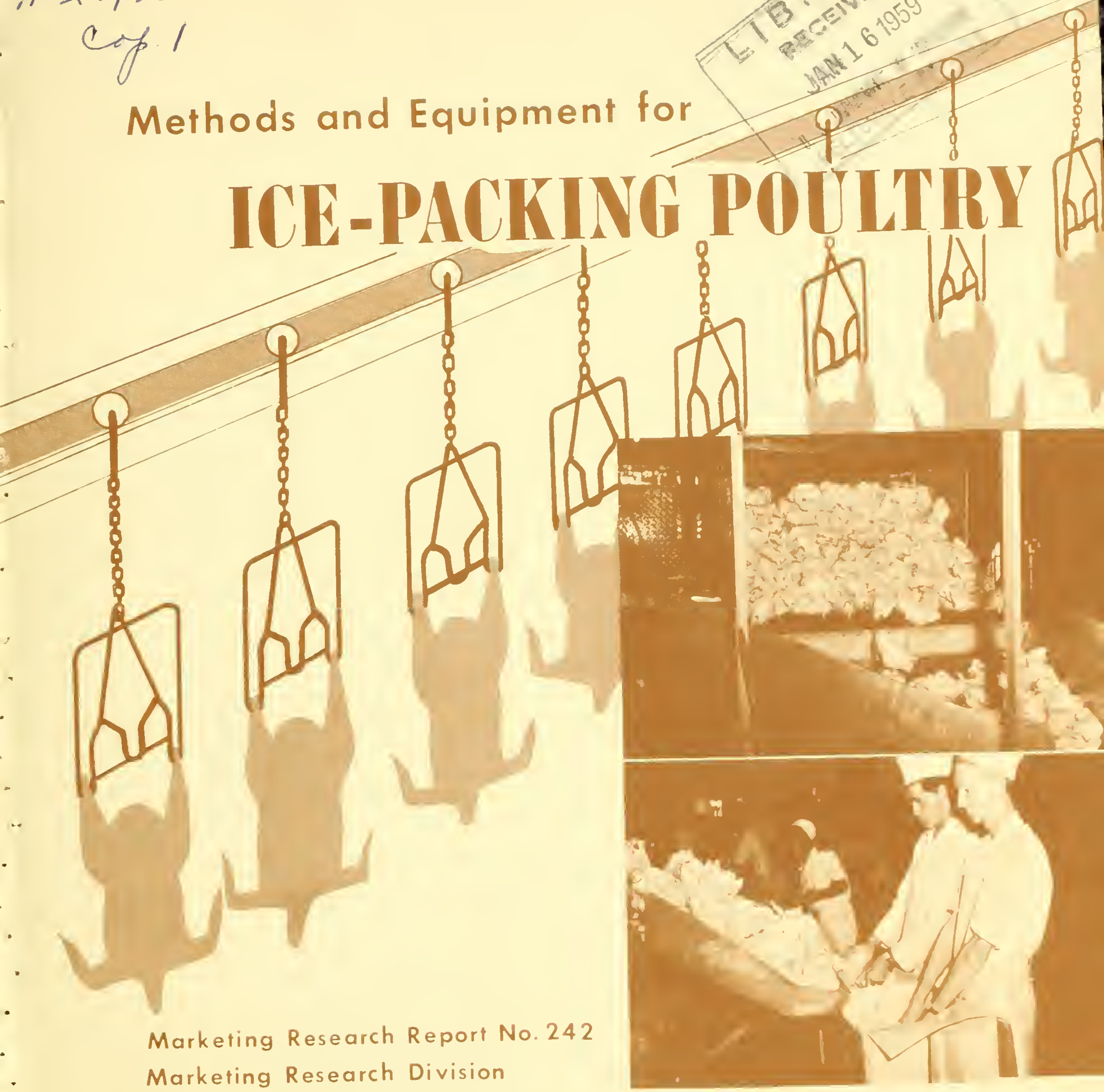
Methods and Equipment for ICE-PACKING POULTRY



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Agricultural Marketing Service
UNITED STATES DEPARTMENT OF AGRICULTURE in cooperation with the
University of Georgia, College of Agriculture Experiment Stations

PREFACE

This report of research on methods and equipment employed in packing ice-packed whole ready-to-cook chicken in Georgia poultry plants is part of a larger project dealing with the more efficient work methods, equipment, and facilities for the off-farm handling, killing, dressing, eviscerating, cutting up, chilling, and packing of poultry. The work was under the supervision of Harold D. White, agricultural engineer, College of Agriculture, University of Georgia, Athens, Georgia, and John A. Hamann, marketing research analyst, Transportation and Facilities Branch, Marketing Research Division, Agricultural Marketing Service, Washington, D. C.

The study covers an area in poultry processing to which very little attention has been given in the past. Research techniques were employed to measure man and machine input requirements and resultant outputs, an approach that has not been previously employed in analyzing these operations.

The authors received valuable suggestions from Fred C. Winter, Professor of Industrial Engineering, Columbia University, and Consulting Engineer to Transportation and Facilities Branch.

The following Georgia poultry processing plants made their plant facilities available for this study:

Athens Poultry, Inc., Athens.
Cagle's, Inc., Atlanta.
Gainesville Fryer, Inc., Gainesville.
Piedmont Poultry, Inc., Gainesville.
Southern Poultry Co., Monroe.
Tennessee Egg Co., Atlanta.
Tugalo Poultry Co., Toccoa.

Childs, Rex Elijah, 1921–

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HIGHLIGHTS

In a plant ice-packing an annual volume of 250,000 boxes of ready-to-cook chicken, a saving of approximately $3,500 per year in labor and equipment costs can be effected by transferring poultry from chill tanks to packing table with a hydraulic tank tipper, equipment that was developed during the course of the study. In addition, the discomfort and fatigue usually associated with the job are greatly reduced.

A further saving of $2,000 can be effected by using an integrated packing line in conjunction with the hydraulic tank tipper. This packing line, developed during the course of the study, provides for excellent drainage of ice and chill water from the carcass and an additional opportunity for check grading the product prior to packing.

The study and evaluation of operations, equipment, and layouts also resulted in developing more efficient crew sizes and general guide lines for packing area layouts and facilities.

In order to provide for the efficient movement of packing materials from storage to packing station, the in-plant location of the storage space in relation to the packing area is an important factor in packing operation efficiency.

The gravity chute method of transporting formed boxes from makeup to packing station is the most economical of several methods. However, the monorail chain or cable conveyor, although only slightly more costly is more versatile in that it can be adapted to almost any layout.

A scale operator can normally weigh and mark each box of packed poultry 33 percent faster than he can weigh and mark the data on a card and staple it to the box end.

Productivity per worker in the box closing operation increases 33 percent when 2 workers, rather than one, close and stack boxes.

Well planned storage areas and proper equipment layout provide for smooth, uninterrupted product flow. Smooth concrete floors, proper floor drains, properly maintained equipment, and adequate lighting are necessary for a safe, sanitary and efficient operation.

METHODS AND EQUIPMENT FOR ICE-PACKING POULTRY

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BACKGROUND OF STUDY

The material in this report is an analysis of methods, techniques, and equipment used in packaging whole ice-packed ready-to-cook chickens. The research was limited to operations involving 3,000 to 5,000 birds per hour. First, an analysis of the existing operations and facilities used in the case study plants was made. Then improved facilities, methods, and equipment were developed and tested for the purpose of increasing operating efficiency. The existing and the new operations were then compared in time and motion studies. The data are in terms of a daily output of 1,000 boxes of poultry (25,000 birds).

North Georgia was chosen for selected case studies because the greatest number of typical commercial poultry plants processing whole ready-to-cook chicken for packing in ice were concentrated in this area. They were convenient to one another and thus lent themselves to comparative studies. Their facilities furnished the proper environment for research and development work.

After an initial survey, the packing area was selected as the most practical area in which to begin research work. The packing operation included receiving, storing, setting up, and distributing wirebound wooden boxes normally used in the ice-packing of whole ready-to-cook chickens. Some exceptions were found, but usually birds weighing up to 2 pounds are packed 30 per box; from 2 to 2½ pounds, 25 per box; and from 2¾ to 3¼ pounds, 20 per box. In this report a box of poultry infers 25 head averaging approximately 60 pounds net weight. The packing operation also includes removing ice-chilled chickens from chill vats, packing birds into containers, weighing boxes of poultry and recording identifying information on box, capping poultry in boxes with crushed or flake ice, closing and securing box lids, and stacking boxes preparatory to shipment or temporary storage (fig. 1).

OBJECTIVES OF THE STUDY

This study was made to determine the most efficient and economical methods and equipment to use in packing ice-packed whole ready-to-cook chickens in plants with a volume of 25,000 to 40,000 chickens per day. The sequential breakdown was as follows: (1) Measure the efficiency of currently used methods and equipment, (2) make improvements in methods and techniques where possible, (3) adapt existing commercial equipment to packing operations where applicable, (4) develop and construct new equipment where the need existed and commercial equipment was not available, (5) incorporate into packing methods and equipment those features that were conducive to maintaining quality of product, and (6) compare existing work methods and equipment with the improved methods and equipment developed during the study.

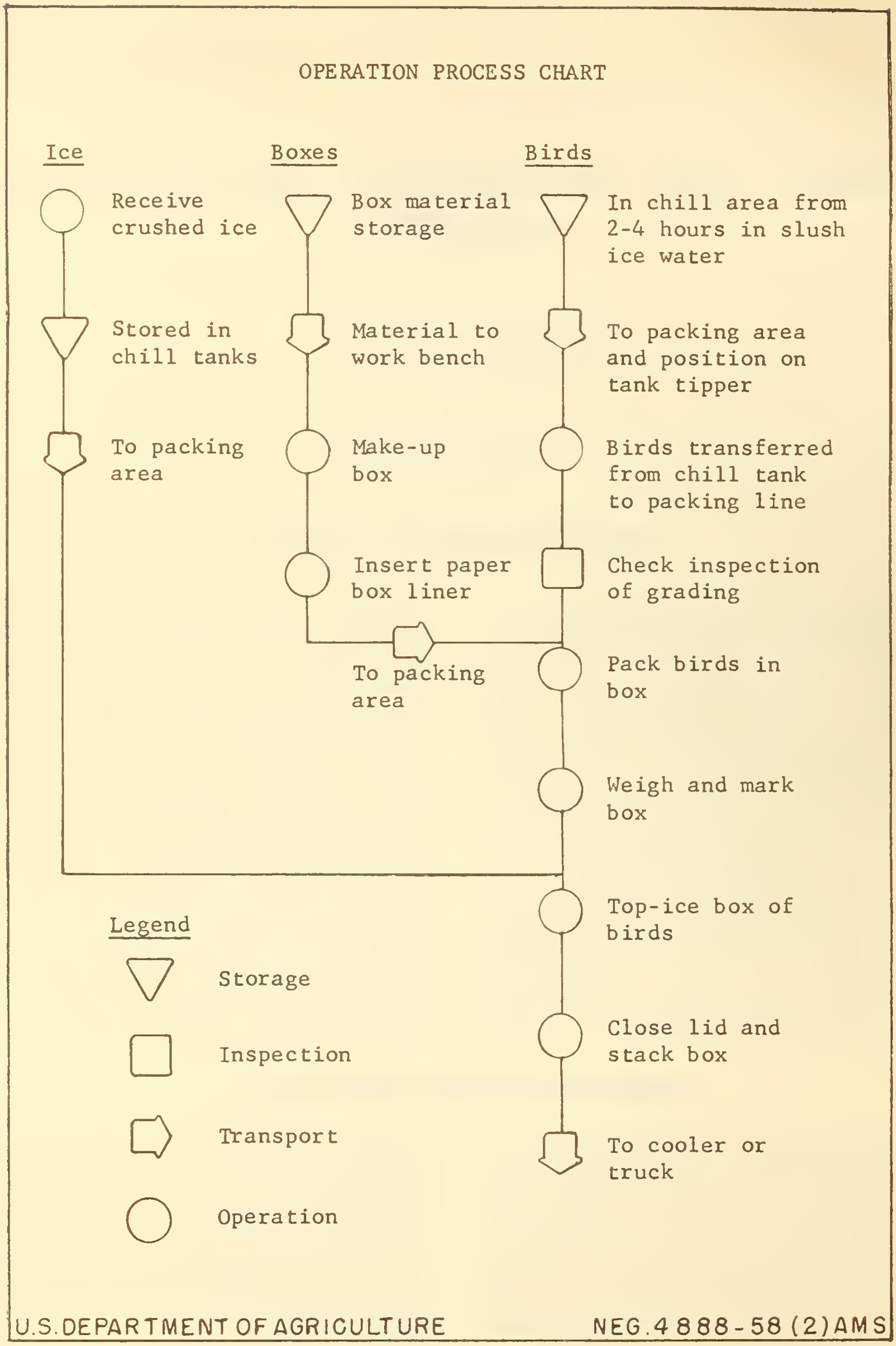

Figure 1. A process chart of a poultry packing operation.

PACKING MATERIALS HANDLING

Whole ready-to-cook chickens were packed in wirebound wood veneer boxes having overall outside dimensions of approximately 24 inches in length, 18 inches in width, and 9 inches in depth. Each container was lined with a paper liner and capped with crushed or flake ice before being wired shut.

Receiving

Wirebound wood boxes were received at poultry processing plants collapsed or knocked down in 10-box bundles weighing about 60 pounds. The bundles, bound together by a wire near each end, were approximately 2 feet wide, 4½ feet long, and occupied 9 square feet of floor space.

For ease of stacking and removing from stack, bundles of boxes should be stacked approximately 5 feet high (fig. 2). Stacking at this height, a van load of boxes (250 bundles) can be stacked in an area 11 by 25 feet (fig. 3). Where storage space is limited, box material can be stacked higher, but there will be additional labor costs.

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Figure 2. Stacking poultry boxes.

Wirebound wood boxes were usually received direct from the factory by auto truck. In some instances where spurs were available, shipments were received by rail. Truck loads varied from 240 to 300 bundles, and a railroad car held approximately 600 bundles.

The labor requirement for manually unloading 100 bundles was 0.74 man hour (table 1). Receiving facilities studied included a receiving dock, truck bed height. The average distance from truck to storage area was 30 feet. Under these conditions the elapsed time required to perform the job of manually unloading, transporting, and stacking the material in 5-foot stacks was also 0.74 hour. At a labor rate of $1.25 per hour (Appendix, page 33), this amounted to less than $0.001 per box.

Where storage areas were not as accessible or where unloading docks were not of proper height, the receiving labor and equipment costs increased (fig. 4).

Since the labor required to receive and store knocked-down boxes was very small and truck or carload quantities were delivered at intermittent intervals, expensive power equipment did not appear to be justified for receiving, transporting, and storing boxes.

Where power equipment was already on hand it was used effectively when the storage area was 50 to 100 feet from the receiving dock. Generally, the storage area was convenient to the unloading area in plants especially designed for poultry processing.

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Figure 3. Poultry boxes stacked in storage.

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Figure 4. Unloading poultry boxes mechanically.

