worker takes the core sample. The remaining three workers stack and position the bags in the shipping vehicle.

For all three warehouse sizes, the handtruck operators set the pace for loading out bags; they require 0.08 hour per 1,000 pounds of wool. Total labor required is 0.56 man-hour.

Loading out bales of wool by handtruck takes one more worker. This eighth worker helps stack and position the bales in the shipping vehicle. Jobs of the other workers are the same as described for loading out bags by handtruck, and the same equipment is used.

The two workers transporting bales on handtrucks set the pace for the operation; they require 0.07 hour per 1,000 pounds of wool. The elapsed time is the same for all three warehouse sizes. Labor required is 0.56 man-hour.

When bags or bales are loaded out by clamp truck, three workers are used. The clamp truck operator transports two bags or one bale at a time from the storage area to a portable platform scale, and then from the scale to the shipping vehicle, where he stacks them. The second worker weighs the bag or bale and records data (fig. 9), and the third worker obtains the core sample.

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FIGURE 9.—Weighing a bag of wool on a portable platform scale.

TABLE 3.—*Labor and equipment requirements and costs per 1,000 pounds for packaging and storing wool, by method and warehouse size*

Method, and volume handled per year	Requirements		Costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Bag and handtruck:					
500,000 pounds	1. 50	0. 60	1. 88	0. 30	2. 18
1 million pounds	1. 50	. 60	1. 88	. 16	2. 04
2 million pounds	1. 50	. 60	1. 88	. 09	1. 97
Bag and clamp truck:					
500,000 pounds	1. 39	. 66	1. 74	. 54	2. 28
1 million pounds	1. 39	. 66	1. 74	. 28	2. 02
2 million pounds	1. 39	. 66	1. 74	. 17	1. 91
Bale and handtruck:					
500,000 pounds	1. 10	. 66	1. 38	1. 02	2. 40
1 million pounds	1. 10	. 66	1. 38	. 52	1. 90
2 million pounds	1. 10	. 66	1. 38	. 27	1. 65
Bale and clamp truck:					
500,000 pounds	. 95	. 51	1. 19	1. 24	2. 43
1 million pounds	. 95	. 51	1. 19	. 64	1. 83
2 million pounds	. 95	. 51	1. 19	. 34	1. 53

TABLE 4.—*Labor and equipment requirements and costs per 1,000 pounds for loading out wool, by method and warehouse size*

Method, and volume handled per year	Requirements		Costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Bag and handtruck:					
500,000 pounds	0. 56	0. 32	0. 70	0. 42	1. 12
1 million pounds	. 56	. 32	. 70	. 21	. 91
2 million pounds	. 56	. 32	. 70	. 11	. 81
Bag and clamp truck:					
500,000 pounds	. 63	. 63	. 79	. 81	1. 60
1 million pounds	. 63	. 63	. 79	. 46	1. 25
2 million pounds	. 66	. 66	. 83	. 28	1. 11
Bale and handtruck:					
500,000 pounds	. 56	. 28	. 70	. 42	1. 12
1 million pounds	. 56	. 28	. 70	. 21	. 91
2 million pounds	. 56	. 28	. 70	. 11	. 81
Bale and clamp truck:					
500,000 pounds	. 39	. 39	. 49	. 54	1. 03
1 million pounds	. 39	. 39	. 49	. 30	. 79
2 million pounds	. 42	. 42	. 53	. 19	. 72

In loading out bags by clamp truck, the clamp truck operator is the pace setter. This job requires 0.22 hour per 1,000 pounds in the largest warehouse, and 0.21 hour in the other warehouses. The total labor required is 0.66 man-hour in the largest warehouse, and 0.63 in the other two.

The clamp truck operator is also the pace setter for loading out bales. He takes 0.14 hour per 1,000 pounds in the largest warehouse, and 0.13 hour in the other warehouses. Labor requirements are 0.42 man-hour in the largest warehouse, and 0.39 man-hour in the other warehouses.

Labor and equipment requirements and costs per 1,000 pounds of wool for the four methods are shown in table 4. Loading out bales by clamp truck is the lowest cost method for all three warehouse sizes. The cost is 8 percent less than for loading out bags by handtruck in the small warehouse, 13 percent less in the medium-size warehouse, and 11 percent less in the large warehouse.

Summary of Requirements and Costs for Wool Warehouse Operations

The costs for the manual (handtruck) methods and equipment and the mechanized (clamp truck) methods and equipment are shown for the four warehouse operations in table 5.

In the table, manual methods include receiving wool by handtruck; grading by the method using seven workers, handtruck, hoist, and wool cart; packaging graded wool in bags and storing by handtruck; and loading out bags by handtruck. Mechanized methods include receiving by clamp truck; grading by the method using clamp truck, conveyor, and wool cart; packaging graded wool in bales and storing by clamp truck; and loading out bales by clamp truck. Equipment used in each method is listed in appendix, table 8.

Warehouse owners using some of the variations in method described, such as packaging in bales, but using handtrucks instead of a clamp truck, can compute costs for their operations from the tables already given and from table 8 in the appendix.

The mechanized methods are cheaper than the manual methods for all three warehouse sizes. In the warehouse handling 2 million pounds of wool annually, costs for the four operations are reduced about 28 percent. Annual costs would be $16,760 with the manual methods and $12,040 with the mechanized methods, or a saving of $4,720 per year. In the warehouse handling 1 million pounds of wool annually, the reduction is about 22 percent. Annual costs would be $8,830 with manual methods, and $6,900 with mechanized methods. The mechanized methods reduce handling costs about 10 percent in the warehouse handling 500,000 pounds of wool annually. Costs per year would be $4,380 with mechanized methods, and $4,860 with manual methods. Savings are greater as the volume of wool handled increases because of better utilization of the equipment.

EFFECTS OF VOLUME HANDLED ON COSTS

One of the assumptions used in this report is that each size warehouse would have one capacity turnover per year. In actual practice the volume handled by each size warehouse might vary considerably from region to region and from year to year. To show the effects of volume handled on labor and equipment costs, an example is presented in table 6 using the 1-million-pound-capacity warehouse operating at half capacity (500,000 pounds) and at two turnovers (2 million pounds).

TABLE 5.—*Labor and equipment costs per 1,000 pounds for performing wool warehouse operations, by method and warehouse size*

Warehouse size and operation	Manual methods [1]			Mechanized methods [2]		
	Labor	Equipment	Total	Labor	Equipment	Total
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Warehouse handling 500,000 pounds of wool annually:						
Receiving	1. 05	0. 42	1. 47	0. 41	1. 30	1. 71
Grading	4. 18	. 77	4. 95	2. 55	1. 04	3. 59
Packaging and storing	1. 88	. 30	2. 18	1. 19	1. 24	2. 43
Loading out	. 70	. 42	1. 12	. 49	. 54	1. 03
Total	7. 81	1. 91	9. 72	4. 64	4. 12	8. 76
Warehouse handling 1 million pounds of wool annually:						
Receiving	1. 10	. 21	1. 31	. 43	. 74	1. 17
Grading	4. 18	. 39	4. 57	2. 55	. 56	3. 11
Packaging and storing	1. 88	. 16	2. 04	1. 19	. 64	1. 83
Loading out	. 70	. 21	. 91	. 49	. 30	. 79
Total	7. 86	. 97	8. 83	4. 66	2. 24	6. 90
Warehouse handling 2 million pounds of wool annually:						
Receiving	1. 10	. 11	1. 21	. 44	. 45	. 89
Grading	4. 18	. 21	4. 39	2. 55	. 33	2. 88
Packaging and storing	1. 88	. 09	1. 97	1. 19	. 34	1. 53
Loading out	. 70	. 11	. 81	. 53	. 19	. 72
Total	7. 86	. 52	8. 38	4. 71	1. 31	6. 02

[1] Receiving—by handtruck; grading—7 workers, handtruck, hoist, and wool cart; packaging and storing, and loading out—bags and handtruck.

[2] Receiving—by clamp truck; grading—by 5 workers, clamp truck, conveyor, and wool cart; packaging and storing, and loading out—bales and clamp truck.

TABLE 6.—*Labor and equipment costs per 1,000 pounds of wool handled for the 1-million-pound-capacity warehouse operating at an annual rate of ½ turnover and at 2 turnovers, by operation and method*

Operation and method [1]	½ turnover			2 turnovers		
	Labor	Equipment	Total cost	Labor	Equipment	Total cost
	Dollars	*Dollars*	*Dallors*	*Dollars*	*Dollars*	*Dollars*
Receiving:						
Manual	1. 10	0. 42	1. 52	1. 10	0. 11	1. 21
Mechanized	. 43	1. 32	1. 75	. 43	. 46	. 89
Grading:						
Manual	4. 18	. 77	4. 95	4. 18	. 21	4. 39
Mechanized	2. 55	1. 04	3. 59	2. 55	. 32	2. 87
Packaging and storing:						
Manual	1. 88	. 30	2. 18	1. 88	. 09	1. 97
Mechanized	1. 19	1. 24	2. 43	1. 19	. 31	1. 50
Loading out:						
Manual	. 70	. 42	1. 12	. 70	. 11	. 81
Mechanized	. 49	. 54	1. 03	. 49	. 17	. 66
Total manual	7. 86	1. 91	9. 77	7. 86	. 52	8. 38
Total mechanized	4. 66	4. 14	8. 80	4. 66	1. 26	5. 92

[1] Manual and mechanized methods are described in footnotes to table 5.

TABLE 7.—*Labor and equipment costs per 1,000 pounds of wool, by warehouse size, annual volume, and handling method*

Volume handled per year, and method	500,000-pound capacity			1-million-pound capacity			2-million-pound capacity		
	Labor	Equipment	Total	Labor	Equipment	Total	Labor	Equipment	Total
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
250,000 pounds:									
Manual	7. 81	3. 82	11. 63	7. 86	3. 82	11. 68	7. 86	3. 87	11. 73
Mechanized	4. 64	7. 88	12. 52	4. 66	7. 88	12. 54	4. 71	8. 24	12. 85
500,000 pounds:									
Manual	7. 81	1. 91	9. 72	7. 86	1. 91	9. 77	7. 86	1. 94	9. 80
Mechanized	4. 64	4. 12	8. 76	4. 66	4. 14	8. 80	4. 71	4. 12	8. 83
1 million pounds:									
Manual	7. 81	. 97	8. 78	7. 86	. 97	8. 85	7. 86	. 97	8. 83
Mechanized	4. 64	2. 24	6. 88	4. 66	2. 24	6. 90	4. 71	2. 24	6. 95
2 million pounds:									
Manual	7. 81	. 52	8. 32	7. 86	. 52	8. 38	7. 86	. 52	8. 38
Mechanized	4. 64	1. 26	5. 90	4. 66	1. 26	5. 92	4. 71	1. 31	6. 02
3 million pounds:									
Manual				7. 86	. 35	8. 21	7. 86	. 35	8. 21
Mechanized				4. 66	1. 05	5. 71	4. 71	1. 08	5. 79
4 million pounds:									
Manual				7. 86	. 27	8. 13	7. 86	. 27	8. 13
Mechanized				4. 66	1. 10	5. 76	4. 71	1. 13	5. 84
5 million pounds:									
Manual				7. 86	. 22	8. 08	7. 86	. 22	8. 08
Mechanized				4. 66	1. 00	5. 66	4. 71	1. 03	5. 74

In calculating costs at different volumes the labor costs are the same per 1,000 pounds regardless of volume. The increased total costs at lower volumes and the reduced costs at higher volumes result from changes in annual equipment use. It is assumed that there are no changes in the layout which could affect cost. The amount of equipment and the equipment ownership cost remain unchanged.

Receiving, and packaging and storing are the operations that can be performed at lower cost by manual methods in the half-capacity turnover. Mechanized methods cost 23 cents per 1,000 pounds more than manual methods for receiving and 25 cents per 1,000 pounds more for packaging and storing. At 2-capacity turnovers per year, mechanized methods cost 32 cents less per 1,000 pounds for receiving and 47 cents less per 1,000 pounds for packaging and storing than the manual methods.