TABLE 1.—*Labor required by one worker to unload and stack manually the equivalent of 1,000 empty wirebound boxes* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Walk empty from storage to truck	*Hours*	*Man-hours* 0. 28
Take bundle from stack and turn around		. 12
Walk with bundle to storage and stack bundle		. 34
Total labor		. 74
Total elapsed hours	[2] 0. 74	

[1] One worker walks into the truck, picks up a bundle, carries it 30 feet to storage and puts it on the stack. Each bundle consists of 10 knocked-down boxes.

[2] A rate of 1,351 boxes unloaded per elapsed hour.

Box liners of wax or parchment paper used to line ice-packed poultry boxes were received in cartons of 500 sheets per box. At least a month's supply of 50 to 100 bundles were in one delivery. Under normal operating conditions a typical plant would use only about 2 to 4 bundles per day. Thus the cost of receiving and storing liners for 1,000 boxes (2 bundles) was negligible.

Storage

The location of the packing material storage area in relation to packing operations was important because it had a significant bearing on the methods used to move packing material from the storage and makeup area to the packing area.

Special construction was not necessary for packing material storage; however, the material had to be kept free of dust, moisture, and rodents and insects, with provision for winter heating and summer cooling for employee comfort. Where storage areas were located over the processing operations, the floor was required to be dust tight. This was accomplished by a double floor laminated with building paper or a tight fitting ceiling over the processing area, so that dirt couldn't sift through and contaminate poultry (in accordance with Regulations of the United States Department of Agriculture).

Forming and Transporting Boxes to Packing Station

To minimize extra handling of packing materials, boxes were normally made up or formed in the storage room. The tools required for this operation were a pair of wire cutters for opening bundles and a wirebound box makeup tool to secure the wire loop fasteners (fig. 5).

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Figure 5. Box makeup tools: Wire cutter and wirebound box makeup tool.

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Figure 6. Making up wirebound boxes.

A bundle of the knocked-down boxes from storage was generally placed on a low makeup table. After the two tie wires were cut and removed, box ends were bent into place and wire fasteners were positioned and secured with the wirebound box makeup tool. The operation was performed on top of an opened bundle; thus, the forming operation was performed at about waist height (figs. 5 and 6).

Manual Transport

The procedure used in forming wirebound boxes was about the same throughout the plants studied.

Four different methods of transporting the boxes to the packing area were used: (1) Carried by hand, (2) transported by 4-wheel hand truck, (3) transported by gravity chute, and (4) transported by monorail conveyor.

The labor required for a 2-man crew to form 1,000 boxes and manually transport them 40 feet to packing station was 10.84 man-hours in 5.42 elapsed hours (table 2). Since the boxes had to be stacked before transporting, the lids were closed and secured with one hook. This element of work required 0.8 man-hour. The manual transport of boxes (fig. 7) to the packing station required 1.68 man-hours of labor; thus, although no equipment was required, 2.48 man-hours, or 22.9 percent of the total labor was required due to the absence of transport equipment. This method is usually employed where the plant layout is such that better methods cannot be used. The normal production rate for a 2-man crew using the manual transport method was 185 boxes per elapsed hour.

TABLE 2.—*Labor required for a 2-man crew to form 1,000 wirebound boxes and transport manually to packing station* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Manually transport boxes 15 feet from storage to work bench	*Hours*	*Man-hours* 0. 50
Clip and remove wire binders		. 49
Form boxes:		
Make up box		3. 74
Move box to lining station		. 74
Line formed boxes:		
Insert paper liner [2]		1. 70
Close lid, secure one hook		. 80
Set box aside on stack		. 74
Manually transport 5-high stacks of formed boxes 40 feet, position at packing station and return to box forming station		1. 68
Total productive labor		10. 39
Unproductive labor:		
Box former waits on supplier		. 45
Total labor		10. 84
Total elapsed hours	[3] 5. 42	

[1] One worker clips and puts aside wire binders, forms boxes and moves them to lining station. Second crewman transports bundles of knocked-down boxes from storage to box makeup bench, inserts liner in made-up boxes, closes and fastens lids, stacks boxes, carries 5-high stacks to packing area, and returns to box lining station.

[2] One rectangular sheet of paper inserted lengthwise of box.

[3] A rate of 185 boxes formed and delivered to packing station per elapsed hour.

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Figure 7. Carrying boxes to packing area.

In a period of 5.42 elapsed hours a 2-man crew required 10.84 manhours to form 1,000 wirebound boxes and manually transport them 40 feet to the packing station.

The operation is handled as follows: One worker supplies bundles of boxes to makeup bench and inserts paper liners into made-up boxes, closes box lids, stacks them 5 high, carries them 40 feet to the packing station, and returns to the box forming station. A second worker clips binding wire on bundles of boxes and discards the wire; then forms the boxes and sets them aside for the lining station.

The labor cost for the operation computed at $1.25 per hour (Appendix, page 33) was $13.55. Since the equipment involved was insignificant, $13.55 represents the total cost (table 6).

4-Wheel Hand Truck

Labor required for a 2-man crew to form and transport 1,000 boxes 40 feet to the packing station by 4-wheel hand truck is shown in table 3. Lids also had to be closed and secured. The use of transport equipment (fig. 8) reduced the transport time to 0.62 man-hour (table 3). Although the addition of the lid closing time increased the labor required for this mode of transport by 1.40 man-hours, it required 1.06 man-hours less labor and 0.08 man-hour less idle time than the manual transport method. These savings were due largely to fewer trips to the packing station.

The use of three 4-wheel hand trucks for transporting 1,000 boxes to the packing station reduced the elapsed time to 4.85 hours. Thus, the resulting labor requirement for a 2-man crew was 9.70 man-hours with a total of 14.55 machine-hours for the hand trucks.

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Table 3.—*Labor required for a 2-man crew to form 1,000 wirebound boxes and transport to packing station by 4-wheel hand truck* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Manually transport 1,000 boxes 15 feet from storage to work bench	*Hours*	*Man-hours* 0.50
Clip and remove wire binders		.49
Form boxes:		
Make up boxes		3.74
Move box to lining station		.74
Line formed boxes:		
Insert paper liner [2]		1.70
Close lid, secure 1 hook		.80
Set box aside on stack on 4-wheel truck		.74
Transport three 7-high stacks of formed boxes 40 feet on 4-wheel hand truck and position at packing station		.32
Push empty 4-wheel hand truck from packing station to box lining station [3]		.30
Total productive labor		9.33
Unproductive labor:		
Box former waits on supplier		.37
Total labor		9.70
Total elapsed hours	[4] 4.85	

[1] One worker forms and moves box to lining station. Second crewman transports material to workbench, clips and asides wire binders, inserts liner, closes and fastens lid, stacks box on 4-wheel hand truck, pushes three 7-high stacks of boxes to packing station, and returns with an empty 4-wheel hand truck to lining station.

[2] One rectangular sheet of paper inserted lengthwise of box.

[3] Three 4-wheel hand trucks are used so that boxes do not have to be unloaded at packing station at time of delivery.

[4] A rate of 206 boxes formed and delivered to packing station per elapsed hour.

The 2-man box makeup and supply operation was handled the same as when manual transport was employed except that the worker who supplies bundles to the makeup bench also clips and removes the tie wires and uses three hand trucks alternately to transport the made-up boxes to the packing station. The addition of three 4-wheel hand trucks to the operation added $0.08 to the cost of making up and supplying 1,000 boxes, but the labor cost at $1.25 per hour (Appendix, page 33) was reduced to $12.12, thereby reducing the overall cost to $12.20 (table 6). The 4-wheel hand truck method of transporting boxes was used only where the particular layout prohibited the use of better methods and where adequate aisle space was available for truck movement from box forming station to packing station.

BN5813

Figure 8. Hand trucking boxes to packing area.

Gravity Chute

One of the least expensive ways to transport boxes to the packing area is by gravity conveyor or chute (fig. 9). If boxes are formed on a higher elevation than the packing area, a gravity chute can be installed at small cost with practically no maintenance cost for several years. Where the descent to the packing area is great enough and sharp turns are not involved, the chute can be constructed of smooth pipe, steel rods, or sheet metal. Where the descent is slight or where sharp turns are required, it is best to build the bottom of the chute out of wheel-type conveyor at additional cost. The examples cited in this report are based on a chute with bottom constructed of wheel-type conveyors.

Some advantages of using the gravity chute were: (1) Ownership and operating cost was low. (2) Labor to transport boxes from forming station to packing station was not required. (3) Box lids did not have to be closed to be transported to packing station. (4) The chute was constructed to position the box in a handy position for the packer, thus keeping the time required to obtain boxes at a minimum.

Some disadvantages of using the gravity chute were: (1) The work station for forming boxes was "fixed"; that is, it could not be moved closer to

BN5814

Figure 9. Transporting boxes to packing station by gravity chute.

the stacks of material as the stack diminished. Therefore, the stacks of knocked-down boxes had to be stored near the work station or additional labor would have been required to supply boxes to the forming station. (2) The gravity chute could be used only if boxes were formed adjacent to and at a higher level than the packing area. (3) In some layouts the chute could not be used because it would take up space required for other purposes. (4) The gravity chute could not be used where boxes were formed at a lower level than the packing station without additional equipment.

TABLE 4.—*Labor required for a 2-man crew to form 1,000 wirebound boxes and transport to packing station by gravity chute* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Manually transport boxes 15 feet from storage to work bench	*Hours*	*Man-hours* 0. 50
Clip and remove wire binders		. 49
Form, line, & supply boxes:		
Make up boxes		3. 74
Insert paper liner [2]		1. 70
Set box aside in gravity chute		. 74
Total productive labor		7. 17
Unproductive labor		None
Total elapsed hours	[3] 3. 59	

[1] Crewmen work independently of each other, one stationed on each side of the gravity chute.
[2] One rectangular sheet of paper inserted lengthwise of box.
[3] A rate of 278 boxes formed and conveyed to packing station per elapsed hour.

Since no labor was used for transporting boxes by the gravity chute, the total labor required to form 1,000 boxes was reduced to 7.17 man-hours and wait time was eliminated (table 4).

The two men making up and supplying boxes worked independently of each other on each side of the chute. Each worker provided his own supply of knocked-down boxes to the workbench, removed wire binders, made up and lined boxes, and placed them into the gravity chute. The elapsed time was 3.59 hours during which boxes were formed and delivered to the packing station at a rate of 278 per hour. The equipment cost for 3.59 machine-hours amounted to only $0.06, based on the use of 40 feet of gravity chute (table 6). The labor at $1.25 per hour (Appendix, page 33) amounted to $8.96 for a total equipment and labor cost of $9.02.

Monorail Conveyor

An improved method for transporting boxes from forming station to packing station in large volume plants was the overhead monorail cable conveyor with suspended forks or carriers on which the boxes were conveyed past the packer in a continuous procession (fig. 10). This method could be adapted to almost any layout.

Advantages of the overhead monorail conveyor were: (1) Box lids did not have to be closed for boxes to be moved. (2) Boxes could be conveyed from any level, either above or below the packing area. Thus, the box makeup room did not have to be within the immediate vicinity or at a level above the packing area. (3) Overhead space was used, leaving floor space available for other uses. (4) The conveyor could extend the entire length of box material storage rooms, thus reducing walk time to and from storage area. (5) The conveyor—usually a minimum of 100 feet in length—held a large reserve of boxes, assuring a ready supply to the packers at all times. (6) More

BN5815

Figure 10. Transporting boxes to packing station by monorail cable conveyor with suspended carriers.

than one operator could form boxes without worker interference. (7) More than one packing line could be supplied by one conveyor. (8) The conveyor could be speeded up or slowed down in coordination with the need for boxes.

Carriers on the conveyor were spaced about 4 feet apart. Since the boxes were 2 feet long, the spacing left a 2-foot clearance between boxes on the line, thus avoiding a jam at sharp turns or dips. The conveyor traveled at a speed sufficient to more than keep the packers supplied with boxes. If the boxes were not needed they passed by the packing station and made the circuit again. The operator who formed boxes maintained a reserve supply on hand; thus, each carrier could be kept loaded even though the forming operation was interrupted occasionally.

The labor requirement for forming, lining, and supplying 1,000 boxes was 6.67 man-hours (table 5). This was the same as the labor required in the chute method of supplying boxes. However, since the distance between box storage and the forming station was less than where the forming station was in a fixed position, the labor of supplying boxes from storage was reduced to 0.33 man-hour and the elapsed time was reduced to 3.5 hours.

In using a monorail cable conveyor to transport 1,000 wire-bound boxes to the packing station in the box makeup and supply operation, the workers in a 2-man crew operate independently of each other. They each obtain their own supply of knocked-down boxes, form, insert a box liner, and move the made-up box to one of the conveyor carriers.

Although the equipment cost, at $0.24 per 1,000 boxes, was 4 times greater than the chute method, the overall cost of equipment and labor was $0.03 less than the chute method (table 6).

The cost for forming and transporting 1,000 boxes by the manual or 4-wheel hand truck method amounted to $3.18 to $4.56 more than by gravity chute or monorail cable conveyor (table 6). This is about a 25 to 35 percent higher cost. For this reason the manual and 4-wheel hand truck methods of transporting boxes to the packing station should be used only where the plant layout does not permit the use of the better methods.

Where a 2-man crew was used, the cost for forming 1,000 boxes and transporting by gravity chute was practically the same as by monorail

TABLE 5.—*Labor required for a 2-man crew to form 1,000 wirebound boxes and transport to packing station by monorail cable conveyor with suspended carriers* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Manually transport boxes 5 feet from storage to work bench	*Hours*	*Man-hours* 0.33
Clip and remove wire binders		.49
Form, line, & supply boxes:		
Make up boxes		3.74
Insert paper liner [2]		1.70
Set box aside on suspended carrier		.74
Total productive labor		7.00
Unproductive labor		None
Total elapsed hours	[3] 3.50	

[1] Crewmen work independently, each supplying his own material, forming and placing boxes on conveyor.
[2] One rectangular sheet of paper inserted lengthwise of box.
[3] A rate of 286 boxes formed and conveyed to packing station per elapsed hour.

TABLE 6.—*Comparative labor and equipment costs and hourly production rates for a 2-man crew to form 1,000 wirebound boxes and transport 40 feet to packing station by specified methods and types of equipment* [1]

Method	Elapsed time required	Production rate per hour	Labor and equipment costs		
			Labor [2]	Equipment	Total
	Hours	*Boxes*	*Dollars*	*Dollars*	*Dollars*
Manually transport	5.42	185	13.55	[3] 0.00	13.55
Transport by 4-wheel truck	4.85	206	12.12	[4] .08	12.20
Transport by gravity chute	3.59	278	8.96	[5] .06	9.02
Transport by monorail cable conveyor	3.50	286	8.75	[6] .24	8.99

[1] Based on sufficient volume for 2,000 hours' operation annually.
[2] Wage rate $1.25 per hour (Appendix, page 33).
[3] Cost of small wooden table and box forming tools per 1,000 boxes is negligible for practical purposes.
[4] Three hand trucks in continuous use at $0.0058 per truck hour (Appendix, table 26).
[5] 40-foot gravity chute with wheel conveyor bottom in continuous use at $0.0188 per hour (Appendix, table 26).
[6] 100 feet of monorail cable conveyor with 25 carriers in continuous use at $0.0687 per hour (Appendix, table 26).

cable conveyor when based on 100 linear-feet-of monorail conveyor and 40 feet of gravity chute with wheel conveyor sections for a bottom (table 6). Although more labor was required when using the gravity chute, it was offset by higher equipment cost for the use of the monorail. A production rate of a 2-man crew for providing boxes was 278 per hour when using the gravity chute and 286 boxes per hour when using the monorail cable conveyor with suspended carriers.