Grading and loading out have lower costs by mechanized methods at both volumes. At 2 million pounds annually in the 1-million-pound-capacity warehouse, the savings due to mechanized methods are substantially more than at half-capacity turnover.

There is a slight advantage in using the mechanized methods when only half-capacity turnover is handled. The manual methods cost $9.77 per 1,000 pounds compared to $8.80 for the mechanized methods. Annually this saving is $485.

When the 1-million-pound-capacity warehouse handles 2 million pounds annually the savings for the mechanized methods are $2.46 per 1,000 pounds or $4,920 per year.

Table 7 shows the comparative labor and equipment cost for handling various annual volumes of wool in the three warehouse sizes covered in this analysis. The more expensive equipment in the mechanized methods cannot be justified at the lowest volume. Warehouses with volumes below approximately 400,000 pounds per year should use the manual methods, and those with volumes above this level should find the mechanized methods more economical. At volumes where the mechanized equipment is utilized more fully, the savings are substantial.

SUGGESTED LAYOUTS FOR HANDLING WOOL IN WAREHOUSES

The primary objectives in planning improved facilities for wool warehouses are: (1) To provide adequate space for ungraded bagged wool and packaged graded wool, and for the grading area and aisles; (2) to develop an arrangement of facilities and equipment that will provide a direct flow of wool through the various work areas and minimize the amount of labor required to receive,

grade, package, store, and load out wool; and (3) to provide for reasonable future expansion of the warehouse without disrupting the flow pattern or incurring prohibitive construction costs. The attainment of these objectives should, of course, correct the defects noted in existing warehouses.

The plans for wool warehouses presented in this section are intended to illustrate only the principles of layout, design, and size in relation to volume handled. These plans are not suggested for any specific warehouse or locality.

The layouts are designed around the mechanized methods of operation. They provide for handling by clamp truck, for storing bagged ungraded wool in stacks eight bags high, and for packaging graded wool in bales and storing the bales in two tiers. A short conveyor is used in the grading operation, and one portable platform scale is provided for the three operations of receiving, grading, and loading out. It is assumed that the majority of the wool received is delivered by truck and that wool is shipped both by truck and by rail. It is further assumed that ceiling height will be such that storing wool up to 12 feet from the floor will not be a problem.

The general layout is the same for the three sizes of warehouses selected. A detailed description, therefore, is given only for the warehouse with a capacity of 500,000 pounds of wool, and dimensions are listed for the warehouses with capacities of 1 million and 2 million pounds.

Layout Designed To Handle 500,000 Pounds of Wool

The layout developed for a warehouse with a capacity of 500,000 pounds of wool is shown in figure 10.

The components of the warehouse are arranged in a compact rectangle. The grading area is in the center of the building, and the storage area for bagged ungraded wool is across the front of the building and to the sides of the grading area. The storage bins for the main grades of loose graded wool are behind the grading area, across the back of the building; the two areas at either end are used for storage of bales of graded wool.

There are two main aisles: One extends from the truck receiving dock at the front of the warehouse through the bagged-wool storage area to the grading area; the other extends across the width of the warehouse, serving the graded-wool storage bins, and leads to loading-out docks at the sides of the building. One dock is for loading out by truck and the other for loading out by rail. The two main aisles are 20 feet wide.

Small storage bins for the minor grades of loose fleeces are across the aisle from the larger bins. Offices are along one side of the storage area for bagged ungraded wool, with an entrance at the front of the building.

The suggested wool warehouse is 141 feet wide and 103 feet deep from front to back, and contains 14,523 square feet. It provides space for 250,000 pounds of ungraded bagged wool, 150,000 pounds of graded wool in bins, and 100,000 pounds of baled graded wool. This composition of storage space is representative of the warehouses studied and is used to illustrate warehouse layout principles. Storage space composition could be changed with relatively minor changes in the layout.

Description of Components

Receiving and loading-out facilities.—The three docks are located to provide for short transporting distance and minimum labor and equipment requirements and costs in receiving and loading out wool. Separate docks are provided for receiving and loading out by motortruck, but the rail dock is used for both receiving and loading out. It is located adjacent to a baled-wool storage area since rail shipments are substantially more than rail receipts in most warehouses.

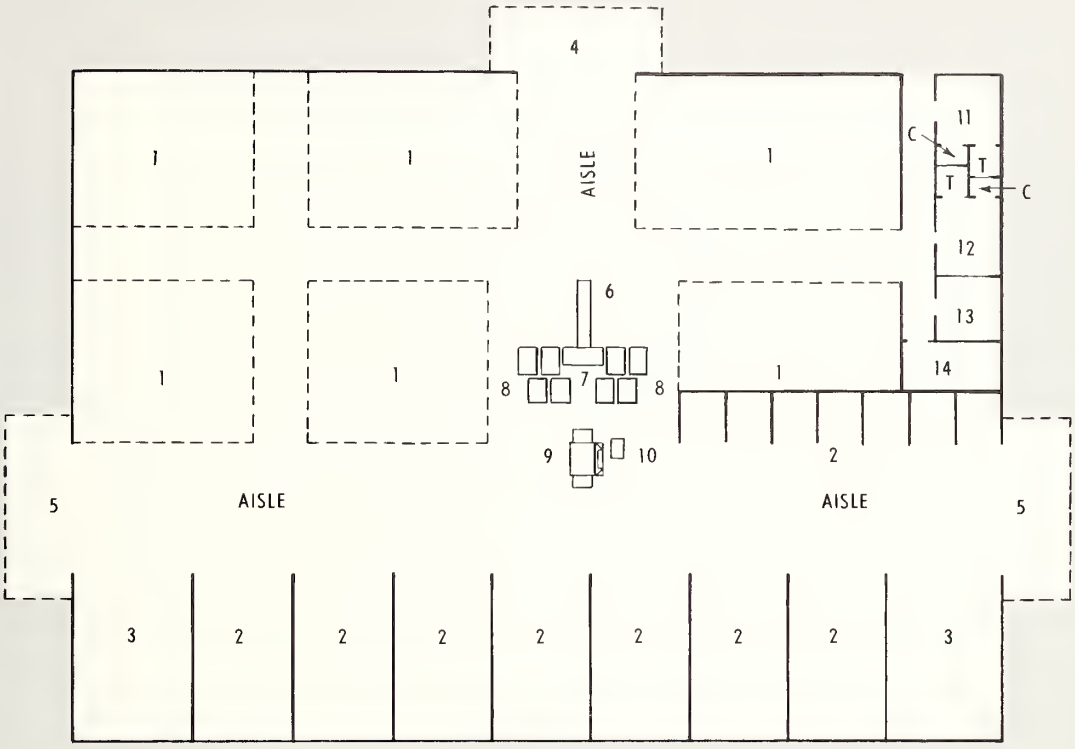
The three docks are constructed of concrete and are about 30 feet long and 10 feet deep. The truck dock should be about 50 inches high and the rail dock about 45 inches high. The truck docks can accommodate two trucks at a time. The rail dock can accommodate only one rail car.

The portable scale can be conveniently located in the aisle near any of the docks when it is needed.

Storage area for ungraded bagged wool.—The assumptions used in computing space requirements of the storage area for ungraded bagged wool are: (1) Bags are 72 inches by 30 inches by 18 inches and contain an average of 120 pounds of wool, (2) bags are stacked in a cordwood pattern eight bags high, (3) a stack covers 15 square feet and contains 960 pounds of wool, and (4) space should be provided in this area for 250,000 pounds or 50 percent of the capacity of the warehouse. Based on these assumptions the space requirements are 3,906 square feet.

The layout provides six storage blocks to hold 250,000 pounds of ungraded bagged wool. Two of the blocks contain 672 square feet each, and one each contains 960, 744, 648, and 544 square feet. The total area for the six blocks is 4,240 square feet. The blocks are separated by aisles 8 feet wide. This width is adequate for maneuvering a clamp truck and positioning wool bags in a block or removing them. Aisle space is in addition to storage space.

Grading area.—The total area for the grading operation is approximately 25 by 29 feet, or 725 square feet. The grading table is the focal point of the grading operation and is located so that it



LEGEND

1. UNGRADED BAGGED WOOL STORAGE AREA
2. GRADED WOOL STORAGE BINS
3. GRADED BALED WOOL STORAGE AREA
4. RECEIVING DOCK
5. SHIPPING DOCKS
6. CONVEYOR
7. GRADING TABLE
8. WOOL CARTS
9. SCALE
10. WEIGHT RECORD TABLE
11. MANAGER'S OFFICE
12. GENERAL OFFICE
13. WELFARE ROOM
14. EQUIPMENT STORAGE ROOM

T. TOILETS
C. CLOSETS

SCALE OF FEET

0 5 10 20 30

FIGURE 10.—Layout of a wool warehouse with a capacity of 500,000 pounds of wool.

is readily accessible to the worker transporting ungraded wool from storage and to the workers transporting graded wool to the bins. Adequate space is provided for the grading operation; however, the location and arrangement of equipment in the area are planned so that grading does not interfere with other warehouse operations. In addition to the grading table, space is provided for a portable dial scale, a 10-foot conveyor leading to the grading table, a small worktable, and the wool carts used in the grading operation. There is also space for the clamp truck to maneuver.

The conveyer carrying fleeces to the grading table is located on the opposite side of the grading table from the grader. Its end reaches the center of that side of the grading table and extends into the table approximately 12 inches. This permits the wool fleeces to leave the conveyor at a point convenient for the grader and prevents fleeces from falling off the table. The opposite end of the conveyor is about 12 inches below floor level and has a hopper around it for rapid and easy emptying of the bags of fleeces onto the conveyor. Adequate space is provided around the conveyor to handle bags and maneuver the transporting vehicle.

The grading table is 3 feet 4 inches by 6 feet. It is equipped with a knee switch, so that the grader can control the conveyor and regulate the arrival of fleeces.

The wool carts are grouped around three sides of the grading table, convenient to the grader. Eight carts are usually all that the grader needs. This number of wool carts can be grouped around the three sides of the grading table in a manner so that the grader need not toss a fleece more than about 6 feet. The wool carts are not in front of the grader because the conveyor is connected to that side of the grading table.

Workers transporting wool carts may move two carts per trip if, for any reason, they are not keeping abreast of the workload. Since 2 workers usually handle the wool carts, a minimum of 12 carts is indicated. Fourteen wool carts will take care of maximum needs and allow one or more carts to be out of service for repairs. The area around the grading table must be adequate for the carts and for the workers to maneuver them.

The portable platform scale is located about 12 feet directly back of the grading table. This location permits weight determinations to be made en route to the graded-wool storage bins with minimum transporting distances from the grading table to the storage bins. A small worktable nearby is used for recording the weight data and to store the weight records.

Graded-wool storage bins.—The assumptions used in computing space requirements for storing graded wool are: (1) A wool fleece weighs 8 pounds and occupies an area of approximately 1.25 cubic feet; (2) wool will be piled an average of 8 feet high in the bins; and (3) space should be provided in the storage bins for 150,000 pounds or 30 percent of the capacity of the warehouse. Based on these assumptions, the space requirements are 2,931 square feet.

The layout provides a total of 14 storage bins to hold 150,000 pounds of graded wool. Seven bins contain 390 square feet each; these are for storage of the main grades of wool handled. There are seven bins of 56 square feet each for the minor grades of wool. The total area for the 14 bins is 3,122 square feet. All of the bins open directly into the main cross aisle so that each is easily accessible with short, direct movement of the wool carts from the grading area. The bins are also well located in relation to the baled-wool storage area. The bins are fairly deep in relation to their width because operations generally can be performed faster and with less travel when the bins are so sized. The large bins are wide enough for the baling equipment to be placed in the front of the bin close to the fleeces and out of the way of traffic in the aisle serving the bins.