The production rate of one worker using either the gravity chute or monorail cable conveyor system of transporting boxes was one-half that of a 2-man crew since each member worked independently. However, the gravity chute is more economical with a 1-man crew because of the initial cost of the monorail cable conveyor. Therefore, peculiarities of the individual plant layout, and volume handled would determine which of the two systems to use.

PRODUCT HANDLING METHODS

Transfer of Poultry From Chill Tanks to Packing Table

USDA regulations require that body temperature of fresh-dressed and eviscerated poultry be reduced to 40° F. or less before packing. Chilling is accomplished by submerging the birds in slush ice for approximately 2 hours. In this study, tanks used for this operation were approximately 5 feet long, 3 feet wide, and 2½ feet deep, and, in most instances, were mounted on casters. The gross weight of the tank, ice, water, and birds was about 1,200 pounds. The poultry was transferred from the chill tank onto a table for packing. This positioned the birds for packing and permitted the release of trapped water from the body cavity of eviscerated poultry.

Manual Transfer

A tank of chilled poultry from which the water had been drained was positioned beside the packing table and the poultry was manually tossed onto the table (fig. 11).

BN 5816

Figure 11. Manually emptying a tank of poultry.

Labor required for a 2-man crew to manually transfer the equivalent of 1,000 boxes of poultry from chill tanks onto a packing table was 13.89 man-hours (table 7).

On smooth concrete floors using chill tanks equipped with full-sized wheels, an empty tank could be rolled aside and a full tank, weighing approximately one-half ton, positioned by one man. However, if tank wheels were worn or the floor was uneven or rough, or where any combinations of these conditions existed, two or more persons were required to push a full tank of birds.

Table 7.—*Labor required for a 2-man crew to manually transfer the equivalent of 1,000 boxes of poultry from chill tanks to packing table* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Obtain and position full tank of birds	*Hours*	*Man-hours* 0.38
Toss birds out of tank		13.33
Push empty chill tank aside		.18
Total productive labor		13.89
Unproductive labor		None
Total elapsed hours	[2] 6.95	

[1] Two-man crew walks 10 feet, pushes and positions tank of poultry to packing station, empties same by reaching into tank, grasping 2 or more birds at a time, tosses them onto packing table until all poultry (375 birds per tank average) is removed, pushes empty tank 10 feet from packing station en route to next full tank.

[2] A rate of 3,597 birds transferred to packing table per elapsed hour.

The total cost for a 2-man crew to transfer chilled poultry manually from chill tanks onto a packing table amounted to $17.36 per 1,000 boxes (table 9). All of this amount was charged to labor since no equipment was involved.

Hydraulic Tank Tipper

This piece of equipment was developed during the course of the study (Equipment Development, page 20). It occupied a fixed position at the poultry packing table and provided a set of runners

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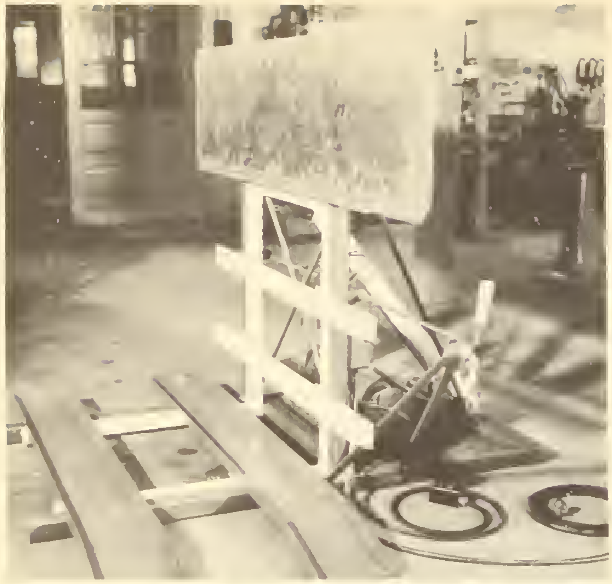


BN 5817

Figure 12.—Hydraulic tank tipper.

similar to an auto grease rack to serve as a loading ramp (fig. 12). After a full tank of poultry was positioned and secured on the rack, a hydraulic lift rotated the tank in a 114-degree arc which was sufficient to cause chilled poultry to slide from the tank. A tank of poultry could be raised, spilled onto the packing table, and the empty tank lowered, all in less than one minute.

Only 2 man-hours were required for emptying the equivalent of 1,000 boxes of poultry from chill tanks onto a packing table with a 1-man crew using the tank tipper (table 8). Under normal operating conditions this amount of work would be performed during a 5- to 7-hour period. The tipper operator had spare time between dumping times of tanks for performing other related jobs in the vicinity. Since only that time actually engaged in the tank emptying was charged to the operation, the total labor and equipment cost for emptying the equivalent of 1,000 boxes of birds from chill tanks was only $3.06 (table 9).

TABLE 8.—*Labor required for a worker to transfer the equivalent of 1,000 boxes of poultry from chill tanks to a standard packing table using the hydraulic tank tipper* [1]

Time item	Elapsed time required	Labor required
Productive labor:	*Hours*	*Man-hours*
Obtain and position full tank of birds		0.67
Raise, empty, and lower tank by hydraulic tipper		.56
Push empty chill tank aside		.20
Total productive labor		1.43
Unproductive labor:		
Operator waits for table to be cleared [2]		.57
Total labor		2.00
Total elapsed hours	[3] 2.00	

[1] Worker walks 10 feet, pushes and positions a tank of poultry onto tank tipper rack, empties tank by use of tipper, and pushes empty tank 10 feet from tipping station en route to next full tank.

[2] A tank of one size birds has to be completely packed before another size is spilled onto packing table.

[3] A potential rate of 12,500 birds transferred to packing table per elapsed hour.

Comparison of Manual and Mechanical Methods of Chill Tank Emptying

The total labor and equipment cost of $3.06 for transferring the equivalent of 1,000 boxes was about 82 percent lower for a 1-man tipper operation when compared with $17.36 for a 2-man manual operation (table 9).

In addition to lower labor and equipment costs, the tipper reduced worker discomfort and fatigue.

TABLE 9.—*Comparative labor and equipment costs for transferring the equivalent of 1,000 boxes of poultry from chill tanks to packing table by specified methods and types of equipment*

Method	Crew size	Elapsed time required	Labor cost [1]	Equipment cost [2]	Total cost
	Men	*Hours*	*Dollars*	*Dollars*	*Dollars*
Manually empty chill tanks	2	6.95	17.36	0.00	17.36
Empty chill tanks with hydraulic tank tipper	1	2.00	2.50	.56	3.06

[1] Wage rate $1.25 per hour (Appendix, page 33).

[2] Since chill tanks are charged to chilling operation, no equipment is chargeable except tank tipper at $0.28 per hour in use (Appendix, table 26.)

Packing

In most instances poultry was packed from a table 5 to 6 feet wide and 8 to 10 feet long. Provisions were made in the table design for water and ice to drop from the birds through a grid or slots in the table top.

Boxes in which poultry was packed were conveyed to the packing station with liners in place and lids open (fig. 13).

After the poultry was packed (fig. 14), it was conveyed directly onto scales for weighing.

Two general methods or arrangements of equipment were employed in packing—a straight line flow of product and a right angle flow.

Straight Line Flow and Standard Packing Table

In this method poultry passed across the packing table and was conveyed onto the scale without changing the direction of product flow (fig. 15). Skate wheel or roller conveyors starting from both ends of the front side of the packing table merged into one line at a point about 10 feet from the packing table. A scale equipped with a conveyor platform was placed in the line immediately after the junction of the two conveyors.

The empty poultry box was placed against the packing table on the conveyor. Birds were moved in an arc of 90 degrees or more from table to box.

The labor requirement for a 2-man crew to pack the equivalent of 1,000 boxes of poultry using the straight line product flow method was 12.81 man-hours in 6.40 hours of elapsed time (table 10). The cost of packing equipment amounted to $0.57 per 1,000 boxes of poultry, making the total labor and equipment cost amount to $16.58 (table 13). This is based on a wage rate of $1.25 per hour (Appendix, page 33) and includes 20 feet of roller conveyor and a standard packing table (Appendix, table 26).

Right Angle Flow and Standard Packing Table

In this method the flow of product made a 90 degree turn after packing.

When using a standard packing table with the right angle flow of product, a roller conveyor runs parallel to the packing table (fig. 16). Opened boxes are positioned on it and the packers stand between the table and conveyor, swinging each bird in a 180-degree arc from table to box.

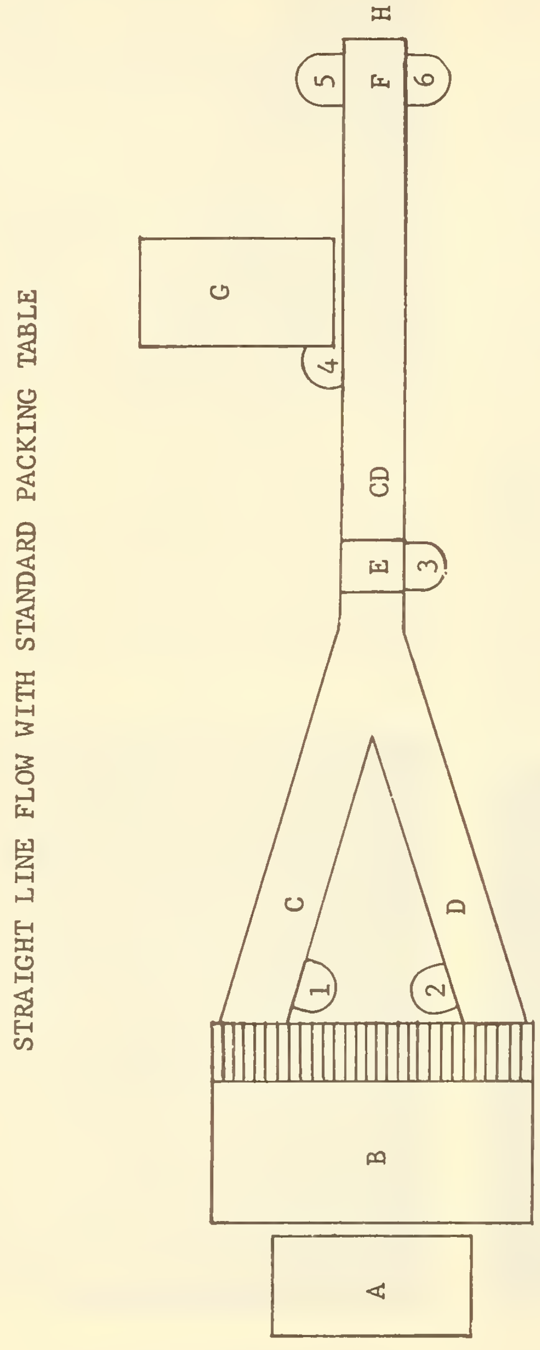
A 2-man crew using right angle flow of product and a standard packing table required 12.48 man-hours to pack 1,000 boxes, the equivalent of 25,000 birds (table 11). Total labor and equipment cost for the 2-man crew to pack this volume was $16.13 (table 13). The equipment included a standard packing table and 15 feet of roller conveyor (Appendix, table 26). Labor costs were figured at $1.25 per hour (Appendix, page 33).

BN5818

Figure 13. Empty box with liner in place.

BN5819

Figure 14. Packed poultry ready for weighing.



Flow of Product

Birds are transferred from chill tank A onto packing table B and are packed into boxes on conveyors C and D at stations 1 and 2. The boxes move long the roller conveyors C and D by gravity and manual help to scale E where weight is recorded on container by operator at work station 3; then boxes of poultry are moved along roller conveyor CD to work station 4 where they are iced from vat G. Lids are closed at F and boxes are stacked at H by workers at stations 5 and 6.

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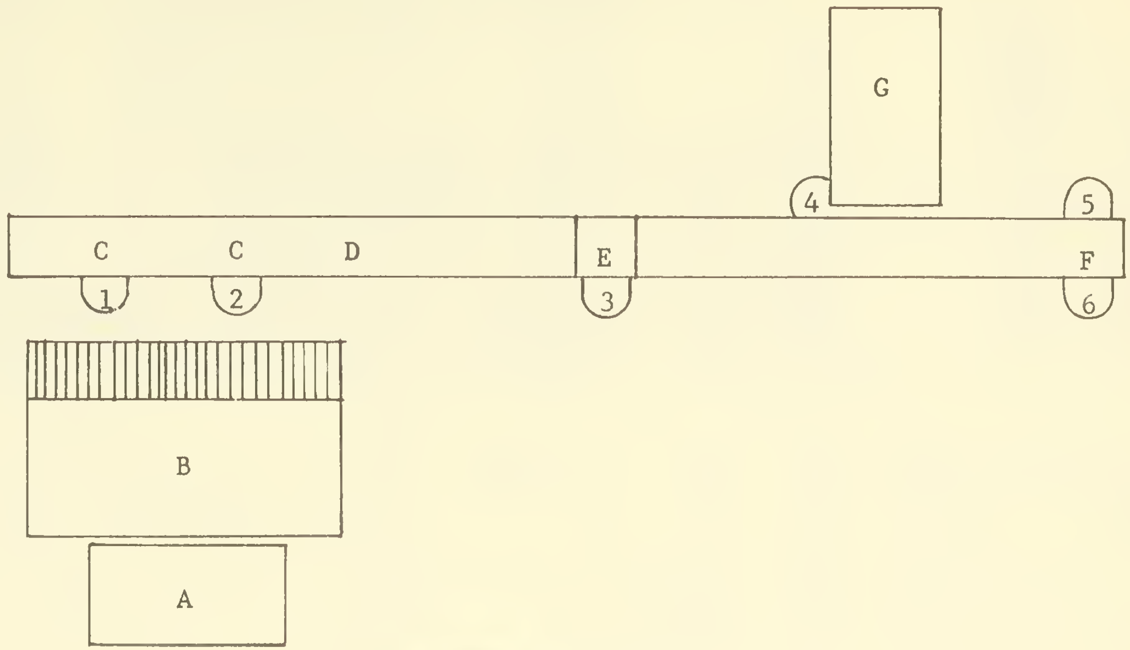
Figure 15. Straight line flow method of packing poultry employing the standard packing table.

RIGHT ANGLE FLOW WITH STANDARD PACKING TABLE



Flow of Product

Birds are transferred from chill tank A onto packing table B, and are packed into boxes at points C on conveyor D from work stations 1 and 2. The boxes move along roller conveyor D parallel to the packing table to scale E where weight is recorded on container by operator at work station 3. Containers are then moved to station 4 where they are top iced from vat G. Lids are closed at point F and boxes are stacked at point H by operators at work stations 5 and 6.

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Figure 16. Right angle method of packing poultry employing standard packing table.