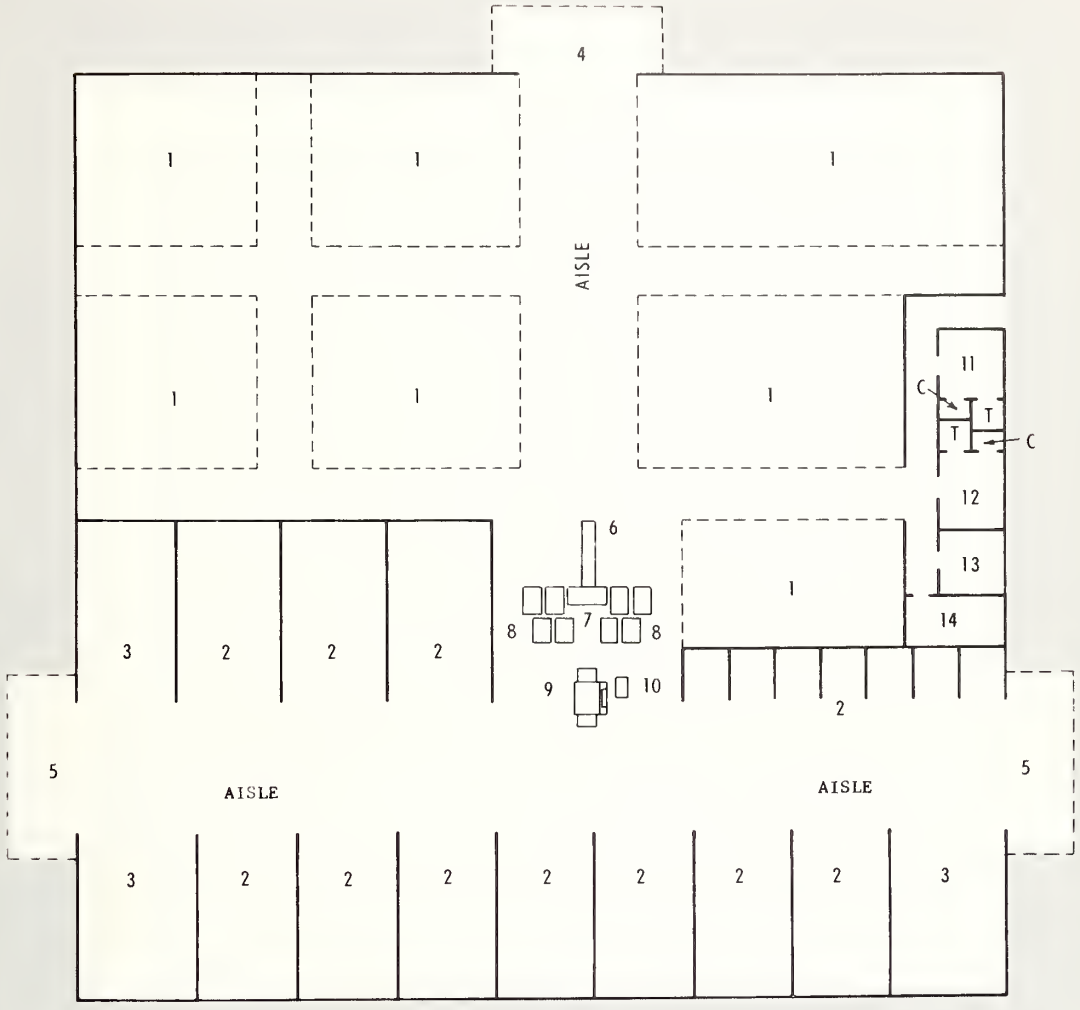
Storage area for graded baled wool.—The assumptions used in computing space requirements for storing graded wool in bales are: (1) Bales are 24 inches by 34 inches by 54 inches, and contain an average of 400 pounds of wool, (2) bales are stacked on end two tiers high, (3) a stack covers 5.7 square feet and contains 800 pounds of wool, and (4) space should be provided for 100,000 pounds or 20 percent of the capacity of the warehouse. Based on these assumptions, the space requirements are 713 square feet.

The layout provides two baled-wool storage areas. Each of the areas is 18 feet by 26 feet; thus the total area provided for storing baled wool is 936 square feet. Their location between the graded wool area and the shipping docks provides short travel distances from graded bins to baled storage and from baled storage to loadout docks.

Offices.—The office area consists of the manager's office, a general office, a welfare room for the employees, and a storage room for miscellaneous equipment and supplies. The manager's office is 10 feet by 11 feet, the general office is 10 feet by 12 feet, the welfare room is 10 feet by 10 feet, and the storage room is 8 feet by 15 feet. A hallway 5 feet wide by 40 feet long provides access to the area. The offices—including closets and toilets, the welfare room, the storage room, and the hallway—contain a total of 600 square feet.

Expansion of Facilities

Additional space to increase the capacity of the warehouse to 750,000 pounds of wool could be obtained by removing the wall at the top of the layout (fig. 11) and adding an area 141 feet wide and 40 feet deep. This would add 5,640 square feet or



LEGEND

1. UNGRADED BAGGED WOOL STORAGE AREA
2. GRADED WOOL STORAGE BINS
3. GRADED BALED WOOL STORAGE AREA
4. RECEIVING DOCK
5. SHIPPING DOCKS
6. CONVEYOR
7. GRADING TABLE
8. WOOL CARTS
9. SCALE
10. WEIGHT RECORD TABLE
11. MANAGER'S OFFICE
12. GENERAL OFFICE
13. WELFARE ROOM
14. EQUIPMENT STORAGE ROOM
T. TOILETS
C. CLOSETS

SCALE OF FEET

0 5 10 20 30

FIGURE 11.—Expansion of the warehouse layout for 500,000 pounds of wool to 750,000 pounds.

about 39 percent of the total area of the warehouse and permit a 50-percent increase in capacity.

The basic arrangement of areas in the warehouse would remain the same. The area added to the layout would be used for ungraded bagged wool. One of the blocks contains 1,484 square feet, one contains 868 square feet, and one contains 784 square feet. An 8-foot-wide aisle provides access to this new row of ungraded-wool blocks in the same manner as shown in the layout for 500,000 pounds of wool. Thus the expanded warehouse provides 6,241 square feet to store 375,000 pounds of wool. Based on the asumptions already stated for ungraded bagged wool, the computed requirements are 5,862 square feet.

The expanded warehouse requires 4,388 square feet for graded-wool bins. The three new bins are 16 feet by 28 feet; the total space provided for bins to handle 225,000 pounds of graded wool in the expanded warehouse is 4,466 square feet.

The additional baled-wool storage space is 15 feet by 28 feet or 420 square feet, located directly across the aisle from the space originally provided adjacent to the truck loadout dock. The area required to store 150,000 pounds of baled wool is 1,070 square feet; the total space provided in the expanded warehouse is 1,356 square feet.

The grading area would be increased by 87 square feet for a total of 812 square feet.

The office area would not be changed in expanding the warehouse.

The warehouse, expanded to a capacity for 750,000 pounds of wool, would contain 20,163 square feet.

Layout Designed To Handle 1 Million Pounds of Wool

A suggested layout for a warehouse with a capacity of 1 million pounds of wool is shown in figure 12. The suggested wool warehouse is 196 feet wide and 128 feet deep, and contains 25,088 square feet. It provides space for 500,000 pounds of ungraded bagged wool, 300,000 pounds of graded wool in bins, and 200,000 pounds of baled graded wool.

Dimensions of Components

Storage area for ungraded bagged wool.—Using the assumptions previously stated, 7,813 square feet are required for storing 500,000 pounds of ungraded bagged wool.

The layout provides eight storage blocks. Three of the blocks contain 704 square feet each, and one each contains 1,344, 1,280, 1,216, 1,200, and 1,109 square feet. The total area for the eight blocks is 8,261 square feet.

Grading area.—The total area for the grading operation is approximately 30 feet by 32 feet, or 960 square feet.

Graded-wool storage bins.—Based on the assumptions previously listed, the space requirements are 5,862 square feet for storing graded wool in bins.

The layout provides a total of 16 storage bins to hold 300,000 pounds of graded wool. Eight of the bins contain 684 square feet each, four bins contain 72 square feet each, and four contain 64 square feet each. The eight small bins are used for holding the small amounts of "offgrade" wool. If necessary, these small bins could be subdivided into smaller bins in those warehouses having a larger number of offgrades. The total area provided by the 16 bins is 6,016 square feet. All of the bins open onto the main cross alley which makes them easily accessible to the grading area and the baled-wool storage area.

Storage area for graded baled wool.—The space requirements to store 200,000 pounds of baled wool are 1,426 square feet. Each of the two areas provided is 26 feet by 38 feet; the total area is 1,976 square feet.

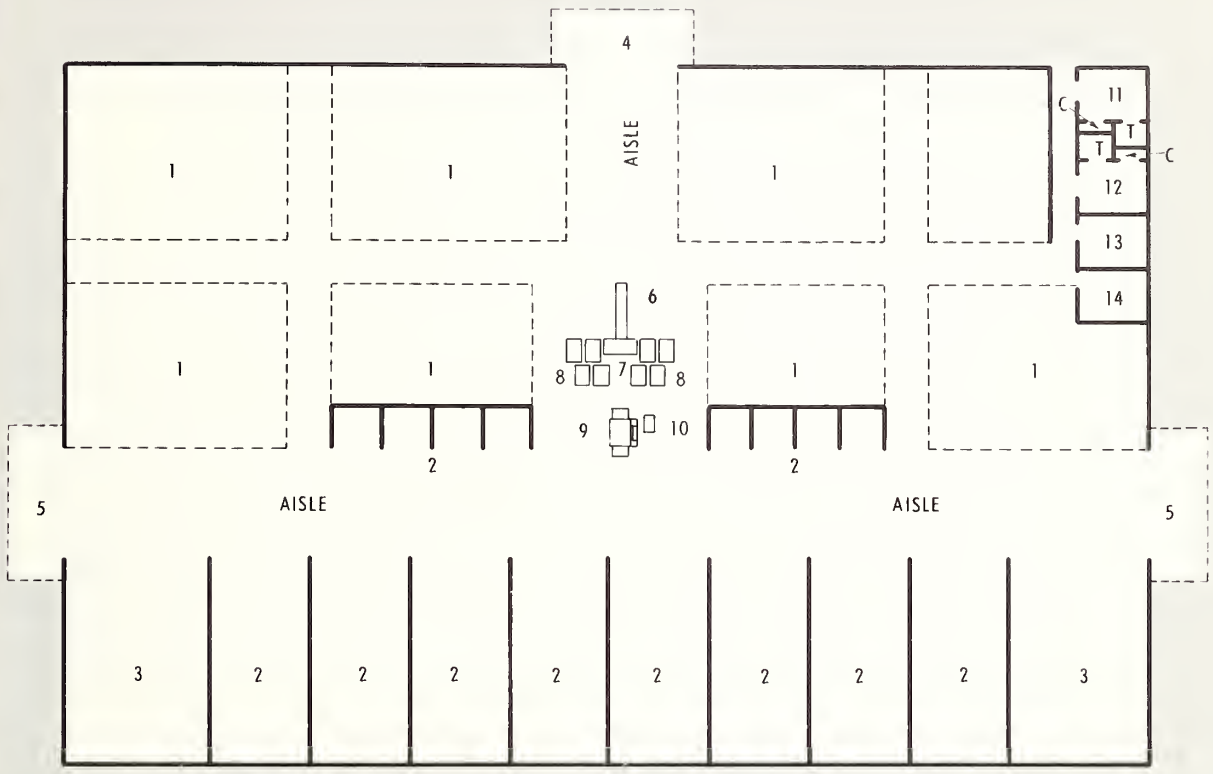
Offices.—The office area is slightly larger than that provided for the warehouse handling 500,000 pounds of wool. The manager's office is 10 feet by 13 feet, the general office is 12 feet by 13 feet, the welfare room is 10 feet by 13 feet, and the storage room is 9 feet by 13 feet. A hallway 5 feet wide and 40 feet long provides access to the area. The offices—including closets and toilets, the welfare room, and the hallway—contain a total of 811 square feet.