Table 10.—*Labor required for a 2-man crew to pack 1,000 boxes of poultry using a standard packing table and straight line product flow* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Push full box aside, position empty box for packing	*Hours*	*Man-hours* 2. 23
Pack poultry		10. 58
Total productive labor		12. 81
Unproductive labor		None
Total elapsed hours	[2] 6. 40	

[1] Two packers work independently of each other—obtain empty box from chute, pack 25 birds into box, and push full box aside.
[2] A rate of 156 boxes of poultry packed per elapsed hour.

Table 11.—*Labor required for a 2-man crew to pack 1,000 boxes of poultry using a standard packing table and right angle product flow* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Push full box aside, position empty box for packing	*Hours*	*Man-hours* 2. 23
Pack poultry		10. 25
Total productive labor		12. 48
Unproductive labor		None
Total elapsed hours	[2] 6. 24	

[1] Two packers work independently of each other—obtain empty boxes from chute and pack 25 birds into box—but the workers must complete cycle together so the two boxes of poultry can be pushed aside simultaneously.
[2] A rate of 160 boxes of poultry packed per elapsed hour.

Right Angle Flow and Integrated Packing Line

The product flow also made a 90-degree turn after packing when the integrated packing line was used (fig. 17). The packing line was developed to increase packing operation efficiency. This was accomplished by: (1) A more uniform flow of product reducing crew wait time, (2) advantageous bird position for packing, (3) a constant and minimum reach, and (4) empty boxes being conveyed directly into packing position with lids open and liners in place ready to receive birds. The integrated packing line also provided adequate carcass draining time and permitted a final inspection during the time the poultry traveled up an inclined conveyor to the packing station.

In using the integrated packing line, chill tank loads of poultry were dumped into a hopper and metered out onto an inclined belt conveyor that positioned birds on an apron-like shelf at packing height.

The labor required for a 2-man crew to pack 25,000 birds, the equivalent of 1,000 boxes, from the integrated packing line was 10.41 man-hours in 5.20 elapsed hours (table 12).

Cost of owning and operating this equipment—the gravity hopper, a belt conveyor with packing apron, and 15 feet of roller conveyor—amounted to $1.70 per 1,000 boxes packed. The total labor cost (at $1.25 per hour) was $13.01, making a total labor and equipment cost of $14.71 per 1,000 boxes (table 13).

Table 12.—*Labor required for a 2-man crew to pack 1,000 boxes of poultry using the integrated packing line and right angle product flow* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Push full box aside, position empty box for packing	*Hours*	*Man-hours* 2. 18
Pack poultry		8. 23
Total productive labor		10. 41
Unproductive labor		None
Total elapsed hours	[2] 5. 20	

[1] Two crewmen work together—each packing one-half the contents of separate boxes. As second packer pushes full box aside, first packer pushes one-half filled box to second packer and simultaneously positions empty box for himself.
[2] A rate of 192 boxes of poultry packed per elapsed hour.

Comparison of Packing Methods

When packing from a standard table, the right angle flow of product was generally preferred to the straight line flow because: (1) Empty boxes were more easily conveyed to the packers, (2) boxes could be moved back and forth along the conveyor to keep them adjacent to a supply of birds, thus keeping the distance between birds and box at a minimum, and (3) when using the straight line flow, boxes jammed at the point along the conveyor just prior to the scale where the two conveyors merged into one. However, in some instances, the plant layout dictated the method that could be used.

Table 13 illustrates the labor and equipment costs for a 2-man crew to pack 1,000 boxes of poultry, the equivalent of 25,000 birds, using: (1) straight line flow with a standard packing table, (2) right angle flow with a standard packing table, and (3) right angle flow with the integrated packing line.

When using a 2-man crew, the right angle product flow method was slightly better than the straight line flow when packing from a standard table. However, the integrated packing line was even better since the elapsed time was reduced to 5.20 hours from 6.24 when compared with the standard packing table with right angle flow.

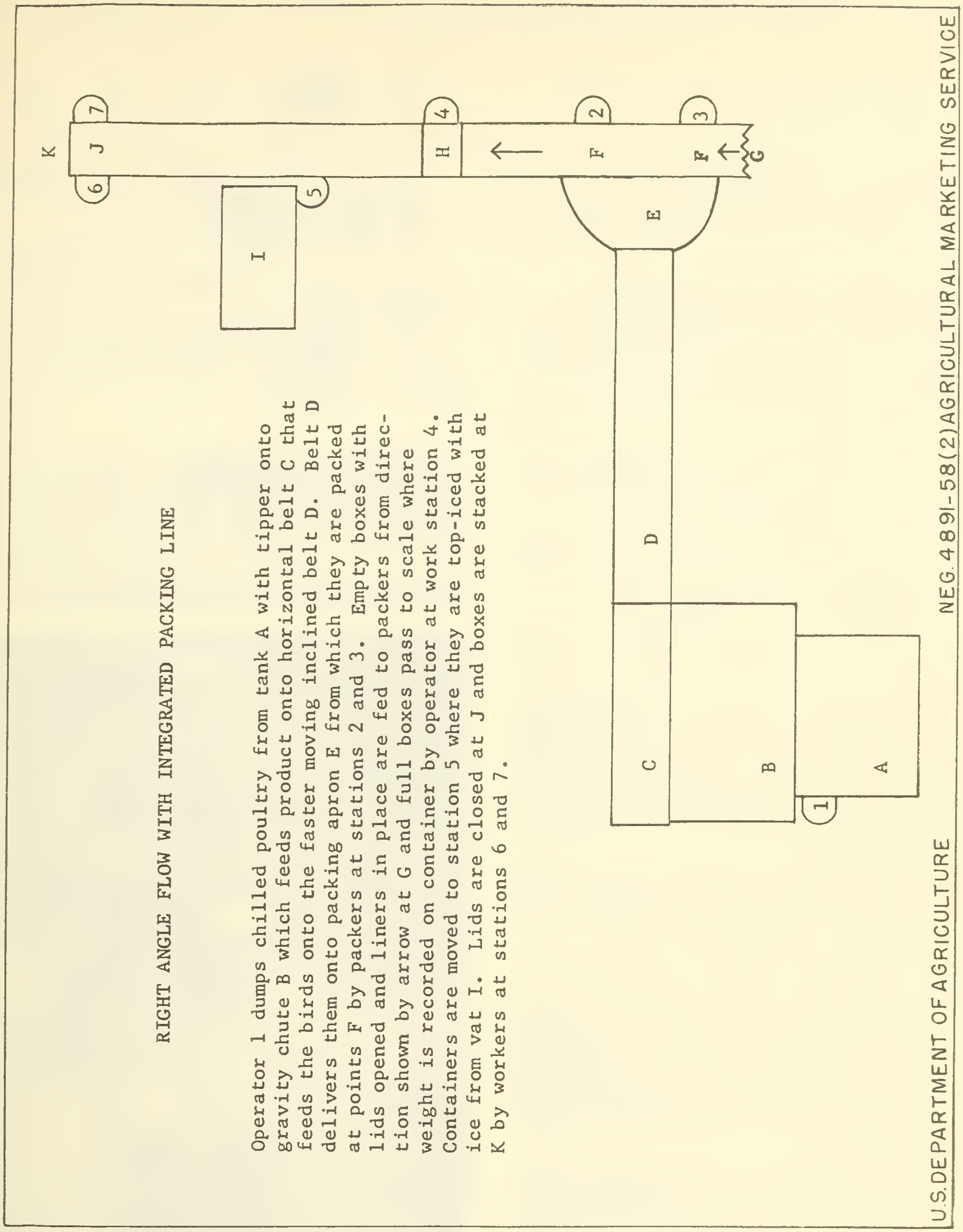


Figure 17. Right angle method employing integrated packing line, inclined gravity chute and crossfeed conveyor.

TABLE 13.—*Comparative labor and equipment costs for packing 1,000 boxes of poultry by specified methods and types of equipment* [1]

Method	Crew size	Elapsed time required	Labor cost [2]	Equipment cost	Total cost
	Men	*Hours*	*Dollars*	*Dollars*	*Dollars*
Pack birds from standard table with straight line product flow	2	[3] 6. 40	16. 01	[4] 0. 57	16. 58
Pack birds from standard table with right angle product flow	2	[5] 6. 24	15. 60	[6] . 53	16. 13
Pack birds from integrated packing line using right angle product flow	2	[7] 5. 20	13. 01	[8] 1. 70	14. 71

[1] Volume sufficient for 2,000 operating hours annually.
[2] Wage rate $1.25 per hour (Appendix, page 33).
[3] A production rate of 156 boxes packed per hour.
[4] Based on 20 feet of roller conveyor at $0.0182 per hour and a standard packing table at $0.0712 per hour (Appendix, table 26).
[5] A production rate of 160 boxes packed per hour.
[6] Based on 15 feet of roller conveyor at $0.0137 per hour and a standard packing table at $0.0712 per hour (Appendix, table 26).
[7] A production rate of 192 boxes packed per hour.
[8] Based on one gravity fed hopper at $0.1402 per hour, one conveyor with packing apron at $0.1733 per hour, and 15 feet of roller conveyor at $0.0137 per hour (Appendix, table 26).

Total costs were reduced by $1.42 per 1,000 boxes even though the equipment cost increased from $0.53 to $1.70. The normal rate of a 2-man crew packing from the integrated packing line was 4,800 birds per hour as compared with 4,000 per hour when packing from a standard packing table.

Weighing and Marking Boxes

The method of weighing ice-packed poultry consisted of positioning a platform type scale with a large dial and sweep hand indicator in the roller conveyor line leading from the packing station. Boxes from the packers moved along a 4 to 8 foot section of conveyor onto the scale platform equipped with a continuing section of roller conveyor. The roller conveyor space between the packing and weighing stations allowed flexibility in coordinating the output of the packer and scale operator.

Identifying information of the content of each box was marked on the box end. It included the size of bird, net weight of box, number of head per box, and the grade (fig. 18).

Another method of applying box content information was to mark it on a small card and staple it to the box. Table 14 shows that the normal rate of weighing and marking the information on the box was 1,000 boxes in 5.07 man-hours or 197 boxes per elapsed hour. The labor cost then amounted to $6.34 for weighing and marking the weight and other information on the box end (table 16).

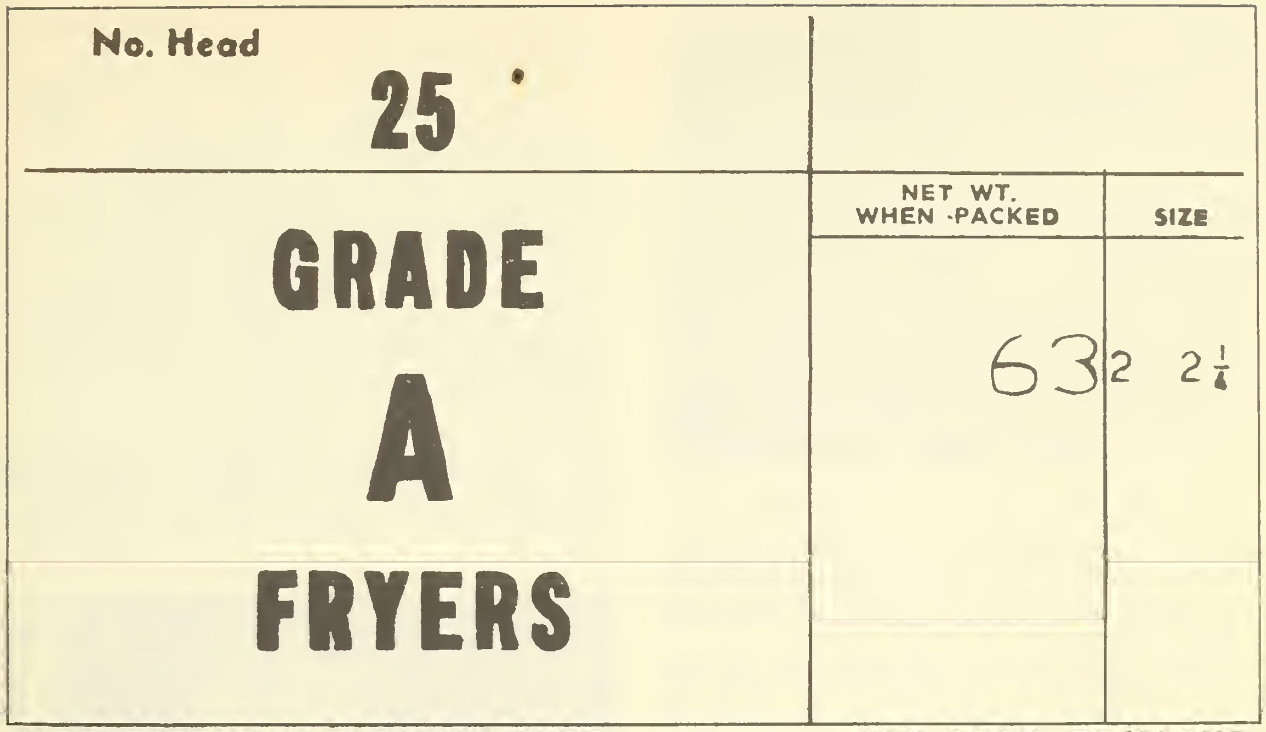
When the scale weight and other information was marked on a small card and fastened onto the case end, the required labor increased to 6.76 man-hours (table 15). The total labor cost for weighing and marking 1,000 boxes amounted to $8.45 (table 16).

A comparison of labor and equipment costs for both methods of marking shows a saving of $2.34 per 1,000 boxes (table 16) when marking the data directly on the box.

Generally, the legibility of information printed on cards was better and reduced tally errors, but since the print was small it took longer to make the tally. In high production plants the weighing operation was sometimes the packing line bottleneck and determined the output of the packing crew. This was not a desirable situation since the scale operator was more likely to make an

BN5820

Figure 18. Weighing and marking ice-packed poultry.



U.S. DEPARTMENT OF AGRICULTURE NEG. 4892-58 (2) AMS

Figure 19. One type identification card used with the automatic scale.

error in weight determination and marking when working under pressure. A small weight error repeated throughout the day could severely affect the profits of the business.

An automatic scale has been developed that prints the weight, size and class, reducing the time for the weighing operation (fig. 19). In plants where this piece of equipment proves to be successful and practical, improved crew balance and increased production of packing crews can be attained and thereby effect considerable savings. This would also eliminate, to a great extent, the human error that enters into the weighing operation.

TABLE 14.—*Labor required for one worker to weigh 1,000 boxes of poultry and mark identifying data on each box end* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Move full box aside, position another on scale	*Hours*	*Man-hours* 2. 25
Read scale, mark data on box		2. 82
Total productive labor		5. 07
Unproductive labor		None
Total elapsed hours	[2] 5. 07	

[1] One worker moves a weighed and marked box of poultry aside, positions next box, determines net weight indicated on scale, marks it on the box end along with the identifying information and head count.

[2] A rate of 197 boxes weighed and marked per elapsed hour.

TABLE 15.—*Labor required for one worker to weigh 1,000 boxes of poultry, mark identifying data on cards, and staple cards to end of boxes* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Move full box aside, position another on scale	*Hours*	*Man-hours* 2. 25
Read scale, mark data on card		2. 86
Staple card to box		1. 65
Total productive labor		6. 76
Unproductive labor		None
Total elapsed hours	[2] 6. 76	

[1] One worker moves a weighed and marked box of poultry aside, positions next box on scale, reads scale, marks information on card and staples same to box end.

[2] A rate of 148 boxes weighed and tagged per elapsed hour.

Table 16.—*Comparative labor and equipment costs for one worker to weigh 1,000 boxes of poultry and place identifying data on box by specified methods* [1]

Method	Crew size	Elapsed time required	Labor cost [2]	Equipment cost	Total cost
	Men	*Hours*	*Dollars*	*Dollars*	*Dollars*
Weigh box and mark data on end of box	1	[3] 5. 07	6. 34	[4] 0. 67	7. 01
Weigh box, mark data on card, and staple card to box	1	[5] 6. 76	8. 45	[4] . 90	9. 35

[1] Annual volume sufficient to require 2,000 hours operation.
[2] Wage rate $1.25 per hour (Appendix, page 33).
[3] A production rate of 197 boxes per hour.
[4] Based on one large dial platform scale at $0.1281 per hour and a 5-foot section of roller conveyor at $0.0046 per hour (Appendix, table 26).
[5] A production rate of 148 boxes per hour

Topping Box with Ice

From 30 to 35 pounds of crushed ice were placed on top of the birds in each box. In most instances the ice was manually scooped from an ice bin and tossed into the box. Some plants packed from 3 to 5 boxes per minute, requiring the shoveling of about 100 pounds of ice per minute.

Crushed ice for poultry chill tanks (fig. 20) was generally delivered to the icing station from the plant ice crushing operation or from the supply of crushed ice delivered to the plant. The 230-gallon chill tanks hold approximately 1,000 pounds of ice. Another method of crushed ice delivery to the icing station was by screw conveyor discharging crushed ice into a receiving tank. Using either of these methods required manual shoveling of ice into the box. Some systems of metering ice into the box mechanically are being tried, but research work is needed to solve the many problems encountered in storing, conveying and metering at the rate required by the icing operations.

The required labor for icing 1,000 boxes of poultry is 3.08 man-hours (table 17). The labor and equipment costs for the icing operation are $4.40 per 1,000 boxes of poultry. This is based on a wage rate of $1.25 per hour (Appendix, page 33), on 5 chill tanks used continuously and a 5-foot section of roller conveyor (Appendix, table 26).

BN5821

Figure 20. A tank load of ice.

Table 17.—*Labor required for one worker to scoop crushed ice manually from bin into 1,000 boxes of poultry* [1]

Time item	Elapsed time required	Labor required
	Hours	*Man-hours*
Productive labor:		
Push empty tank aside		0. 09
Push and position full tank of ice		. 19
Scoop ice into box		2. 80
Total productive labor		3. 08
Unproductive labor		None
Total elapsed hours	[2] 3. 08	

[1] Worker moves empty ice tank aside en route to a full tank, pushes full tank to and positions it at icing station, and ices weighed boxes of poultry with scoop full of ice.
[2] A rate of 324 boxes top iced per elapsed hour.

Closing and Stacking Boxes of Packed Poultry

This is an operation where individual productivity increased when the crew size was increased from 1 man to 2 men. Ice was usually piled higher than the box edges and had to be pressed down as the lid was fitted to the box. Four wire loop hooks were threaded and secured by hand. It was an unusually difficult job for one operator due to the necessity of having to effect a good lid closure in an over-full box while bending the wire hooks in place, and the weight (approximately 100 pounds) of an iced box of poultry was more than an average man could readily lift and stack five high.

The operation was performed in two ways: (1) One man closed and stacked boxes unassisted (figs. 21 and 22). Usually this was done without the use of tools. In one instance, the wire loop hooks were bent down with a hammer without requiring additional time. In this instance, lids were pulled down tighter, producing a neater and stronger box.

The required labor for 1,000 boxes was 8 man-hours or a normal production rate of 125 boxes per hour for a one man operation (table 18). Since only a short conveyor was required for equipment, the major cost involved was for labor. The total equipment and labor cost for this operation was $10.04 (table 20). (2) Two men close and stack the same box (figs. 23 and 24). In this case the hammer method of bending the hooks is impractical since the men work too close to one another for a free hammer swing. When employing the two-man method the required labor was reduced to 6 man-hours for a normal production rate of 333 boxes per hour, or an average of 166 boxes per man (table 19). The total labor and equipment cost was therefore reduced to $7.51 (table 20).

BN5822

Figure 21. One man closing box.

Two reasons why the 2-man method increased individual productivity were that (1) it was much easier for two people to fit and force the lid into place over the crushed ice, and (2) two men could grasp the 100-pound box by its ends and swing it onto the stack with less effort than was required for one man to perform the same operation. The operation was too difficult and the lift too heavy for one person to perform at a continuous fast pace.

Recently a semi-automatic wirebound box closing device was developed that effects a neat closure and securely fastens the wire loops. It appears to have a practical application, especially in large volume plants, but its use was not widespread enough to evaluate its merits in this report.

When the 1-man method of stacking and closing was compared with the 2-man method, it was noted that not only a saving of $2.53 per 1,000 boxes handled was effected (table 20), but the production rate per worker was increased by 41 boxes and the elapsed time on the job was reduced from 8 to 3 hours.

BN5823

Figure 22. One man stacking.

TABLE 18.—*Labor required for one worker to close and stack 1,000 boxes of poultry* [1]

Time item	Elapsed time required	Labor required
Productive labor:	*Hours*	*Man-hours*
Close box lid and secure		6.65
Stack boxes in 5-high stacks		1.35
Total productive labor		8.00
Unproductive labor		None
Total elapsed hours	[2] 8.00	

[1] Position box lid, engage and secure 4 wire loop fasteners and stack closed box 5 high.

[2] A rate of 125 boxes closed and stacked per elapsed hour.

TABLE 19.—*Labor required for a 2-man crew to close and stack 1,000 boxes of poultry* [1]

Time item	Elapsed time required	Labor required
Productive labor:		
Close box lid, secure, and stack boxes in 5-high stacks	*Hours*	*Man-hours* 6.00
Unproductive labor		None
Total labor		6.00
Total elapsed hours	[2] 3.00	

[1] Each crewman threads and secures 2 wire loops per box and both men toss box onto stack.

[2] A rate of 333 boxes closed and stacked per elapsed hour.

BN5824

Figure 23. Two men closing box.

BN5825

Figure 24. Two men stacking.

TABLE 20.—*Comparative labor and equipment costs for closing and stacking 1,000 boxes of poultry by specified methods* [1]

Method	Crew size	Elapsed time required	Labor cost [2]	Equipment cost	Total cost
	Men	*Hours*	*Dollars*	*Dollars*	*Dollars*
Close and stack boxes in 5-high stacks	1	[3] 8.00	10.00	[4] 0.04	10.04
Close and stack boxes in 5-high stacks	2	[5] 3.00	7.50	[4] .01	7.51

[1] Volume sufficient to provide 2,000 hours of operation annually.
[2] Wage rate $1.25 per hour (Appendix, page 33).
[3] A production rate of 125 boxes per hour.
[4] Based on a 5-foot section of roller conveyor at $0.0046 per hour (Appendix, table 26).
[5] A production rate of 333 boxes per hour.

DESIGN AND DEVELOPMENT OF IMPROVED POULTRY PACKING EQUIPMENT

Equipment manufacturers and plant management have made significant contributions toward the development of improved methods, techniques, and efficient materials handling equipment in the poultry processing plant during the recent rapid growth of the poultry processing operation. During this time, however, the transition from New York dressed to ready-to-cook poultry and a change from dry chilling to ice chilling also took place requiring the development of different methods for handling the product as well as new equipment and additional facilities required for the additional steps in processing. Nearly all areas of the processing plant, including the packing area, were affected.

Packing methods and techniques developed during the transition period resulted primarily from ideas and ingenuity of plant management. Thus, a variety of methods and equipment for performing various operations in different plants lacked uniformity.

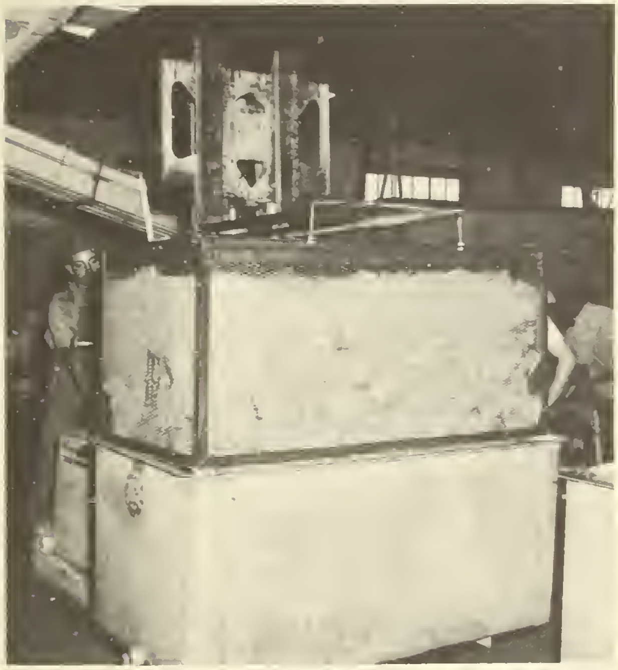
Analysis of operations in a number of plants showed that excess man-hours were expended due to lack of adequate equipment, inefficient methods, or lack of crew balance. Careful study showed that the greatest need was for improved equipment to increase packing efficiency. Time studies indicated that (1) when birds could be mechanically transferred from chill tanks to packing table, product flow would be smoother and less labor would be required; and (2) when birds were positioned more advantageously for the packer, fatigue would be reduced and productivity increased.

A preliminary survey of commercial equipment to perform these operations indicated that none existed nor was available for modification to satisfy the need.

The first step taken to correct this condition was to devise a mechanical means to empty chilled poultry from 230 gallon chill tanks onto a packing table. The amount of labor required to transfer birds manually from chill tanks plus the strain and discomfort to the workers clearly indicated a need for mechanical means to perform the operation.

Insert Basket Liner

An insert basket liner for chill tanks was the first piece of equipment developed for the purpose of mechanically transferring birds from chill tanks to packing table.



(BN 5826)

Figure 25. Insert basket elevated by a fork lift truck.

(BN 5827)

Figure 26. Birds being released from the insert basket liner onto a packing table.

The use of an insert basket (fig. 25) in existing chill tanks appeared to offer possibilities in plants where a fork lift truck or an overhead monorail, trolley and electric hoist were available. It was simple in design and could be constructed in any sheet metal shop. The essential parts were the angle iron frame, one-half inch expanded metal sides, and the two swinging trap doors with trip mechanism for a bottom. The trap doors were locked in place automatically as the liner was set inside the tank. After the birds were placed in the basket liner and chilled, the liner could be lifted out of the tank by means of a fork lift truck (fig. 25) or an electric chain hoist and positioned over and emptied onto a packing table by tripping the release mechanism of the trap doors. (fig. 26).

Although first tests of the unit in connection with the packing tables in existence at that time showed possibilities, the incomplete release of chill water and ice particles from the poultry required consideration for providing improved carcass drainage, required by Federal Regulations. Successful use can now be considered feasible in connection with the recently developed integrated packing line (page 23). The cost of a finished insert basket liner was estimated to be $105 per unit.

Fork Lift Truck Tank Tipper

It was found that a fork lift truck with a 360 degree revolving fork for emptying tank loads of chilled poultry onto packing tables (fig. 27) could be utilized if the tank could be held in place on the fork. To satisfy this requirement, metal channels were welded to the underside of the chill tank, forming tubes into which the truck forks could be inserted. This permitted lifting and rotating the tank without danger of the tank falling off the forks.

The channels were attached to the long dimension of the tank for two reasons: (1) A tank could be removed from a group with more ease and dispatch; and (2) The tank did not have to be lifted as high for rotating as would be the case if the fork entry were from the side.

Limited tests with this device indicated that the truck operator could maintain a supply of birds for the packers with time left for performing other materials handling operations. It was also noted that this device could not be recommended for all types of layouts and sizes of operation. Its use could be justified only after careful consideration of the plant layout, rate of plant production, and other materials handling that could be done in addition to transferring birds so as to fully utilize a relatively expensive piece of equipment. Comparative data were not obtained for the rotating fork lift tipper because of limitations within plants as to facilities and equipment available for tests under actual operating conditions.

Future packing methods involving ice-chilled poultry could very well lead to a system in which the lift truck with revolving forks would be the

BN 5828

Figure 27. Rotating empty chill tank with fork lift truck.

most practical means of transferring poultry from chill tanks because of production volume, plant layout and additional related work for a fork lift truck.

Hydraulic Tank Tipper

Another device developed for transferring birds from the chill tanks was a stationary hydraulically operated tilting device which raised a tank of birds and dumped the contents onto a packing table. It could be installed quickly, was self-contained, did not require changes in plant operations, building structure or equipment arrangement, and the initial cost was low.

The tipper had a set of tracks onto which loaded chill tanks could be rolled by one man. The tracks were mounted on forks which rotated through a 115 degree arc, raising the tank approximately 4 feet and emptying the birds onto a packing table (fig. 28).

Stress analyses were made of all the load carrying machine members so as to keep the size small. Special design features were incorporated in order to make it self-contained. A low base structure was required so that tanks could easily be pushed onto the tracks on top of the base. Alternatives would have required (1) a heavier, thicker base and mechanical tank positioning; or (2) a fixed base in the concrete floor. The first alternative would have increased the cost and tank handling time. The second would have required an expensive experimental installation of a permanent nature that would not have been acceptable to the management of the plants in which the device was tested. After the proper equipment arrangement in a plant was determined from preliminary test results, the tipper was fastened to the floor to prevent a slight tendency for the unit to creep when in constant use.

The final design provided for a rugged machine. A loaded tank could be raised, emptied and lowered in seconds. The tipper operator had time for other duties.

Track spacing and track width were determined by measuring width between various casters. Track widths were designed to accommodate most of the commercially manufactured chill tanks now in use. A solid plate can be substituted for the tracks, thus permitting the use of tanks of all widths.

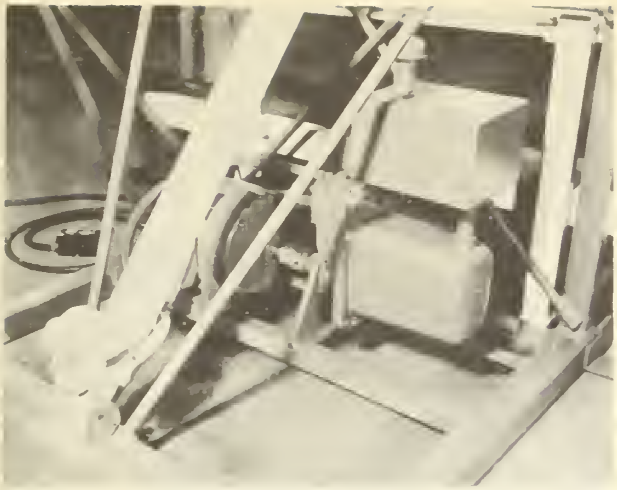
A hydraulic cylinder was selected which would have the proper length and diameter and was capable of operating at 1,000 pounds per square inch. A double acting cylinder was used because of the greater protection against water entering at the cylinder seals.