Expansion of Facilities

The capacity of the warehouse could be expanded to 1½ million pounds of wool by removing the wall at the top of the layout (fig. 13) and adding an area 196 feet wide and 49 feet deep. This would add 9,604 square feet or about 38 percent to the total area of the warehouse and permit a 50-percent increase in capacity.

The basic arrangement of areas in the warehouse would remain the same. The area added to the warehouse would be used to store ungraded bagged wool. The expanded layout contains 10 storage blocks for ungraded bagged wool. Two of the blocks contain 1,470 square feet each, two contain 1,400 square feet each, two contain 1,120 square feet each, and the other four contain 1,176, 1,152, 1,024, and 560 square feet. Thus, 11,892 square feet of storage area is provided for 750,000 pounds of ungraded bagged wool. The computed space requirements, based on the assumptions already stated, are 11,719 square feet. An additional 8-foot-wide aisle extends the width of the warehouse to provide access to the new blocks of ungraded bagged wool.

The expanded warehouse would have 21 graded-wool storage bins. Eight of the bins contain 684 square feet each, four contain 72 square feet each,



LEGEND

1. UNGRADED BAGGED WOOL STORAGE AREA
2. GRADED WOOL STORAGE BINS
3. GRADED BALED WOOL STORAGE AREA
4. RECEIVING DOCK
5. SHIPPING DOCKS
6. CONVEYOR
7. GRADING TABLE
8. WOOL CARTS
9. SCALE
10. WEIGHT RECORD TABLE
11. MANAGER'S OFFICE
12. GENERAL OFFICE
13. WELFARE ROOM
14. EQUIPMENT STORAGE ROOM
T. TOILETS
C. CLOSETS

SCALE OF FEET

0 5 10 20 30

FIGURE 12.—Layout of a wool warehouse with a capacity of 1 million pounds of wool.

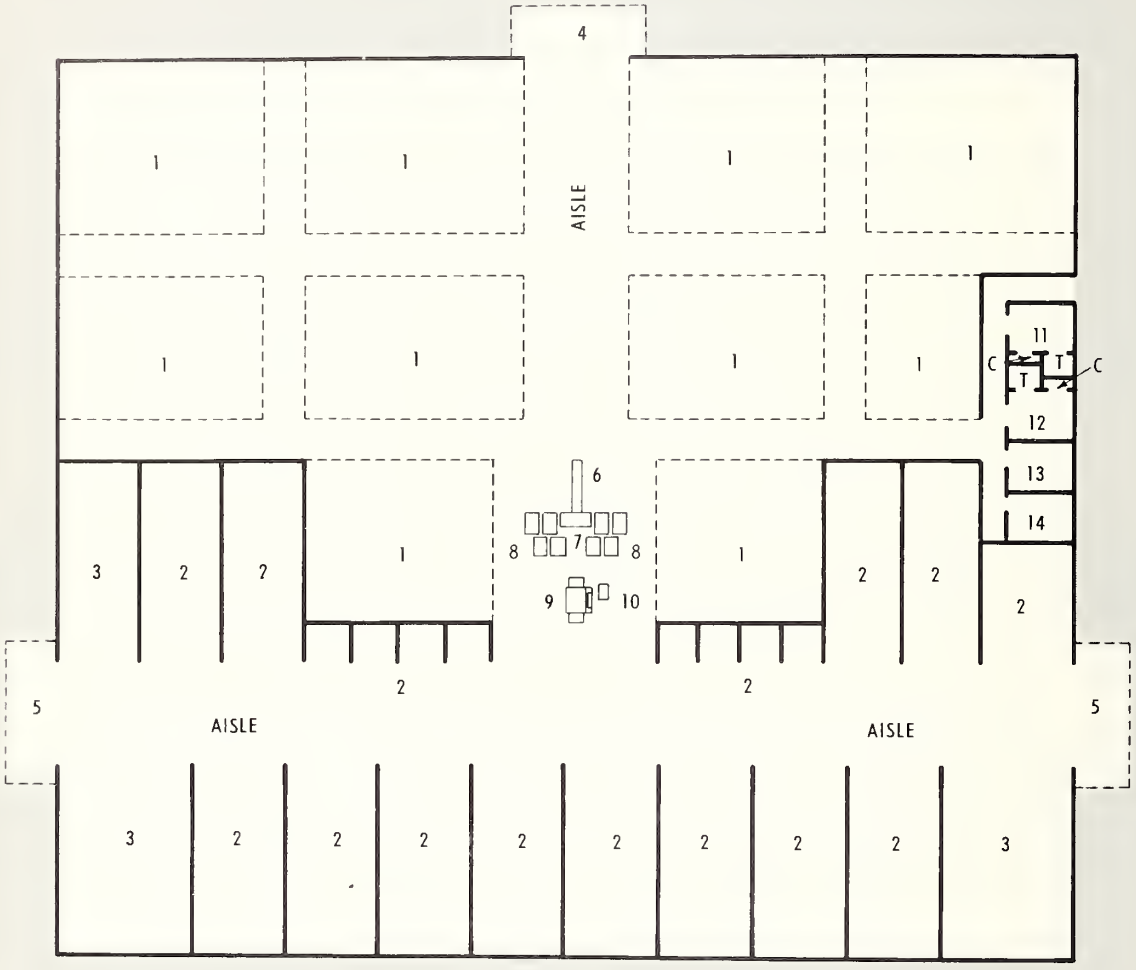


FIGURE 13.—Expansion of the warehouse layout for 1 million pounds of wool to 1½ million pounds.

four contain 64 square feet each, two contain 640 square feet each, two contain 600 square feet each, and one contains 414 square feet. Thus the expanded warehouse provides 8,910 square feet to store 450,000 pounds of graded wool in bins. The computed requirement for this volume is 8,797 square feet.

The additional storage area for baled wool would be 16 feet by 40 feet or 640 square feet and would be located across the 20-foot aisle from the original baled-wool storage area adjacent to the truck loadout dock. The area required to store 300,000 pounds of baled wool is 2,139 square feet. The total area provided in the expanded warehouse is 2,616 square feet.

The grading area would be increased by 320 square feet.

The office area would not be changed in expanding the warehouse.

The warehouse, expanded to a capacity for 1½ million pounds of wool, would contain 34,692 square feet.

Layout Designed To Handle 2 Million Pounds of Wool

A suggested layout for a warehouse with a capacity of 2 million pounds of wool is shown in figure 14. The suggested wool warehouse is 262 feet wide and 164 feet deep, and contains 42,968 square feet. Space is provided for 1 million pounds of ungraded bagged wool, 600,000 pounds of graded wool in bins, and 400,000 pounds of baled graded wool.

Dimensions of Components

Storage area for ungraded bagged wool.—The space required for storage of 1 million pounds of wool is 15,624 square feet.

The layout provides eight storage blocks. Two of the storage blocks contain 2,160 square feet, two contain 1,344 square feet, and the other four blocks contain 2,520, 2,436, 2,400, and 1,560 square feet. The total area for the eight blocks is 15,924 square feet. Access to the blocks is provided by a system of aisles 8 feet wide.

Grading area.—The total area for the grading operation is approximately 32 feet by 42 feet, or 1,344 square feet.

Graded-wool storage bins.—The space requirements, based on the assumptions already stated, are 11,700 square feet.

The layout provides 17 storage bins to hold 600,000 pounds of graded wool. Nine of the bins contain 1,188 square feet each, and eight bins contain 168 square feet each. The small bins are used to hold the small amounts of "offgrade" wool. The total area provided by the 17 storage bins is 12,036 square feet. All of the bins open onto the main cross alley, making them easily accessible to the grading area and the baled-wool storage area.

Storage area for graded baled wool.—Based on the previously stated assumptions, the space requirements to store 400,000 pounds of baled wool are 2,852 square feet.

Each of the two baled-wool storage areas is 32 feet by 54 feet; thus the total area provided for storing baled wool is 3,456 square feet.

Offices.—The manager's office is 10 feet by 14 feet, the general office is 12 feet by 14 feet, the welfare room is 10 feet by 14 feet, and the storage room for miscellaneous supplies and equipment is 10 feet by 14 feet. A hallway 5 feet wide and 40 feet long provides access to the area. The offices—including closets and toilets, the welfare room, the storage room, and the hallway—contain a total of 872 square feet.

Expansion of Facilities

Additional space to expand the capacity of the warehouse to 3 million pounds of wool could be obtained by removing the wall at the top of the layout and adding an area 262 feet wide and 78 feet deep (fig. 15). This would add 20,436 square feet or about 47 percent to the original area of the warehouse and permit a 50-percent increase in capacity.

The basic arrangement of areas in the warehouse would remain the same. The area added to the warehouse would be used to store ungraded bagged wool. The expanded layout contains 10 blocks for ungraded bagged wool. Two of the blocks contain 2,592 square feet, two contain 2,484 square feet, two contain 1,632 square feet, and the other four contain 2,880, 2,760, 2,668, and 2,233 square feet. Thus 23,957 square feet of storage area is provided for 1½ million pounds of ungraded bagged wool. The computed space requirements are 23,436 square feet.

The expanded warehouse has 21 graded-wool storage bins. Nine of the storage bins contain 1,188 square feet each, eight contain 288 square feet each, two contain 1,131 square feet each, one contains 1,740 square feet, and one contains 798 square feet. Thus, the expanded layout provides 17,796 square feet to store 900,000 pounds of graded wool in bins. The computed space requirements are 17,550 square feet.

The expanded warehouse contains three baled-wool storage areas. Two of the areas contain 1,728 square feet each, and one contains 1,740 square

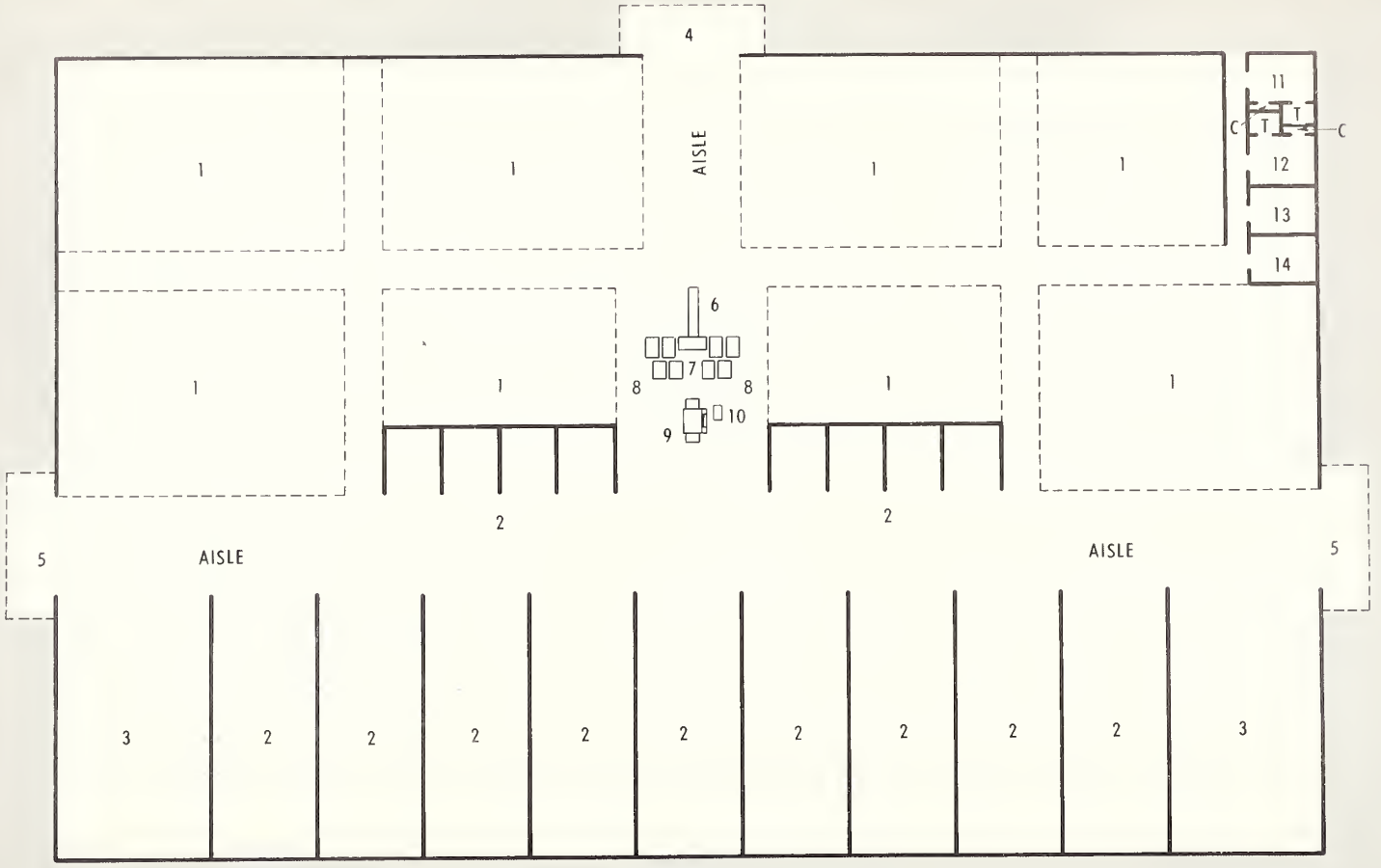


FIGURE 14.—Layout of a wool warehouse with a capacity of 2 million pounds of wool.

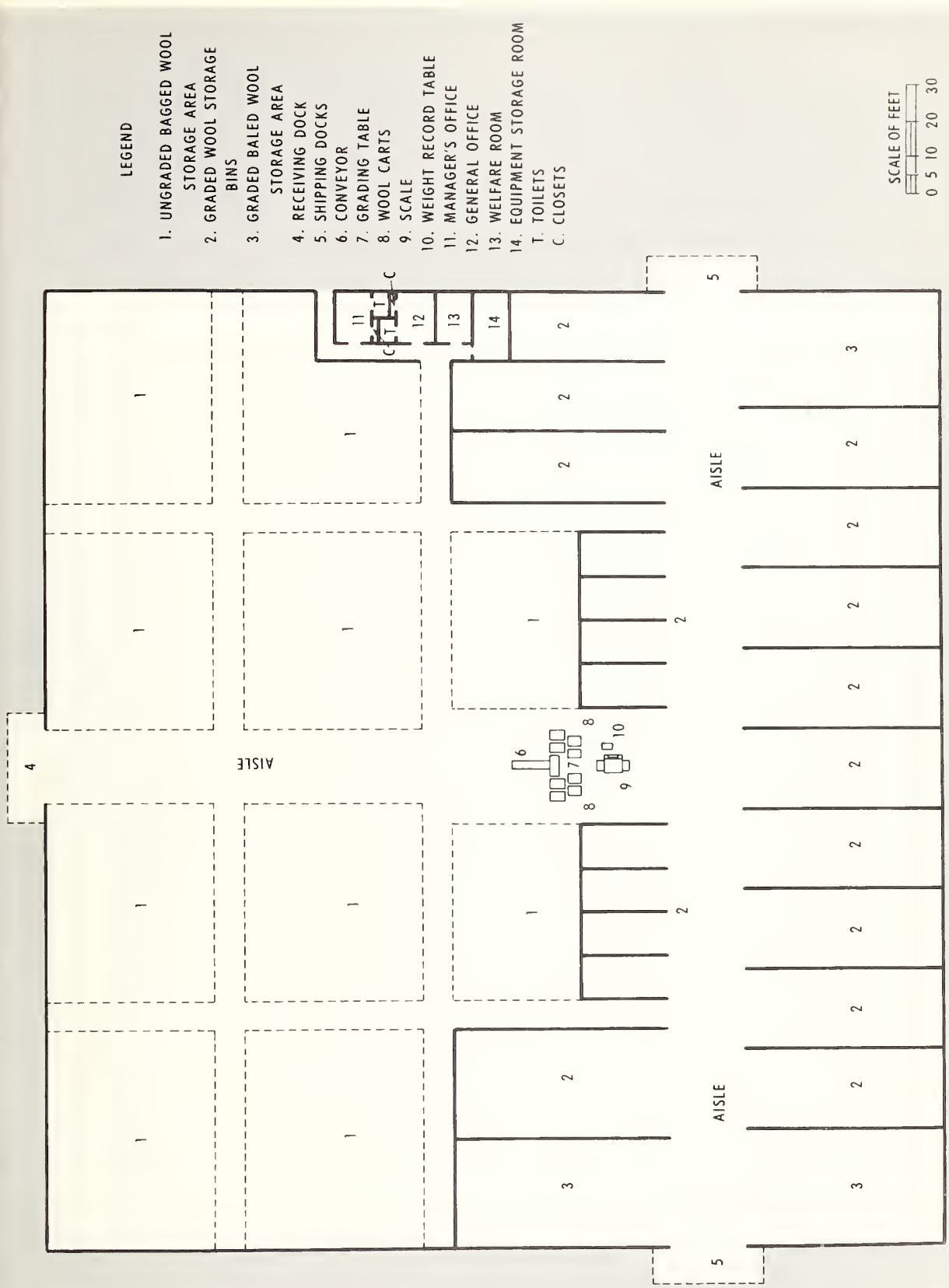


FIGURE 15.—Expansion of the warehouse layout for 2 million pounds of wool to 3 million pounds.

feet. To store 600,000 pounds of baled wool, 5,196 square feet are provided. The computed space requirements are 4,278 square feet.

The location and arrangement of equipment in the grading area remain the same. However, due to the increased size of the small graded-wool storage bins and of the ungraded bagged-wool storage block alongside the grading area, the size of the grading area is increased by 512 square feet.

The facilities in the office area would not be changed in expanding the warehouse.

The warehouse, expanded to a capacity for 3 million pounds of wool, would contain 63,404 square feet.

APPENDIX

Nine tables have been developed as aids in comparing labor and equipment requirements and costs. Table 8 shows the ownership and operating costs for each item of equipment used. Costs are shown for two methods and three warehouse sizes. Tables 9 through 11 show the productive, unproductive, and total labor requirements per 1,000 pounds by time item, method, operation, and warehouse size. Table 12 shows the equipment requirements and costs per 1,000 pounds for each item of equipment used, by method, operation, and warehouse size. The productive labor requirements for transporting 1,000 pounds of wool specified distances by type of transporting equipment are shown in tables 13 through 16.

TABLE 8.—*Ownership and operating costs of equipment used in wool warehouses handling 500,000, 1 million, and 2 million pounds annually*

Equipment	Amount of equipment	Size or capacity	Initial cost	Expected life	Ownership costs				Operating costs			Total annual cost	Total annual usage	Cost per hour of use	Cost per 1,000 pounds
					Depreciation	Interest	Insurance and taxes	Total	Fuel and electricity	Maintenance	Total				
WAREHOUSE HANDLING 500,000 POUNDS ANNUALLY															
Typical Methods															
			Dollars	*Years*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Hours*	*Dollars*	*Dollars*
2-wheel handtruck	5		300	15	20.00	9.00	12.00	41.00		2.38	2.38	43.38	[1] 660	0.0654	0.0863
Installed platform scale:															
Receiving area	1	48 x 60 in.	1,400	15	93.33	42.00	56.00	191.33		3.60	3.60	194.93	105	1.8565	.3899
Grading area	1	48 x 60 in.	1,400	15	93.33	42.00	56.00	191.33		3.60	3.60	194.93	220	.8860	.3898
Loading-out area	1	48 x 60 in.	1,400	15	93.33	42.00	56.00	191.33		.74	.74	192.07	40	4.8017	.3841
Electric hoist	1	½-hp.	325	10	32.50	9.75	13.00	55.25	1.49	1.25	2.74	57.99	220	.2636	.1160
Grading table	1	40 x 72 in.	25	10	2.50	.75	1.00	4.25		.10	.10	4.35	220	.0198	.0087
Wool carts	14	36 x 48 x 30 in.	560	8	70.00	16.80	22.40	109.20		2.70	2.70	111.90	220	.5086	.2238
Bagging machine	1		800	10	80.00	24.00	32.00	136.00	4.05	2.10	6.15	142.15	150	.9477	.2843
Core-sampling set [2]	1		50	5	10.00	1.50	2.00	13.50	.31	.08	.39	13.89	40	.3472	.0278
Suggested Methods															
Clamp truck	1	2,000-lb.	4,600	8	575.00	138.00	184.00	897.00	81.25	74.75	156.00	1,053.00	[3] 320	3.2906	2.1060
Portable platform scale	1	48 x 60 in.	2,000	15	133.33	60.00	80.00	273.33		10.60	10.60	283.93	[4] 440	.6453	.5679
Belt conveyors:															
Grading	1	15 in. x 10 ft.	625	15	41.67	18.75	25.00	85.42	2.84	1.54	4.38	89.80	210	.4276	.1796
Packaging wool in bales	1	15 in. x 10 ft.	625	15	41.67	18.75	25.00	85.42	1.49	.81	2.30	87.72	110	.7975	.1755
Grading table	1	40 x 72 in.	25	10	2.50	.75	1.00	4.25		.10	.10	4.35	210	.0207	.0087
Wool carts	14	36 x 48 x 30 in.	560	8	70.00	16.80	22.40	109.20		2.57	2.57	111.77	210	.5322	.2235
Baling machine	1		3,000	15	200.00	90.00	120.00	410.00	2.97	3.90	6.87	416.87	110	3.7897	.8337
Core-sampling set [5]	1		50	5	10.00	1.50	2.00	13.50	.31	.12	.43	13.93	65	.2143	.0279
WAREHOUSE HANDLING 1 MILLION POUNDS ANNUALLY															
Typical Methods															
2-wheel handtruck	5		300	15	20.00	9.00	12.00	41.00		4.76	4.76	45.76	[6] 1,340	.0341	.0457
Installed platform scale:															
Receiving area	1	48 x 60 in.	1,400	15	93.33	42.00	56.00	191.33		7.19	7.19	198.52	220	.9024	.1985
Grading area	1	48 x 60 in.	1,400	15	93.33	42.00	56.00	191.33		7.19	7.19	198.52	440	.4512	.1985
Loading-out area	1	48 x 60 in.	1,400	15	93.33	42.00	56.00	191.33		1.47	1.47	192.80	80	2.4200	.1936
Electric hoist	1	½-hp.	325	10	32.50	9.75	13.00	55.25	2.97	2.50	5.47	60.72	440	.1380	.0607
Grading table	1	40 x 72 in.	25	10	2.50	.75	1.00	4.25		.19	.19	4.44	440	.0101	.0044
Wool carts	14	36 x 48 x 30 in.	560	8	70.00	16.80	22.40	109.20		5.40	5.40	114.60	440	.2605	.1146
Bagging machine	1		800	10	80.00	24.00	32.00	136.00	8.10	4.20	12.30	148.30	300	.4943	.1483
Core-sampling set [2]	1		50	5	10.00	1.50	2.00	13.50	.61	.16	.77	14.27	80	.1784	.0143