A pump-motor unit with direct connection was mounted on the machine base in order to keep floor space requirements at a minimum, maintain the self-contained unit principle, and allow for easy servicing (fig. 29). A pump with the proper capacity and pressure to drive the hydraulic ram was selected. A 3-horsepower electric motor was used.

There are three main safety features of the tipper: (1) A restricted return valve used at the bottom of the cylinder permitted full flow on the upward stroke and restricted flow through a $\frac{5}{64}$ inch orifice on the return stroke. Thus, the tank descended at a safe rate in case of hose failure as well as during normal operation. (2) A tank catch latched the chill tank to the tipper so that the tank could not topple over accidentally if

BN 5829

Figure 28. Tank tipper dumping tank of poultry onto improved packing table.



BN5830

Figure 29. Hydraulic system of tank tipper.

raised to a fully tipped position with excess speed. (3) The base was designed so that there was no danger of the tipper overturning with a loaded tank.

Packing Table

Design data were not available for an efficient poultry packing table. A table that would hold an entire tank of birds was therefore designed for use in conjunction with the hydraulic tank tipper (fig. 28). Design data pertaining to size, height of packing edge, slope, and spacing of grid bars for ice and water release were obtained by trial and error methods in case study plants. Many features that would contribute to sanitation, efficiency, and economy were included. Grids were spaced to provide for adequate drainage of trapped water and residual ice. It could be easily cleaned and maintained, and could be used with either manual transfer of poultry or transfer by hydraulic tank tipper.

Integrated Packing Line

Time and motion study data of the packing operation revealed that much time was wasted by packers because (1) the reach for birds was long and inconsistent, (2) the distance between table and box was too great, and (3) there was no smooth way of conveying empty boxes with lids open to the packers. These findings led to the development of the integrated packing line, component parts of which are a hopper feeder, a conveyor, and a packing apron used in conjunction with a tank tipper (fig. 30).

Conveyor With Packing Apron

This equipment was designed to receive, elevate, and drop birds onto a packing apron in front of the packer. Empty boxes were conveyed directly into packing position with lids open and liners in place.

The packing position of the box was directly in front of the packer and under the lip of the packing apron (fig. 31). Birds were moved from the apron directly into an awaiting box with minimum packer motion.

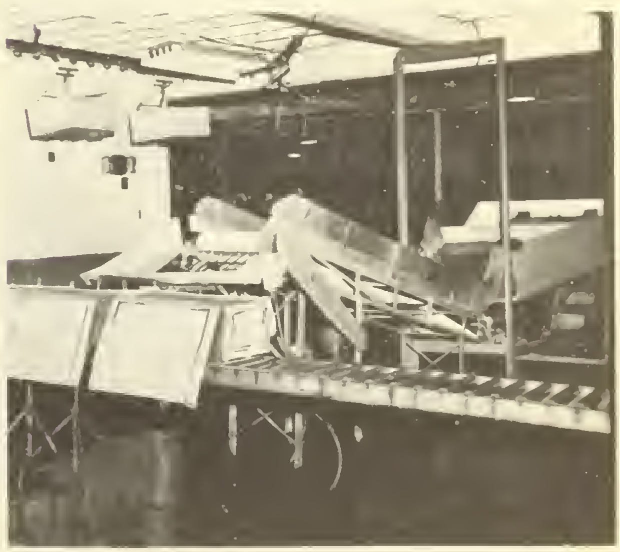
The most suitable width found for the packing apron was 36 inches. With this width, birds were distributed evenly to 2 packers from an 18-inch-wide conveyor belt.

The conveyor belt used to elevate birds to the apron was a rough neopreme-coated rubber belt 18 inches wide. The maximum incline at which birds would properly convey on this type belt was about 22 degrees.

The speed of the inclined conveyor was set to adequately supply the packers with birds at all times. A control switch at the packing station

BN5831

Figure 30. Experimental integrated packing line.



BN5832

Figure 31. Conveyor and packing apron components of integrated line.

permitted the stopping of the conveyor in the event of an oversupply of birds. A conveyor belt speed of about 19 feet per minute was the most suitable to supply two packers.

Two ideas, using different principles, were conceived to distribute birds onto the inclined belt conveyor. One was a shaker hopper utilizing reciprocating action primarily for moving birds onto the conveyor belt; another one was a gravity chute emptying birds onto a crossfeed belt conveyor.

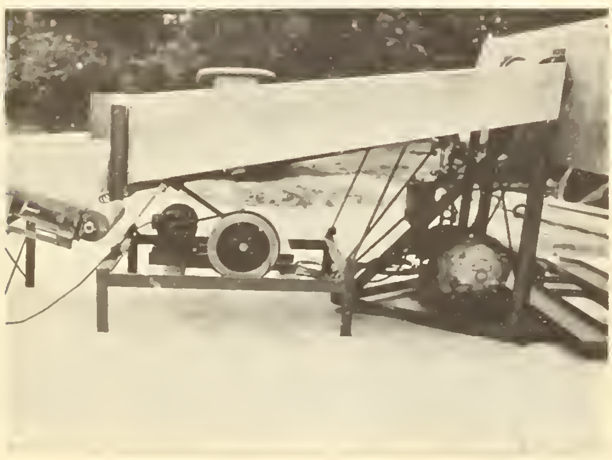
Shaker-Hopper

In developing the shaker-hopper (figs. 32 and 33), various sizes and shapes with different types of outlets and control gates were constructed in order to obtain a uniform flow of birds without occassional bridging. When a vibratory type of feeder was used, all motion was absorbed in the loose skin of the birds and none was transmitted to the remainder of the carcass. The shaker-hopper was then tried at a rather slow rate of motion but with greater amplitude than the vibrator. A series of tests were conducted to determine the proper slope and motion for a hopper bottom.

It was found that a bottom sloping 15 degrees above horizontal mounted on shaker arms set at 60 degrees above horizontal gave the best performance. A movement of ⅜ inch proved to be best. Slight oscillation moved the birds too slowly while a high rate caused erratic movement. The most effective frequency was between 330 and 370 oscillations per minute with not much change in rate of flow within this range. At 310 rpm on the crank pin, a noticeable reduction in flow was observed; above 380 rpm the birds and machine parts approached synchronism so that an erratic motion was imparted.

The proper outlet design for the hopper mouth and sides was developed so as to eliminate fast and erratic feeding as well as bridging and stoppage.

After anticipated loads on all important parts or members of the hopper were calculated, a



BN5833

Figure 32. The shaker-hopper.

BN5834

Figure 33. Hopper receiving a load of chilled poultry.

prototype was constructed for field tests. This model was constructed on a minimum strength basis to determine which parts would require more strength. This was necessary since published information was not available on stresses created by a pile of reciprocating eviscerated poultry carcasses.

The design was revised to meet requirements after the hopper was field tested in a regular plant operation. The shaker-hopper became the third major component of the integrated packing line developed and tested (shaker-hopper, conveyor, and packing apron).

When the three components were combined, they worked as follows: After the tipper transferred an entire tank of birds from the tank into the shaker-hopper at one time, they were fed onto the inclined belt conveyor in a uniform stream. The conveyor belt receiving birds from the shaker-hopper at a point about 25 inches above the floor transferred them from the outlet of the hopper to the packing apron and in position for packing into boxes.

The problem of designing such a system involved placing the birds in position at the proper rate after sufficient carcass draining time. The latter was provided during the shaking operation and ride on the conveyor. Grid bars were installed in the mouth of the hopper and in the bottom of the packing apron to allow crushed ice remaining on the birds to drop off before packing.

Gravity Hopper

The gravity hopper with crossfeed belt conveyor (fig. 34) was developed and tested as an alternative for the shaker-hopper and proved to be cheaper to construct and easier to maintain.

The gravity hopper was built similar to a standard packing table, except that the inclined slope was steeper. Birds were received from the chill tank on a sheet metal chute or hopper about 8 feet in length and 4 feet wide with a slope of about 40 degrees so that birds slid down the incline freely.

The birds slid by force of gravity onto a crossfeed conveyor belt that moved across the hopper mouth but at right angles to it, changing the direction of flow of birds 90 degrees. The birds were then conveyed onto the inclined packing conveyor that moved at about twice the speed of the crossfeed conveyor.

The first experimental model used a slat-type belt made of detachable links with ¼ by ¾ inch cross bars on 2 inch centers. This type belt was used for both the crossfeed conveyor and the inclined packing conveyor. It provided good drainage for birds and added traction which permitted a steep slope of the inclined packing conveyor. However, it proved to be unsatisfactory because (1) giblets fell from birds stuffed before packing, (2) occasional birds hung on grid bars, and (3) the moving grid was a safety hazard to employees working in the vicinity. A rough-surfaced neoprene-coated belt was finally used successfully in lieu of the grid conveyors.

The gravity hopper with an 18-inch crossfeed conveyor belt was substituted in the integrated packing line in place of the shaker-hopper component. Its use has been successfully demonstrated over a period of several months under actual operating conditions. Ownership and operating costs of the gravity hopper are only 70 percent (Appendix, table 26) of the costs of the shaker-hopper. It is also more compact, easier and cheaper to maintain, and capable of performance equal to that of the shaker-hopper.

BN5835

Figure 34. Gravity hopper with crossfeed belt.

IMPROVEMENTS OF PACKING AREA LAYOUTS

Space Requirements

Insufficient space or the improper utilization of space is not conducive to an efficient operation. In Georgia processing plants a great need existed for more space in the packing area or better utilization of the space that was available.

Aisle Space

This space is needed for the sole purpose of efficient movement of personnel and materials. Aisles should be designed for the particular needs they serve, similar to a highway or a street. Some basic rules to consider in laying out aisles in the packing area are: (1) Aisles should be established so as to permit full chill tanks to move into one side of the area and empty tanks to move out of the other side without aisle congestion and in a smooth flow. (2) Mark aisles distinctly. Prohibit temporary obstruction by misplaced chill tanks or other equipment. (3) Allow for an additional foot of aisle width adjacent to posts, walls, or fixed equipment to provide adequate clearance for personnel and transportation equipment.

Equipment Space

Space allotted to equipment in the poultry packing operation should provide for arrangement that includes adequate work space for efficient equipment utilization, cleanup and maintenance. At least 2 feet of clearance should be left between equipment and posts, walls or other equipment to provide adequate operator work space and for cleanup, maintenance, and safety.

Air Space

Utilization of air space can be an important source of floor space savings in the packing area. Since it costs the same as the space near the floor, as much use should be made of it as possible. Equipment such as fans, heaters, and material supply chutes or conveyors should be located overhead with adequate clearance for worker safety and to release floor space for other purposes. If materials or product can be stacked, consideration should be given to the possibility of high-stacking on pallets or skids.

Column Interference

This construction feature can seriously hamper efficient operations. One column misplaced at a strategic point in the packing area can spoil a good layout and obstruct inplant traffic to the extent that best efficiency cannot be attained. The resulting production loss for 1 year can very well amount to many times the cost of relocating the column.

In planning new facilities first consideration should be given to equipment layout and inplant traffic. Then, all necessary columns should be placed so as to incur the least interference.

When columns are required, the round type are preferred from the standpoint of sanitation and safety. Columns consisting of I-shaped beams furnish recesses at floor level where trash and dirt can collect. The corners are hazardous to employees working in the vicinity.

Storage Space

This facility should be located as close as possible to the packing and shipping areas and provide for a product flow that has a minimum number of turns while avoiding traffic congestion at entrance ways. The inside dimensions should be determined in multiples of a pallet width, depth, and load heights with due consideration for pallet clearance of walls and other pallets. Aisle space should be provided within the storage area so as to make possible in and out movement of pallet loads by lift truck with a minimum shifting of storage stock.

Equipment Layout

Proper layout of equipment is essential for maximum efficiency in the packing area. In most instances equipment must be fitted into existing space rather than into space especially constructed for it. Seldom, if ever, does this approach succeed in meeting the requirements for greatest efficiency. However, by using scale size templates of pieces of equipment and scale floor plans and applying the basic principles of efficient layout, maximum effectiveness can be realized under most circumstances.

Some rules to follow in obtaining maximum effectiveness from equipment in a well-planned layout are: (1) Obtain the best equipment available to perform each operation. The best is not always the most expensive or the most complicated. Equipment selection should be based on opinions of manufacturers and their representatives plus users of similar equipment and other persons with a technical background who are capable of analyzing the merits of machines. (2) Maintain equipment in a clean and serviceable condition. (3) Provide adequate work station space. Adequate room for operators is essential as well as room for over travel of machine parts as the machine goes through its cycles. Room must be allowed for quick and easy removal and replacement of machine parts in the event of a breakdown. Adequate room to get materials or product to and away from machines must be provided. (4) The unit(s) of equipment that sets the pace for the operation should receive preferential treatment as to accessibility for product and materials flow. By observing these basic fundamentals, more efficient utilization of labor and equipment is achieved and valuable floor space is conserved.

Flow of Product and Packing Materials

Product flow through the packing area should be smooth, follow the most direct route that is practical and be in coordination with a smooth flow of packing materials. Increased labor and equipment costs and improper space utilization usually occur when the product flow "backtracks," zigzags, is slowed down by congestion, or is stopped for a temporary lack of packing materials. It may be desirable or necessary occasionally to change the direction of product and packing materials flow 90 degrees in their route through the packing area, but it is important that the direction changes are by mechanical rather than manual means (fig. 35). In order to reduce wait time of employees, the packing system should be integrated and synchronized to an even flow past each operator of a balanced crew. Interrupted flow at one work station usually causes unavoidable delays at the other stations. Such interruptions, however short, add up to considerable wait time at the end of the day.

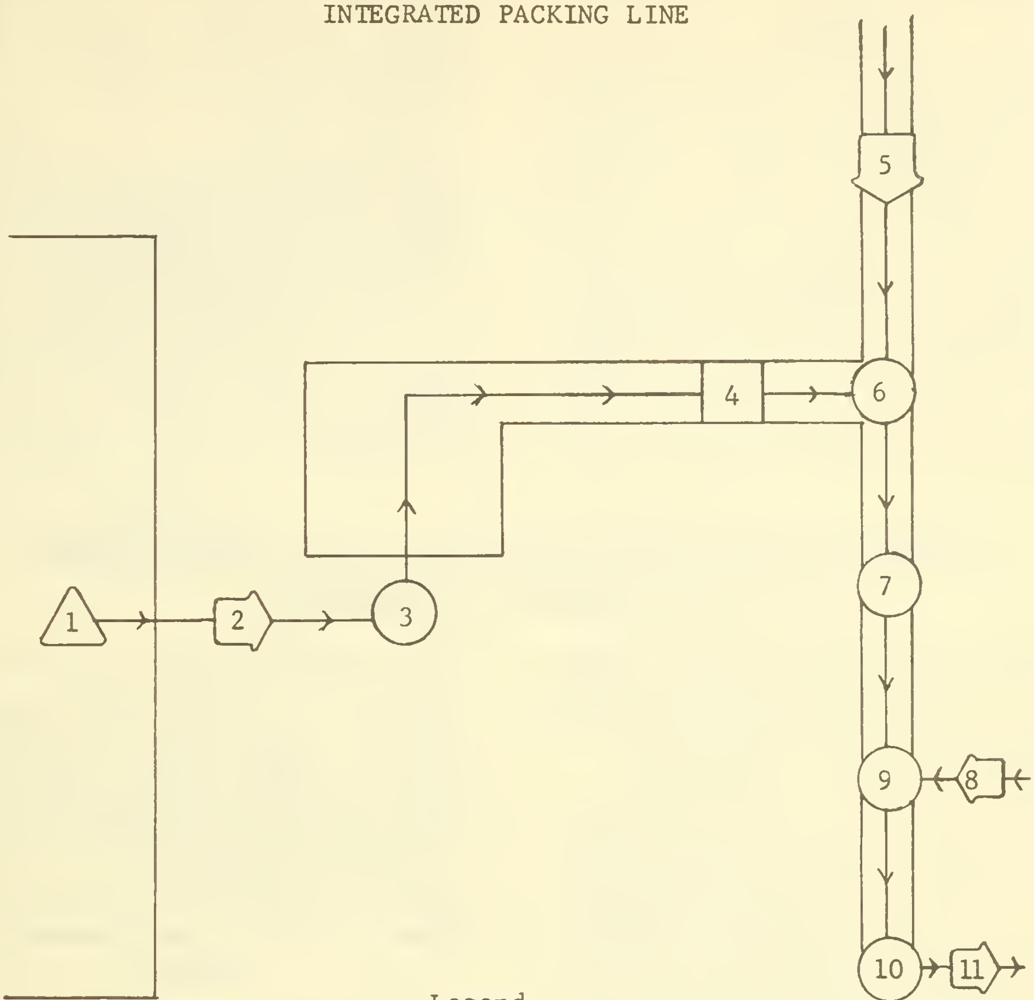
Floors and Drains

To meet safety and sanitary requirements in the packing area, the construction of floors should be given special attention. Because water containing poultry fat and blood from chilled eviscerated poultry is constantly spilled, ordinary concrete floors are not adequate. The surface must be resistant to the action from such fat and blood and yet be able to withstand wear from heavy chill tank wheels while being of a non-skid type. It must be smooth for easy, frequent cleaning and pitched ¼ inch per foot to adequate floor drains to provide for a rapid water runoff.

To meet these requirements the floor should be of reinforced concrete. The cement used for the working surface should have about one pound of coarse carborundum dust per square foot worked into the finish at the time it is layed in order to provide a skidproof surface. Breaks should be repaired promptly when they occur. If they are not repaired promptly, breaks grow progressively worse; the repair cost can easily be as much as the initial floor cost, plus an expensive shutdown of operations. Too, rough floors cause rapid wear on equipment and require more labor to move heavy loads. Worn and rough floors are almost impossible to keep clean.

Floor drains should be equipped with traps and constructed so as to minimize clogging. The sewer system should be constructed so as to provide adequate slope and capacity for removal of waste. Generally, a 4-inch drain line exhausting into a 6-inch main line is adequate. Valley drains should be pitched ½ inch to the foot and provided

A FLOW DIAGRAM INVOLVING
INTEGRATED PACKING LINE



Legend

1. Temporary storage of poultry in chill tanks.
2. Tanks of birds transported to tank tipper
3. Birds spilled into hopper by tank tipper.
4. Birds checked for undergrades.
5. Boxes from make-up room with lids open, liners in place.
6. Birds packed into box.
7. Boxes of poultry weighed and marked.
8. Crushed ice received.
9. Boxes of poultry top-iced.
10. Lids closed and boxes stacked.
11. Boxes of poultry to truck or cooler.

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Figure 35. A product flow diagram of a typical poultry packing room using an integrated packing line.

with a concave bottom. United States Department of Agriculture regulations require that all floor drain lines should be trapped and vented to the outside.

Lighting

Good lighting is essential to performing almost any factory operation safely and efficiently. Where constant and close vision is required to perform an operation, the quantity and quality of light directly affects the morale, productivity, efficiency, and the accuracy of the worker. Good lighting naturally aids in maintaining cleanliness. Improper lighting can cause eyestrain, accidents, labor turnover, and increased production costs. Frequently when the general quality of workmanship in a work area has been found to be inferior, inadequate lighting has been a contributing factor.

Direct or reflected glare should be avoided since glare is annoying and causes eye fatigue. Proper spacing and positioning of light and the use of reflectors will practically eliminate glare.

Natural or daylight provides the best type of light for close work, but it does not maintain uniform illumination and cannot be depended upon except as supplemental to artificial light. The same amount of artificial lighting therefore has to be available regardless of whether natural lighting is utilized or not.

Fluorescent lighting is much preferred over incandescent lighting because (1) it is about three times as efficient, (2) it is the nearest thing to daylight of any practical lighting system, (3) it gives off far less heat than incandescent light, and (4) it diffuses light more effectively.

A minimum of 30 foot-candles of light should be provided at all work surfaces in poultry dressing plants, except at grading and inspection stations where 50 foot-candles should be provided. All other areas in the plant are required to have a minimum of 5 foot-candles measured 30 inches above the floor.

COMBINATIONS OF METHODS AND EQUIPMENT FOR PACKING POULTRY

In this section of the report different combinations of methods, equipment, and crew sizes are assembled to illustrate comparisons as to cost, hourly output, and elapsed time variations resulting when different systems are employed.

Man-hour requirements in the examples are based on normal, uninterrupted product flow (even though a packing crew seldom operates over a long period of time without encountering some delay). Peculiarities of individual plant operations, plus numerous other factors such as improper management, improper layout, lack of crew balance, or mechanical difficulties in equipment, make it practically impossible always to account for or make allowances for all types of delay. However, in instances where unusual conditions caused serious delays that would grossly distort the overall analysis, the data were discarded. Therefore, the processor with similar equipment can use as a guide the tables for the various combinations of equipment and operations providing he considers unusual operating conditions.

Some operations are performed in the same manner in all the examples shown. For example, the gravity chute is used to transport boxes to the packing area. This approach was used because it is generally the cheapest and most practical method. With this equipment, boxes are conveyed with lids open and liners in place. Usually, the lid is bent over into a partially closed position (fig. 9) for conveying, but it is not fastened.

The weighing operation, the top-icing of boxes of poultry, and closing and stacking operations are performed in the same manner in all examples. Variations occur in the equipment and methods used in transferring birds from chill tanks and in packing poultry into boxes.

Manual and hydraulic tank tipper are two methods of transferring poultry from chill tanks used in the examples (tables 21 through 25). Two methods of packing poultry illustrated in these tables are from a standard packing table and from the integrated packing line, with right angle product flow in both methods.

Manual Transfer and Standard Packing Table

8-Man Crew

The labor normally required for an 8-man crew to pack 1,000 boxes of poultry (the equivalent of 25,000 birds) was found to be 57.36 man-hours (table 21). This is a production rate of 139 boxes per elapsed hour. The worker who made and supplied boxes paced the entire operation when he provided 1,000 boxes in 7.17 man-hours. The balance of the crew had varying amounts of wait time, totaling 9.05 man-hours, assigned to them. The labor cost for 1,000 boxes was $71.70 or $0.072 per box (table 25). When equipment cost was added, the total cost amounted to $74.68 for a total unit cost of $0.075 per box.

Tank Tipper Transfer and Standard Packing Table

7-Man Crew

When birds are transferred with the tank tipper, the packing crew is reduced to 7 men because only

TABLE 21.—*Labor required for an 8-man crew to pack 1,000 boxes of poultry using a standard packing table and manual bird transfer with right angle product flow.*[1]

Time item	Crew size	Labor required
Productive labor:		
Form boxes and transport to packing station by gravity chute [2]	*Men* 1	*Man-hours* 7. 17
Manually transfer birds from chill tanks to packing table [3]	2	13. 89
Pack birds from standard table with right angle product flow [4]	2	12. 48
Weigh and mark boxes of poultry [5]	1	5. 07
Scoop crushed ice into boxes of poultry, close lids, and place boxes in 5-high stacks [6]	2	9. 70
Total productive labor		48. 31
Unproductive labor:		
Transfer men wait on box former		. 45
Packers wait on box former		1. 86
Scale operator waits on box former		2. 10
Operators shoveling ice and closing boxes wait on box former		4. 64
Total unproductive labor		9. 05
Total labor		57. 36
Total elapsed hours		*Hours* [7] 7. 17

[1] Volume sufficient to provide 2,000 hours of operation annually.
[2] One worker carries material from box storage to workbench, forms, lines, and places boxes in gravity chute supplying packers.
[3] Two crewmen position tank of chilled poultry at packing table; each worker grasps and tosses two or more birds at a time onto packing table until tank is empty. Empty tank is pushed aside en route to another full tank 10 feet away.
[4] Packers work independently of each other packing into separate boxes.
[5] Worker weighs each box of poultry and records net weight, grade, size, and head count on box end.
[6] Two crewmen assist each other. One worker positions box of poultry; second worker scoops ice into box, returns shovel to ice bin, and assists first worker in closing and stacking boxes.
[7] Production rate of 139 boxes per elapsed hour.

one man is required to operate the tipper (table 22). Only 2 hours (1.43 productive and 0.57 unproductive) are required for the operator to transfer the equivalent of 1,000 boxes of poultry from chill tanks with the tipper. The balance of the elapsed time (5.17 hours) is used by the tipper operator to perform duties in the nearby chill area and is not charged to the packing operation. Therefore, by using the tank tipper, the total labor for packing 1,000 boxes of birds was reduced to 45.02 man-hours, although the elapsed time remained at 7.17 hours.

Total labor cost was reduced from $71.70 to $56.28 (table 25), and equipment cost increased from $2.98 to $4.98, giving a total unit labor and equipment cost of $0.06 per box.

8-Man Crew

Table 23 shows the effects of adding an additional worker to form and supply boxes. The total labor required is increased only 0.66 man-hour, but the elapsed time is decreased from 7.17 to 6.24 hours. This increases the hourly production rate from 139 to 160 boxes per hour.

Total labor and equipment costs are slightly increased to $61.43 or $0.17 per 1,000 boxes (table 25).

TABLE 22.—*Labor required for a 7-man crew to pack 1,000 boxes of poultry transferring birds with hydraulic tank tipper and using a standard packing table with right angle product flow* [1]

Time item	Crew size	Labor required
Productive labor:		
Form boxes and transport to packing station by gravity chute [2]	*Men* 1	*Man-hours* 7. 17
Transfer birds from chill tanks by hydraulic tank tipper [3]	1	1. 43
Pack birds from standard packing table with right angle product flow [4]	2	12. 48
Weigh and mark boxes of poultry [5]	1	5. 07
Scoop crushed ice into boxes of poultry, close lids, and place boxes in 5-high stacks [6]	2	9. 70
Total productive labor		35. 85
Unproductive labor:		
Tipper operator waits on packers [7]		. 57
Packers wait on box former		1. 86
Scale operator waits on box former		2. 10
Operators shoveling ice and closing boxes wait on box former		4. 64
Total unproductive labor		9. 17
Total labor		45. 02
Total elapsed hours		*Hours* [8] 7. 17

[1] Volume sufficient to provide 2,000 hours of operation annually.
[2] One worker carries material from box storage to work bench, forms, lines, and places boxes in gravity chute supplying packers.
[3] One worker positions tank of chilled poultry on tipper rack, secures, dumps with tipper, and pushes empty tank aside en route to next full tank 10 feet away. The operator performs other duties in the chill area. This time is not charged to the packing operation.
[4] Packers work independently of each other packing into separate boxes.
[5] Worker weighs each box of poultry and records net weight, grade, size, and head count on box end.
[6] Two crewmen assist each other. One worker positions box of poultry; second worker scoops ice into box, returns shovel to ice bin and assists first worker in closing and stacking boxes.
[7] When a different size bird is to be packed, all birds of the previous lot must be packed before spilling the next batch onto the table.
[8] Production rate of 139 boxes per elapsed hour.

TABLE 23.—*Labor required for an 8-man crew to pack 1,000 boxes of poultry transferring birds with hydraulic tank tipper and using a standard packing table with right angle product flow* [1]

Time item	Crew size	Labor required
Productive labor:		
Form boxes and transport to packing station by gravity chute [2]	*Men* 2	*Man-hours* 7.17
Transfer birds from chill tanks to packing table with hydraulic tank tipper [3]	1	1.43
Pack birds from standard packing table with right angle product flow [4]	2	12.48
Weigh and mark boxes of poultry [5]	1	5.07
Scoop crushed ice into boxes of poultry, close lids, and place boxes in 5-high stacks [6]	2	9.70
Total productive labor		35.85
Unproductive labor:		
Box formers wait on packers		5.31
Tipper operator waits on packers [7]		.57
Scale operator waits on packers		1.17
Operators shoveling ice and closing boxes wait on packers		2.78
Total unproductive labor		9.83
Total labor		45.68
Total elapsed hours		*Hours* [8] 6.24

[1] Volume sufficient to provide 2,000 hours of operation annually.
[2] Crewmen work independently; carry material from storage to work bench, form boxes, insert liners, and place boxes in gravity chute. One work bench is on each side of chute.
[3] One worker positions tank of chilled poultry on tipper rack, secures, dumps with tipper, and pushes empty tank aside en route to next full tank 10 feet away. The operator performs other duties in the chill area. This time is not charged to the packing operation.
[4] Packers work independently of each other packing into separate boxes.
[5] Worker weighs each box of poultry and records net weight, grade, size, and head count on box end.
[6] Two crewmen assist each other. One worker positions box of poultry; second worker scoops ice into box, returns shovel to ice bin and assists first worker in closing and stacking boxes.
[7] When a different size bird is to be packed, all birds of the previous lot must be packed before spilling the next batch onto the table.
[8] Production rate of 160 boxes per elapsed hour.

Tank Tipper Transfer With Integrated Packing Line

8-Man Crew

When this combination of equipment and crew size is used, the total labor required to pack 1,000 boxes of birds is 38.40 man-hours (table 24). Wait time is 4.63 man-hours, which indicates fairly good crew balance. The elapsed time is 5.20 hours, giving a production rate of 192 boxes per elapsed hour. Total labor and equipment costs amount to $52.87 per 1,000 boxes or about $0.053 per box (table 25).

TABLE 24.—*Labor required for an 8-man crew to pack 1,000 boxes of poultry transferring birds with hydraulic tank tipper using the integrated packing line with right angle product flow* [1]

Time item	Crew size	Labor required
Productive labor:		
Form boxes and transport to packing station by gravity chute [2]	*Men* 2	*Man-hours* 7.17
Transfer birds from chill tanks with tank tipper [3]	1	1.43
Pack birds from integrated packing line with right angle product flow [4]	2	10.40
Weigh and mark boxes of poultry [5]	1	5.07
Scoop crushed ice into boxes of poultry, close lids, and place boxes in 5-high stacks [6]	2	9.70
Total productive labor		33.77
Unproductive labor:		
Box formers wait on packers		3.23
Tipper operator waits on packers [7]		.57
Scale operator waits on packers		.13
Operators shoveling ice and closing boxes wait on packers		.70
Total unproductive labor		4.63
Total labor		38.40
Total elapsed hours		*Hours* [8] 5.20

[1] Volume sufficient to provide 2,000 hours of operation annually.
[2] Crewmen work independently; carry material from storage to work bench, form boxes, insert liners, and place boxes in gravity chute. One work bench is on each side of chute.
[3] One worker positions tank of chilled poultry on tipper rack, secures, dumps with tipper, and pushes empty tank aside en route to next full tank 10 feet away. The operator performs other duties in the chill area. This time is not charged to the packing operation.
[4] First worker packs ½ the birds; then, simultaneously pushes half-filled box to second packer and positions an empty box as second packer pushes full box aside.
[5] Worker weighs each box of poultry and records net weight, grade, size, and head count on box end.
[6] Two crewmen assist each other. One worker positions box of poultry; second worker scoops ice into box, returns shovel to ice bin and assists first worker in closing and stacking boxes.
[7] When a different size bird is to be packed, all birds of the previous lot must be packed before spilling the next batch onto the table.
[8] A production rate of 192 boxes per elapsed hour.