Suggested Methods														
Clamp truck	1	2,000-lb	4,600	8	575.00	138.00	184.00	897.00	162.50	149.50	312.00	1,209.00	[7] 650	1.8600	1.2090
Portable platform scale	1	48 x 60 in	2,000	15	133.33	60.00	80.00	273.33		21.20	21.20	294.53	[8] 890	.3309	.2945
Belt conveyors:															
Grading	1	15 in. x 10 ft	625	15	41.67	18.75	25.00	85.42	5.67	3.08	8.75	94.17	420	.2242	.0942
Packaging wool in bales	1	15 in. x 10 ft	625	15	41.67	18.75	25.00	85.42	2.97	1.61	4.58	90.00	220	.4091	.0900
Grading table	1	40 x 72 in	25	10	2.50	.75	1.00	4.25		.19	.19	4.44	420	.0106	.0044
Wool carts	14	36 x 48 x 30 in	560	8	70.00	16.80	22.40	109.20		5.14	5.14	114.34	420	.2723	.1144
Baling machine	1		3,000	15	200.00	90.00	120.00	410.00	5.94	7.80	13.74	423.74	220	1.9261	.4237
Core-sampling set [5]	1		50	5	10.00	1.50	2.00	13.50	.61	.23	.84	14.34	130	.1103	.0143
WAREHOUSE HANDLING 2 MILLION POUNDS ANNUALLY															
Typical Methods															
2-wheel handtruck	5		300	15	20.00	9.00	12.00	41.00		9.52	9.52	50.52	[9] 2,680	.0188	.0252
Installed platform scale:															
Receiving area	1	48 x 60 in	1,400	15	93.33	42.00	56.00	191.33		7.19	7.19	198.52	440	.4512	.0993
Grading area	1	48 x 60 in	1,400	15	93.33	42.00	56.00	191.33		14.38	14.38	205.71	880	.2338	.1029
Loading-out area	1	48 x 60 in	1,400	15	93.33	42.00	56.00	191.33		2.94	2.94	194.27	160	1.2142	.0971
Electric hoist	1	½-hp	325	10	32.50	9.75	13.00	55.25	5.94	5.00	10.94	66.19	880	.0752	.0331
Grading table	1	40 x 72 in	25	10	2.50	.75	1.00	4.25		.38	.38	4.63	880	.0053	.0023
Wool carts	14	36 x 48 x 30 in	560	8	70.00	16.80	22.40	109.20		10.80	10.80	120.00	880	.1364	.0600
Bagging machine	1		800	10	80.00	24.00	32.00	136.00	16.20	24.60	40.80	176.80	600	.2947	.0884
Core-sampling set [2]	1		50	5	10.00	1.50	2.00	13.50	1.22	1.54	2.76	16.26	160	.1016	.0081
Suggested Methods															
Clamp truck	1	2,000-lb	4,600	8	575.00	138.00	184.00	897.00	325.00	299.00	624.00	1,521.00	[10] 1,380	1.1022	.7605
Portable platform scale	1	48 x 60 in	2,000	15	133.33	60.00	80.00	273.33		42.40	42.40	315.73	[11] 1,820	.1735	.1579
Belt conveyors:															
Grading	1	15 in. x 10 ft	625	15	41.67	18.75	25.00	85.42	11.34	6.16	17.50	102.92	840	.1225	.0515
Packaging wool in bales	1	15 in. x 10 ft	625	15	41.67	18.75	25.00	85.42	5.94	3.22	9.16	94.58	440	.2150	.0473
Grading table	1	40 x 72 in	25	10	2.50	.75	1.00	4.25		.38	.38	4.63	840	.0055	.0023
Wool carts	14	36 x 48 x 30 in	560	8	70.00	16.80	22.40	109.20		10.28	10.28	119.48	840	.1422	.0597
Baling machine	1		3,000	15	200.00	90.00	120.00	410.00	11.88	15.60	27.48	437.48	440	.9943	.2187
Core-sampling set [5]	1		50	5	10.00	1.50	2.00	13.50	1.22	.46	1.68	15.18	280	.0542	.0076

[1] Allocation by operations: Receiving wool—210 hours; grading wool—220 hours; packaging wool—150 hours; and loading out wool—80 hours.

[2] Item used to core-sample wool packaged in bags.

[3] Allocation by operations: Receiving wool, 165 hours; grading wool, 55 hours; packaging wool, 35 hours; and loading out wool, 65 hours.

[4] Allocation by operations: Receiving wool, 165 hours; grading wool, 210 hours; and loading out wool, 65 hours.

[5] Item used to core-sample wool packaged in bales.

[6] Allocation by operations: Receiving wool, 440 hours; grading wool, 440 hours, packaging wool, 300 hours; and loading out wool, 160 hours.

[7] Allocation by operations: Receiving wool, 340 hours; grading wool, 110 hours; packaging wool, 70 hours; and loading out wool, 130 hours.

[8] Allocation by operations: Receiving wool, 340 hours; grading wool, 420 hours; and loading out wool, 130 hours.

[9] Allocation by operations: Receiving wool, 880 hours; grading wool, 880 hours; packaging wool, 600 hours; and loading out wool, 320 hours.

[10] Allocation by operations: Receiving wool, 700 hours; grading wool, 260 hours; packaging wool, 140 hours; and loading out wool, 280 hours.

[11] Allocation by operations: Receiving wool, 700 hours; grading wool, 840 hours, and loading out wool, 280 hours.

TABLE 9.—*Labor requirements per 1,000 pounds for performing operations in a warehouse handling 500,000 pounds of wool annually*

Operation, method, and time item	Productive time			Unproductive time	Total labor requirements
	Base time	Fatigue and personal allowance	Total		
RECEIVING WOOL					
2-wheel handtruck method (4 workers):	*Man-hours*	*Percent*	*Man-hours*	*Man-hours*	*Man-hours*
Set up bridgeplate	0. 05	15	0. 06		
Move empty handtruck from bagged-wool area to loaded truck (average distance 60 feet)	. 05	15	. 06		
Break out bag and position for loading	. 09	15	. 10		
Load bag on handtruck	. 02	15	. 02		
Transport bag to weighing area (average distance 20 feet)	. 03	15	. 03		
Weigh and record	. 14	10	. 15		
Transport bag to storage area (average distance 40 feet)	. 04	15	. 05		
Unload and position bag in storage area	. 05	15	. 06		
Remove bridgeplate	. 05	15	. 06		
Job-regulated wait time				0. 25	
Total			. 59	. 25	0. 84
Clamp truck method (1 worker):					
Set up bridgeplate	. 03	10	. 03		
Move empty clamp truck from bagged-wool storage area to loaded truck (average distance 60 feet)	. 03	10	. 03		
Position 2 bags and pick up for transport	. 05	10	. 06		
Transport bags to weighing area (average distance 20 feet)	. 02	10	. 02		
Weigh and record	. 08	10	. 09		
Transport bags to storage area (average distance 40 feet)	. 03	10	. 03		
Unload and position bags in storage area	. 04	10	. 04		
Remove bridgeplate	. 03	10	. 03		
Job-regulated wait time				None	
Total			. 33		. 33
GRADING WOOL					
Handtruck, hoist, and wool cart method (7 workers):					
Move empty 2-wheel hand truck from grading area to bagged-wool storage area (average distance 50 feet)	. 05	15	. 06		
Load bag on hand truck	. 04	15	. 05		
Transport bag to grading area (average distance 60 feet)	. 05	15	. 06		
Unload bag	. 02	15	. 02		
Cut tie string and open one end of bag	. 04	10	. 04		
Lower hoist, attach hoist clamps, and raise bag	. 07	15	. 08		
Empty fleeces onto floor	. 09	15	. 10		
Lower hoist, detach bag, raise hoist, fold and stack empty bag	. 08	15	. 09		
Pick up fleeces and place on table	. 24	15	. 28		
Pick up, grade, and toss fleeces into wool carts	. 31	15	. 36		
Record data on tally sheet	. 05	10	. 06		
Move loaded carts from grading area to scale (average distance 15 feet)	. 04	15	. 05		
Weigh and record	. 16	15	. 18		
Move carts from scale to storage bins (average distance 40 feet)	. 08	15	. 09		
Empty fleeces into bins	. 21	15	. 24		
Return empty carts to grading area (average distance 50 feet)	. 09	10	. 10		
Clean up around grading area after each owner's lot	. 04	15	. 05		
Job-regulated wait time				1. 17	
Total			1. 91	1. 17	3. 08

TABLE 9.—*Labor requirements per 1,000 pounds for performing operations in a warehouse handling 500,000 pounds of wool annually*—Continued

Operation, method, and time item	Productive time			Unproductive time	Total labor requirements
	Base time	Fatigue and personal allowance	Total		
GRADING WOOL—continued					
Clamp truck, conveyor, and wool cart method (5 workers):					
	Man-hours	*Percent*	*Man-hours*	*Man-hours*	*Man-hours*
Drive empty clamp truck from grading area to bagged-wool storage area (average distance 50 feet)	.03	10	.03		
Position 2 bags and pick up for transport	.04	10	.04		
Drive truck to conveyor in grading area (average distance 50 feet)	.03	10	.03		
Unload bags	.01	10	.01		
Open seam on one side of bag	.05	10	.06		
Place fleeces on conveyor	.11	10	.12		
Fold and stack empty bag	.05	10	.06		
Pick up, grade, and toss fleeces into wool carts	.31	15	.36		
Record data on tally sheet	.05	10	.06		
Move loaded wool carts from grading area to scale (average distance 15 feet)	.05	15	.06		
Weigh and record	.16	15	.18		
Move carts from scale to storage bins (average distance 40 feet)	.08	15	.09		
Empty fleeces from carts into bins	.21	15	.24		
Return empty carts to grading area (average distance 50 feet)	.09	15	.10		
Clean up around grading area after each owner's lot	.04	15	.05		
Job-regulated wait time				.30	
Total			1.49	.30	1.79
PACKAGING AND STORING WOOL					
Bag method (5 workers):					
Attach empty bag to loading hoop	.05	10	.06		
Attach loading hoop with empty bag to bagging machine	.02	10	.02		
Move fleeces from storage bins to platform of bagging machine (average distance 8 feet)	.68	15	.78		
Put fleeces into bag and operate plunger	.18	15	.21		
Detach filled bag	.02	15	.02		
Remove loading hoop from filled bag and place aside	.03	10	.03		
Close open end of filled bag, using needle and cord	.08	10	.09		
Transport on handtruck to storage area (average distance 40 feet)	.02	15	.02		
Unload and stack bag	.05	15	.06		
Return handtruck to bagging area (average distance 40 feet)	.02	15	.02		
Job-regulated wait time				.19	
Total			1.31	.19	1.50
Bale method (5 workers):					
Attach bale covering to baler	.01	10	.01		
Insert and position 5 tie wires to baler	.01	10	.01		
Move fleeces from storage bins to platform of baling machine (average distance 8 feet)	.49	10	.54		
Place fleeces in baler and operate compressor	.16	10	.18		
Tie wires around wool bale	.01	10	.01		
Remove bale from baling machine	.01	10	.01		
Close open end of bale, using needle and cord	.05	10	.06		
Transport on clamp truck to baled-wool storage area (average distance 40 feet)	.02	10	.02		
Unload and stack bale	.03	10	.03		
Return clamp truck to baling area (average distance 40 feet)	.02	10	.02		
Job-regulated wait time				.06	
Total			.89	.06	.95

TABLE 9.—*Labor requirements per 1,000 pounds for performing operations in a warehouse handling 500,000 pounds of wool annually*—Continued

Operation, method, and time item	Productive time			Unproductive time	Total labor requirements
	Base time	Fatigue and personal allowance	Total		
LOADING OUT WOOL					
Bag method (7 workers):	*Man-hours*	*Percent*	*Man-hours*	*Man-hours*	*Man-hours*
Set up bridgeplate	(1)	15	(1)		
Position bag and load onto handtruck	.02	15	.02		
Transport bag to scale (average distance 20 feet)	.02	15	.02		
Weigh and record	.05	10	.06		
Obtain core sample	.07	10	.08		
Transport bag to truck or rail car (average distance 20 feet)	.02	15	.02		
Stack bag in truck or rail car	.11	15	.13		
Return empty handtruck to bagged-wool storage area (average distance 35 feet)	.02	15	.02		
Remove bridgeplate	(1)	15	(1)		
Job-regulated wait time				.21	
Total			.35	.21	.56
Bale method (3 workers):					
Set up bridgeplate	(1)	10	(1)		
Position bale and pick up for transport	.02	10	.02		
Transport bale to scale (average distance 20 feet)	.01	10	.01		
Weigh and record	.03	10	.03		
Obtain core sample	.06	10	.07		
Transport bale to truck or rail car (average distance 20 feet)	.01	10	.01		
Stack bale in truck or rail car	.04	10	.04		
Return empty clamp truck to baled-wool storage area (average distance 35 feet)	.02	10	.02		
Remove bridgeplate	(1)	10	(1)		
Job-regulated wait time				.19	
Total			.20	.19	.39

[1] Less than 0.005 man-hour.

TABLE 10.—*Labor requirements per 1,000 pounds for performing operations in a warehouse handling 1 million pounds of wool annually*

Operation, method, and time item	Productive time			Unproductive time	Total labor requirements
	Base time	Fatigue and personal allowance	Total		
RECEIVING WOOL					
2-wheel handtruck method (4 workers):	*Man-hours*	*Percent*	*Man-hours*	*Man-hours*	*Man-hours*
Set up bridgeplate	0. 05	15	0. 06		
Move empty handtruck from bagged-wool storage area to loaded truck (average distance 85 ft.)	. 07	15	. 08		
Break out bag and position for loading	. 09	15	. 10		
Load bag on handtruck	. 02	15	. 02		
Transport bag to weighing area (average distance 20 ft.)	. 03	15	. 03		
Weigh and record	. 14	10	. 15		
Transport bag to storage area (average distance 65 ft.)	. 06	15	. 07		
Unload and position bag in storage area	. 05	15	. 06		
Remove bridgeplate	. 05	15	. 06		
Job-regulated wait time				0. 25	
Total			. 63	. 25	0. 88
Clamp truck method (1 worker):					
Set up bridgeplate	. 03	10	. 03		
Move empty clamp truck from bagged-wool storage area to loaded truck (average distance 85 ft.)	. 04	10	. 04		
Position 2 bags and pick up for transport	. 05	10	. 06		
Transport bags to weighing area (average distance 20 ft.)	. 02	10	. 02		
Weigh and record	. 08	10	. 09		
Transport bags to storage area (average distance 65 ft.)	. 03	10	. 03		
Unload and position bags in storage area	. 04	10	. 04		
Remove bridgeplate	. 03	10	. 03		
Job-regulated wait time					
Total			. 34		. 34
GRADING WOOL					
Handtruck, hoist, and wool cart method (7 workers):					
Move empty 2-wheel handtruck from grading area to bagged wool storage area (average distance 70 feet)	. 06	15	. 07		
Load bag on handtruck	. 04	15	. 05		
Transport bag to grading area (average distance 70 feet)	. 06	15	. 07		
Unload bag	. 02	15	. 02		
Cut tie string and open one end of bag	. 04	10	. 04		
Lower hoist, attach hoist clamps, and raise bag	. 07	15	. 08		
Empty fleeces onto floor	. 09	15	. 10		
Lower hoist, detach bag, raise hoist, fold and stack bag	. 08	15	. 09		
Pick up fleeces and place on table	. 24	15	. 28		
Pick up, grade, and toss fleeces into wool carts	. 31	15	. 36		
Record data on tally sheet	. 05	10	. 06		
Move loaded carts from grading area to scale (average distance 15 feet)	. 04	15	. 05		
Weigh and record	. 16	15	. 18		
Move carts from scale to storage bins (average distance 50 feet)	. 09	15	. 10		
Empty fleeces into bins	. 21	15	. 24		
Return empty carts to grading area (average distance 60 feet)	. 10	15	. 11		
Clean up around grading area after each owner's lot	. 04	15	. 05		
Job-regulated wait time				1. 13	
Total			1. 95	1. 13	3. 08

TABLE 10.—*Labor requirements per 1,000 pounds for performing operations in a warehouse handling 1 million pounds of wool annually*—Continued

Operation, method, and time item	Productive time			Unproductive time	Total labor requirements
	Base time	Fatigue and personal allowance	Total		
GRADING WOOL—continued					
Clamp truck, conveyor, and wool cart method (5 workers):	*Man-hours*	*Percent*	*Man-hours*	*Man-hours*	*Man-hours*
Drive empty clamp truck from grading area to bagged wool storage area (average distance 70 feet)	.03	10	.03		
Position 2 bags and pick up for transport	.04	10	.04		
Drive truck to conveyor in grading area (average distance 70 feet)	.03	10	.03		
Unload bags	.01	10	.01		
Open seam on one side of bag	.05	10	.06		
Place fleeces on conveyor	.11	10	.12		
Fold and stack empty bag	.05	10	.06		
Pick up, grade, and toss fleeces into carts	.31	15	.36		
Record data on tally sheet	.05	10	.06		
Move loaded wool carts from grading area to scale (average distance 15 feet)	.05	15	.06		
Weigh and record	.16	15	.18		
Move carts from scale to storage bins (average distance 50 feet)	.09	15	.10		
Empty fleeces from carts into bins	.21	15	.24		
Return empty carts to grading area (average distance 60 feet)	.10	15	.12		
Clean up around grading area after each owner's lot	.04	15	.05		
Job-regulated wait time				.27	
Total			1.52	.27	1.79
PACKAGING AND STORING WOOL					
Bag method (5 workers):					
Attach empty bag to loading hoop	.05	10	.06		
Attach loading hoop with empty bag to bagging machine	.02	10	.02		
Move fleeces from storage bins to platform of bagging machine (average distance 8 ft.)	.68	15	.78		
Put fleeces into bag and operate plunger	.18	15	.21		
Detach filled bag	.02	15	.02		
Remove loading hoop from filled bag and place aside	.03	10	.03		
Close open end of filled bag using needle and cord	.08	10	.09		
Transport on handtruck to storage area (average distance 60 ft.)	.03	15	.03		
Unload and stack bag	.05	15	.06		
Return handtruck to bagging area (average distance 60 ft.)	.03	15	.03		
Job-regulated wait time				.17	
Total			1.33	.17	1.50
Bale method (5 workers):					
Attach bale covering to baler	.01	10	.01		
Insert and position 5 wire ties to baler	.01	10	.01		
Move fleeces from storage bins to platform of baling machine (average distance 8 ft.)	.49	10	.54		
Place fleeces in baler and operate compressor	.16	10	.18		
Tie wires around wool bale	.01	10	.01		
Remove bale from baling machine	.01	10	.01		
Close open end of bale, using needle and cord	.05	10	.06		
Transport on clamp truck to bale storage area (average distance 60 ft.)	.02	10	.02		
Unload and stack bale	.03	10	.03		
Return clamp truck to baling area (average distance 60 ft.)	.02	10	.02		
Job-regulated wait time				.06	
Total			.89	.06	.95

TABLE 10.—*Labor requirements per 1,000 pounds for performing operations in a warehouse handling 1 million pounds of wool annually*—Continued

Operation, method, and time item	Productive time			Unproductive time	Total labor requirements
	Base time	Fatigue and personal allowance	Total		
LOADING OUT WOOL					
Bag method (7 workers):	*Man-hours*	*Percent*	*Man-hours*	*Man-hours*	*Man-hours*
Set up bridgeplate	[1]	15	[1]		
Position bag and load onto handtruck	.02	15	.02		
Transport bag to scale (average distance 20 ft.)	.02	15	.02		
Weigh and record	.05	10	.06		
Obtain core sample	.07	10	.08		
Transport bag to truck or rail car (average distance 30 ft.)	.02	15	.02		
Stack bag in truck or rail car	.11	15	.13		
Return empty handtruck to bagged-wool storage area (average distance 45 ft.)	.03	15	.03		
Remove bridgeplate	[1]	15	[1]		
Job-regulated wait time				.20	
Total			.36	.20	.56
Bale method (3 workers):					
Set up bridgeplate	[1]	10	[1]		
Position bale and pick up for transport	.02	10	.02		
Transport bale to scale (average distance 20 ft.)	.01	10	.01		
Weigh and record	.03	10	.03		
Obtain core sample	.06	10	.07		
Transport bale to truck or rail car (average distance 30 ft.)	.01	10	.01		
Stack bale in truck or rail car	.04	10	.04		
Return empty clamp truck to baled-wool storage area (average distance 45 ft.)	.02	10	.02		
Remove bridgeplate	[1]	10	[1]		
Job-regulated wait time				.19	
Total			.20	.19	.39

[1] Less than 0.005 man-hour.

TABLE 11.—*Labor requirements per 1,000 pounds for performing operations in a warehouse handling 2 million pounds annually*

Operation, method, and time item	Productive time			Unproductive time	Total labor requirements
	Base time	Fatigue and personal allowance	Total		
RECEIVING WOOL					
2-wheel handtruck method (4 workers):	*Man-hours*	*Percent*	*Man-hours*	*Man-hours*	*Man-hours*
Set up bridgeplate	0. 05	15	0. 06		
Move empty handtruck from bagged-wool storage area to loaded truck (average distance 110 ft.)	. 08	15	. 09		
Break out bag and position for loading	. 09	15	. 10		
Load bag on handtruck	. 02	15	. 02		
Transport bag to weighing area (average distance 20 ft.)	. 03	15	. 03		
Weigh and record	. 14	10	. 15		
Transport bag to storage area (average distance 90 ft.)	. 07	15	. 08		
Unload and position bag in storage area	. 05	15	. 06		
Remove bridgeplate	. 05	15	. 06		
Job-regulated wait time				0. 23	
Total			. 65	. 23	0. 88
Clamp truck method (1 worker):					
Set up bridgeplate	. 03	10	. 03		
Move empty clamp truck from bagged-wool storage area to loaded truck (average distance 110 ft.)	. 04	10	. 04		
Position 2 bags and pick up for transport	. 05	10	. 06		
Transport bags to weighing area (average distance 20 ft.)	. 02	10	. 02		
Weigh and record	. 08	10	. 09		
Transport bags to storage area (average distance 90 ft.)	. 04	10	. 04		
Unload and position bags in storage area	. 04	10	. 04		
Remove bridgeplate	. 03	10	. 03		
Job-regulated wait time					
Total			. 35		. 35
GRADING WOOL					
Handtruck, hoist, and wool cart method (7 workers):					
Move empty 2-wheel handtruck from grading area to bagged-wool storage area (average distance 85 ft.)	. 07	15	. 08		
Load bags on handtruck	. 04	15	. 05		
Transport bag to grading area (average distance 85 ft.)	. 07	15	. 08		
Unload bag	. 02	15	. 02		
Cut tie string and open one end of bag	. 04	10	04		
Lower hoist, attach hoist clamps, and raise bag	. 07	15	. 08		
Empty fleeces onto floor	. 09	15	. 10		
Lower hoist, detach bag, raise hoist, fold and stack bag	. 08	15	. 09		
Pick up fleeces and place on table	. 24	15	. 28		
Pick up, grade, and toss fleeces into wool carts	. 31	15	. 36		
Record data on tally sheet	. 05	10	. 06		
Move loaded carts from grading area to scale (average distance 15 ft.)	. 04	15	. 05		
Weigh and record	. 16	15	. 18		
Move carts from scale to storage bins (average distance 65 ft.)	. 10	15	. 12		
Empty fleeces into bins	. 21	15	. 24		
Return empty carts to grading area (average distance 75 ft.)	. 12	15	. 14		
Clean up around grading area after each owner's lot	. 04	15	. 05		
Job-regulated wait time				1. 06	
Total			2. 02	1. 06	3. 08

TABLE 11.—*Labor requirements per 1,000 pounds for performing operations in a warehouse handling 2 million pounds annually*—Continued

Operation, method, and time item	Productive time			Unproductive time	Total labor requirements
	Base time	Fatigue and personal allowance	Total		
GRADING WOOL—continued					
Clamp truck, conveyor, and wool cart method (5 workers):					
	Man-hours	*Percent*	*Man-hours*	*Man-hours*	*Man-hours*
Drive empty clamp truck from grading area to bagged-wool storage area (average distance 85 ft.)	.04	10	.04		
Position 2 bags and pick up for transport	.04	10	.04		
Drive truck to conveyor in grading area (average distance 85 ft.)	.04	10	.04		
Unload bags	.01	10	.01		
Open seam on one side of bag	.05	10	.06		
Place fleeces on conveyor	.11	10	.12		
Fold and stack empty bag	.05	10	.06		
Pick up, grade, and toss fleeces into carts	.31	15	.36		
Record data on tally sheet	.05	10	.06		
Move loaded wool carts from grading area to scale (average distance 15 ft.)	.05	15	.06		
Weigh and record	.16	15	.18		
Move carts from scale to storage bins (average distance 65 ft.)	.10	15	.12		
Empty fleeces from carts into bins	.21	15	.24		
Return empty carts to grading area (average distance 75 ft.)	.11	15	.13		
Clean up around grading area after each owner's lot	.04	15	.05		
Job-regulated wait time				.24	
Total			1.57	.24	1.81
PACKAGING AND STORING WOOL					
Bag method (5 workers):					
Attach empty bag to loading hoop	.05	10	.06		
Attach loading hoop with empty bag to bagging machine	.02	10	.02		
Move fleeces from storage bins to platform of bagging machine (average distance 8 ft.)	.68	15	.78		
Put fleeces into bag and operate plunger	.18	15	.21		
Detach filled bag	.02	15	.02		
Remove loading hoop from filled bag and place aside	.03	10	.03		
Close open end of filled bag, using needle and cord	.08	10	.09		
Transport on handtruck to storage area (average distance 85 ft.)	.03	15	.04		
Unload and stack bag	.05	15	.06		
Return handtruck to bagging area (average distance 85 ft.)	.03	15	.04		
Job-regulated wait time				.15	
Total			1.35	.15	1.50
Bale method (5 workers):					
Attach bale-covering to baler	.01	10	.01		
Insert and position 5 tie wires to baler	.01	10	.01		
Move fleeces from storage bins to platform of baling machine (average distance 8 ft.)	.49	10	.54		
Place fleeces in baler and operate compressor	.16	10	.18		
Tie wires around wool bale	.01	10	.01		
Remove bale from baling machine	.01	10	.01		
Close open end of bale, using needle and cord	.05	10	.06		
Transport on clamp truck to bale storage area (average distance 85 ft.)	.02	10	.02		
Unload and stack bale	.03	10	.03		
Return clamp truck to baling area (average distance 85 ft.)	.02	10	.02		
Job-regulated wait time				.06	
Total			.89	.06	.95

TABLE 11.—*Labor requirements per 1,000 pounds for performing operations in a warehouse handling 2 million pounds annually*—Continued

Operation, method, and time item	Productive time			Unproductive time	Total labor requirements
	Base time	Fatigue and personal allowance	Total		
LOADING OUT WOOL					
Bag method (7 workers):	*Man-hours*	*Percent*	*Man-hours*	*Man-hours*	*Man-hours*
Set up bridgeplate	(1)	15	(1)		
Position bag and load onto handtruck	.02	15	.02		
Transport bag to scale (average distance 20 ft.)	.02	15	.02		
Weigh and record	.05	10	.06		
Obtain core sample	.07	10	.08		
Transport bag to truck or rail car (average distance 40 ft.)	.02	15	.02		
Stack bag in truck or rail car	.11	15	.13		
Return empty handtruck to bagged-wool storage area (average distance 55 ft.)	.03	15	.03		
Remove bridgeplate	(1)	15	(1)		
Job-regulated wait time				.20	
Total			.36	.20	.56
Bale method (3 workers):					
Set up bridgeplate	(1)	10	(1)		
Position bale and pick up for transport	.02	10	.02		
Transport bale to scale (average distance 20 ft.)	.01	10	.01		
Weigh and record	.03	10	.03		
Obtain core sample	.06	10	.07		
Transport bale to truck or rail car (average distance 40 ft.)	.02	10	.02		
Stack bale in truck or rail car	.04	10	.04		
Return empty clamp truck to baled-wool storage area (average distance 55 ft.)	.02	10	.02		
Remove bridgeplate	(1)	10	(1)		
Job-regulated wait time				.21	
Total			.21	.21	.42

[1] Less than 0.005 man-hour.

TABLE 12.—*Equipment requirements and costs per 1,000 pounds for handling wool, by size of warehouse*

Operation, method, and item of equipment	Warehouse handling 500,000 pounds of wool annually		Warehouse handling 1 million pounds of wool annually		Warehouse handling 2 million pounds of wool annually	
	Machine-hours	*Dollars*	*Machine-hours*	*Dollars*	*Machine-hours*	*Dollars*
RECEIVING WOOL						
Handtruck method:						
2-wheel handtruck	0.42	0.0272	0.44	0.0148	0.44	0.0080
Installed platform scale	.21	.3899	.22	.1985	.22	.0993
Total	.63	.4171	.66	.2133	.66	.1073
Clamp truck method:						
Clamp truck	.33	1.0859	.34	.6324	.35	.3858
Portable platform scale	.33	.2130	.34	.1125	.35	.0607
Total	.66	1.2989	.68	.7449	.70	.4465
GRADING WOOL						
Handtruck, hoist, and wool cart method:						
2-wheel handtruck	.44	.0285	.44	.0148	.44	.0080
Electric hoist	.44	.1160	.44	.0607	.44	.0331
Grading table	.44	.0087	.44	.0044	.44	.0023
Wool carts	.44	.2238	.44	.1146	.44	.0600
Installed platform scale	.44	.3898	.44	.1985	.44	.1029
Total	2.20	.7668	2.20	.3930	2.20	.2063
Clamp truck, conveyor, and wool cart method:						
Clamp truck	.11	.3620	.11	.2046	.13	.1433
Conveyor	.42	.1796	.42	.0942	.42	.0515
Grading table	.42	.0087	.42	.0044	.42	.0023
Wool carts	.42	.2235	.42	.1144	.42	.0597
Portable platform scale	.42	.2710	.42	.1390	.42	.0729
Total	1.79	1.0448	1.79	.5566	1.81	.3297
PACKAGING AND STORING WOOL						
Handtruck and bagging-machine method:						
Bagging machine	.30	.2843	.30	.1483	.30	.0884
2-wheel handtruck	.30	.0194	.30	.0101	.30	.0055
Total	.60	.3037	.60	.1584	.60	.0939
Clamp truck and baling-machine method:						
Conveyor	.22	.1755	.22	.0900	.22	.0473
Clamp truck	.07	.2303	.07	.1302	.07	.0772
Baling machine	.22	.8337	.22	.4237	.22	.2187
Total	.51	1.2395	.51	.6439	.51	.3432
LOADING OUT WOOL						
Handtruck method:						
2-wheel handtruck	.16	.0116	.16	.0060	.16	.0033
Installed platform scale	.08	.3841	.08	.1928	.08	.0971
Core-sampling set	.08	.0278	.08	.0143	.08	.0081
Total	.32	.4235	.32	.2131	.32	.1085
Clamp truck method:						
Clamp truck	.13	.4278	.13	.2438	.14	.1543
Portable platform scale	.13	.0839	.13	.0430	.14	.0243
Core-sampling set	.13	.0279	.13	.0143	.14	.0076
Total	.39	.5396	.39	.3011	.42	.1862

TABLE 13.—*Average productive labor requirements for transporting 1,000 pounds of bagged ungraded wool specified distances, by type of transporting equipment*

Distance (feet)	2-wheel handtruck		Clamp truck	
	Base time	Productive time [1]	Base time	Productive time [2]
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
10	0. 0153	0. 0176	0. 0111	0. 0122
20	. 0250	. 0288	. 0181	. 0199
30	. 0333	. 0383	. 0229	. 0252
40	. 0403	. 0463	. 0264	. 0290
50	. 0472	. 0543	. 0292	. 0321
60	. 0541	. 0622	. 0313	. 0344
70	. 0597	. 0687	. 0334	. 0367
80	. 0653	. 0751	. 0348	. 0383
90	. 0708	. 0814	. 0361	. 0397
100	. 0750	. 0863	. 0375	. 0413
110	. 0791	. 0910	. 0389	. 0428
120	. 0833	. 0958	. 0396	. 0436
130	. 0875	. 1006	. 0403	. 0443
140	. 0916	. 1053	. 0410	. 0451
150	. 0958	. 1102	. 0417	. 0459

[1] Includes 15-percent allowance for fatigue and personal needs.
[2] Includes 10-percent allowance for fatigue and personal needs.

TABLE 14.—*Average productive labor requirements for transporting 1,000 pounds of loose graded wool specified distances in carts*

Distance (feet)	Base time	Productive time [1]
	Man-hours	*Man-hours*
10	0. 0300	0. 0345
20	. 0500	. 0575
30	. 0633	. 0728
40	. . 0750	. 0863
50	. 0867	. 0997
60	. 0983	. 1130
70	. 1100	. 1265
80	. 1217	. 1400
90	. 1333	. 1533
100	. 1450	. 1668
110	. 1567	. 1802
120	. 1683	. 1935
130	. 1800	. 2070
140	. 1933	. 2223
150	. 2067	. 2377

[1] Includes 15-percent allowance for fatigue and personal needs.

TABLE 15.—*Average productive labor requirements for transporting 1,000 pounds of bagged graded wool specified distances, by type of transporting equipment*

Distance (feet)	2-wheel handtruck		Clamp truck	
	Base time	Productive time [1]	Base time	Productive time [2]
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
10	0. 0093	0. 0107	0. 0078	0. 0086
20	. 0140	. 0161	. 0122	. 0134
30	. 0180	. 0207	. 0149	. 0164
40	. 0213	. 0245	. 0173	. 0190
50	. 0240	. 0276	. 0196	. 0216
60	. 0267	. 0307	. 0217	. 0239
70	. 0293	. 0337	. 0235	. 0259
80	. 0320	. 0368	. 0251	. 0276
90	. 0347	. 0399	. 0264	. 0290
100	. 0373	. 0429	. 0275	. 0303
110	. 0400	. 0460	. 0283	. 0311
120	. 0427	. 0491	. 0289	. 0318
130	. 0453	. 0521	. 0293	. 0322
140	. 0480	. 0552	. 0296	. 0326
150	. 0507	. 0583	. 0299	. 0329

[1] Includes 15-percent allowance for fatigue and personnal needs.
[2] Includes 10-percent allowance for fatigue and personnal needs.

TABLE 16.—*Average productive labor requirements for transporting 1,000 pounds of baled graded wool specified distances, by type of transporting equipment*

Distance (feet)	2-wheel handtruck		Clamp truck	
	Base time	Productive time [1]	Base time	Productive time [2]
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
10	0. 0074	0. 0085	0. 0067	0. 0074
20	. 0116	. 0133	. 0108	. 0119
30	. 0151	. 0174	. 0133	. 0146
40	. 0180	. 0207	. 0155	. 0171
50	. 0206	. 0237	. 0172	. 0189
60	. 0227	. 0261	. 0187	. 0206
70	. 0245	. 0282	. 0198	. 0218
80	. 0259	. 0298	. 0208	. 0229
90	. 0272	. 0313	. 0218	. 0240
100	. 0285	. 0328	. 0227	. 0250
110	. 0297	. 0342	. 0235	. 0259
120	. 0309	. 0355	. 0242	. 0266
130	. 0321	. 0369	. 0248	. 0273
140	. 0333	. 0383	. 0252	. 0277
150	. 0344	. 0396	. 0255	. 0281

[1] Includes 15-percent allowance for fatigue and personal needs.
[2] Includes 10-percent allowance for fatigue and personal needs.

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