CONCLUSIONS

Table 25 compares the cost of packing the equivalent of 25,000 birds (1,000 boxes) using 4 different methods with various crew sizes and types of equipment. Many other combinations could be assembled from the information in this report. For instance, the hydraulic tank tipper could be used in all the examples, or the integrated packing line could be used with manual transfer resulting in varying total costs.

A mechanical tank tipper for transferring birds from chill tanks onto a packing table or other receptacle for packing can be justified costwise in all size operations covered in this report—20,000 to 40,000 birds per day plants. In fact, the greater the volume packed, the greater the justification for using a mechanical tank tipper.

For an equal volume of poultry transferred from chill tanks, the labor and equipment costs of the tipper operation are about 18 percent as much as a 2-man crew using the manual method (table 9). The tank tipper can deliver over 12,000 birds to packers per hour, a greater volume than was being packed by any plant.

When an 8-man packing crew using manual bird transfer (table 25) employs a tank tipper for transferring birds to a standard packing table, the crew size is reduced to 7 men and the total labor and equipment costs are reduced by 19.5 percent—from $74.68 to $61.26 per 1,000 boxes of poultry packed.

Of the examples shown in table 25, the hydraulic tank tipper with integrated packing line was the most economical combination of equipment to use. Using the same crew size and volume of product, poutlry can be packed from the integrated packing line for about 29 percent less total labor and equipment cost (from $74.68 to $52.87) than is experienced when using manual transfer and packing from a standard table. This means that for 2,000 operating hours per year, 384,000 boxes can be packed from the tipper and integrated line for $459 less than 278,000 boxes can be packed from a standard table using manual transfer, or $0.075 total labor and equipment cost per box packed as compared with $0.053 per box. This economy was brought about by smoother flow of product and better crew balance resulting from improved methods and equipment.

Table 25.—*Comparative labor and equipment costs for packing 1,000 boxes of poultry using specified crew sizes, methods, and types of equipment* [1]

Method [2]	Crew size	Elapsed time required	Labor and equipment required		Labor and equipment costs		
			Labor	Equipment	Labor [3]	Equipment	Total
	Men	*Hours*	*Man-hours*	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Manual bird transfer; pack from standard table	8	[4] 7.17	57.36	7.17	71.70	[5] 2.98	74.68
Tank tipper transfer; pack from standard table	7	[4] 7.17	[6] 45.02	7.17	56.28	[7] 4.98	61.26
Tank tipper transfer; pack from standard table	8	[8] 6.24	[6] 45.68	6.24	57.10	[7] 4.33	61.43
Tank tipper transfer; pack from integrated packing line	8	[9] 5.20	[6] 38.40	5.20	48.00	[10] 4.87	52.87

[1] Volume sufficient to require 2,000 hours of operation annually.

[2] Methods and equipment used in all 4 examples are the same except in transferring birds from chill tanks and the packing operation. In all methods boxes are formed and then transported to packing station by gravity chute; right angle product flow is used in packing; boxes of poultry are weighed on large dial platform scale in conveyor line; 2 crewmen assist each other in icing, closing, and stacking boxes.

[3] Wage rate $1.25 per hour (Appendix, page 33).

[4] A production rate of 139 boxes per elapsed hour.

[5] Includes 40 feet of gravity chute at $0.0188 per hour, one standard packing table at $0.0712 per hour, one large dial platform scale at $0.1281 per hour, 5 chill tanks for storing ice at $0.1745 per hour, and 30 feet of roller conveyor at $0.0228 per hour (Appendix, table 26).

[6] Only 2 hours of tipper operator's time required. Balance charged to duties performed in chill area.

[7] Includes 40 feet of gravity chute at $0.0188 per hour, one hydraulic tank tipper at $0.2787 per hour, one standard packing table at $0.0712 per hour, one large dial platform scale at $0.1281 per hour, 5 chill tanks for storing ice at $0.1745 per hour, and 30 feet of roller conveyor at $0.0228 per hour (Appendix, table 26).

[8] A production rate of 160 boxes per elapsed hour.

[9] A production rate of 192 boxes per elapsed hour.

[10] Includes 40 feet of gravity chute at $0.0188 per hour, one hydraulic tank tipper at $0.2787 per hour, one gravity fed hopper with packing conveyor at $0.3135 per hour, one large dial platform scale at $0.1281 per hour, 5 chill tanks for storing ice at $0.1745 per hour, and 30 feet of roller conveyor at $0.0228 per hour (Appendix, table 26).

RECOMMENDATIONS

Plant management should study means of bringing about efficiencies of operation. A logical sequence of steps to follow would be:

1. Observe the entire crew and determine which component of an operation is limiting the overall production.
2. Study the component selected and try to improve it by rearrangement of layout, improved equipment, and method, or by more capable operators.
3. After one component has been improved as much as possible, continue on to the next limiting component until the best combinations of methods, crew sizes, and equipment are being used throughout the operation. Thus, the causes of all delays can be analyzed most effectively and avoidable delays can be eliminated for the smoothest uninterrupted flow of product possible.

Just as pennies grow into a large sum in a savings account, small economies effected throughout a process amount to big savings over a period of time.

APPENDIX

Grading Poultry

In case study plants where data were collected for this study of packing operations, plant personnel under direction of management handled all grading and inspection of product and operations.

In selecting individual plants, consideration was given as to whether facilities, equipment and operations in the packing area met the minimum requirements set forth in the U. S. Department of Agriculture regulations.

Labor Costs

A labor cost figure of $1.25 per hour was developed by averaging the wage rate for packing area employees in the plants studied. The hourly rate used throughout the study included the regular time pay rate plus administrative and other miscellaneous expenses.

Equipment Costs

Ownership and operating cost figures have been compiled and tabulated in table 26 for various pieces of equipment used in packing ice-packed poultry. These cost figures are used to compare packing systems which are composed of various methods and types of equipment. Cost figures are estimations based on information obtained from equipment manufacturers, plant managers, public utility companies, and investment agencies. Costs were figured on the basis of the initial installation cost.

Ownership Costs

These costs are composed of (1) depreciation, (2) interest, and (3) insurance and taxes. Equipment is depreciated rather fast in a poultry processing plant for two reasons: (a) obsolescence due to the fast growth of the industry, and (b) deterioration due to adverse moisture conditions.

Depreciation is figured on the straight line basis on the estimated life of the equipment. Interest is figured at 5 percent of the average investment cost of the equipment for its expected life. Insurance and taxes are figured at 4 percent of the initial investment cost of the equipment.

Operating Costs

These costs are based on power and maintenance requirements. An estimated rate of $0.02 per KWH is used for electricity. The actual rate is determined by the amount of electricity that is kept available at the plant and the amount that is used per month. Therefore, the rate per KWH varies from plant to plant.

Maintenance costs had to be estimated because few, if any, poultry processing plants have cost accounting systems that accurately record these costs. However, all cost estimates were made by experienced persons with a thorough knowledge of the equipment and the conditions under which it operates.

TABLE 26.—*Ownership and operating costs for various types of materials handling equipment used in packing poultry based on 2,000 operating hours per year*

Equipment	Amount of equipment	Initial cost [2]	Expected life	Ownership cost				Operating cost			Total annual cost	Cost per hour
				Depreciation	Interest [3]	Insurance and taxes [3]	Total	Power [4]	Maintenance	Total		
	Units	*Dollars*	*Years*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Hydraulic tank tipper [1]	1	1,500.00	5	300.00	37.50	60.00	397.50	100.00	60.00	160.00	557.50	0.2787
Shaking hopper [1]	1	1,000.00	5	200.00	25.00	40.00	265.00	21.60	120.00	141.60	406.60	0.2033
Gravity fed hopper [1]	1	750.00	5	150.00	18.75	30.00	198.75	21.60	60.00	81.60	280.35	0.1402
Conveyor with packing apron [1]	1	1.000.00	5	200.00	25.00	40.00	265.00	21.60	60.00	81.60	346.60	0.1733
Packing table [1]	1	500.00	5	100.00	12.50	20.00	132.50	------	10.00	10.00	142.50	0.0712
Scale (platform type, large dial-sweep hand)	1	650.00	5	130.00	16.25	26.00	172.25	------	84.00	84.00	256.25	0.1281
Chill tank	1	150.00	5	30.00	3.75	6.00	39.75	------	30.00	30.00	69.75	0.0349
Roller conveyor section	10′	50.00	5	10.00	1.25	2.00	13.25	------	5.00	5.00	18.25	0.0091
4-wheel platform hand truck	1	40.00	10	4.00	1.00	1.60	6.60	------	5.00	5.00	11.60	0.0058
Wheel conveyor section (light use—dry)	10′	32.50	10	3.25	.81	1.30	5.36	------	1.00	1.00	6.36	0.0032
Gravity chute with wheel conveyor bottom (light use—dry)	10′	[5] 50.00	10	5.00	1.25	2.00	8.25	------	1.25	1.25	9.50	0.0047
Monorail conveyor with 25 suspended carriers (light use—dry)	100′	[5] 700.00	15	46.67	17.50	28.00	92.17	20.00	25.00	45.00	137.17	0.0686

[1] Metal parts of equipment coming in contact with product made of stainless steel.

[2] F. o. b. Factory. Price likely to vary between manufacturers.

[3] Interest at 5 percent of average investment—insurance and taxes 4 percent of initial investment.

[4] Rate estimated at $0.02 per KWH. Actual rate determined on demand basis.

[5] Includes cost of installation.

Definition of Terms

Terms used in this report concerning research methods and techniques that require some clarification are defined as follows:

OPERATION. One of the larger sub-divisions of a job.

ELEMENT. A sub-division of an operation.

UNAVOIDABLE DELAY. A delay that occurs during an operation that cannot be controlled by the workers.

AVOIDABLE DELAY. A delay occurring during an operation that can be controlled by the workers.

MOTION AND TIME STUDY. An industrial engineering technique used to analyze an operation for determining most effective work area layout, the minimum and most efficient motions to use, and the time required to perform each element of the operation.

BASE TIME. Actual time required for an average skilled worker working at a normal pace to perform a segment of work.

FATIGUE ALLOWANCE. A percentage added to the base time to compensate for fatigue, based on difficulty of performing the operation and the working conditions.

PERSONAL ALLOWANCE. A percentage added to the base time to compensate for time required by workers for personal needs.

PRODUCTIVE TIME. The base time for performing an operation with fatigue and personal allowances added.

PRODUCTIVITY. Actual performance in output per unit of time.

MAN-MINUTE. One man working one minute.

MAN-HOUR. One man working one hour.

CREW BALANCE. A crew is in perfect balance along a production line when the product being processed flows at a normal rate in and out of each work area at the exact rate at which each operator can properly complete his assigned task.

WAIT TIME. Idle time imposed on workers because the product moving along the production line does not reach them at a fast enough rate, usually due to an unbalanced crew.

ELAPSED TIME. The actual expired time from start to finish of an operation.

READY-TO-COOK-CHICKEN. Any dressed poultry from which the protruding pin feathers, vestigial feathers, head, crop, oil gland, trachea, esophagus, entrails, reproductive organs, and lungs, have been removed and with or without giblets is ready to cook without further processing (sometimes referred to as eviscerated).

ICE-PACKED POULTRY. Dressed or ready-to-cook poultry that has been cooled to 40° F. prior to packing and covered with sufficient crushed or flake ice during packing to maintain the 40° F. temperature, in the plant awaiting shipment or when in actual shipment.

Standard Data

Fatigue and personal allowances for performing various operations in packing ice-packed poultry:

Time item	*Allowances* Fatigue	Personal	Total
	Percent	*Percent*	*Percent*
Manually remove 60-pound bundle of knocked-down wirebound boxes from stack, transport 5–50 feet, and place on stack or work bench	20	5	25
Clip 2 wire binders per bundle and toss aside	5	5	10
Form wirebound boxes	15	5	20
Insert paper liner in box	5	5	10
Close empty box lid, secure one hook	5	5	10
Toss box aside into chute or other receptacle	5	5	10
Manually carry 5-high stack of empty boxes 5–50 feet and set down	10	5	15
Push 4-wheel platform hand truck loaded with empty boxes	10	5	15
Push empty 4-wheel hand truck	5	5	10
Release one hook, open box lid	5	5	10
One man manually pushes loaded chill tank (1,200 lbs.) with good wheels on smooth, level floor	20	5	25
Two men manually push loaded chill tank (1,200 lbs.) with good wheels on smooth, level floor and onto tank tipper rack	15	5	20
One man manually pushes empty chill vat on smooth, level floor	10	5	15
Manually toss chilled poultry from tank onto packing table	25	5	30
One man manually pushes loaded chill tank (1,200 lbs) with good wheels onto tank tipper rack	25	5	30
Dump tankload of birds with hydraulic tank tipper	5	5	10
One man pushes empty tank off tipper track	10	5	15
Push full box of birds along conveyor and position empty box for packing	10	5	15
Pack birds in box	20	5	25
Push full box off scale along conveyor and position another on scale	10	5	15
Weigh box of poultry and mark identifying data on end of box	5	5	10
Weigh box of poultry and mark identifying data on card	5	5	10
Staple card to end of box	5	5	10
Scoop from 30 to 35 lbs. ice from bin into boxes of poultry	25	5	30
One man closes and fastens box lid	20	5	25
One man stacks 100 lb. boxes in 5-high stack	25	5	30
Two men close and fasten box lid	15	5	20
Two men stack 100 lb. boxes in 5-high stack	15	5	20

Labor requirements per 1,000 boxes for performing various operations in forming and transporting wirebound boxes used for packing poultry:

Time item	Crew size	Base time	Fatigue and personal allowances	Productive time
	Men	*Man-hours*	*Man-hours*	*Man-hours*
Manually transport knocked-down boxes 15 feet from stack to work bench [1]	1	0. 40	0. 10	0. 50
Clip 2 wire binders per bundle and toss aside	1	0. 45	0. 04	0. 49
Form boxes—open knocked-down box, insert end wires, and bend wire loops	1	3. 12	0. 62	3. 74
Insert paper liner [2]	1	1. 55	0. 15	1. 70
Close box lids and secure one hook	1	0. 73	0. 07	0. 80
Move boxes to other end of work bench, onto a stack, into a gravity chute, or onto a suspended carrier	1	0. 67	0. 07	0. 74
Transport boxes 40 feet by 4-wheel hand truck and return empty—21 boxes per trip	1	0. 54	0. 08	0. 62
Manually transport boxes 40 feet and return empty—5 boxes per trip	1	1. 46	0. 22	1. 68

[1] Knocked-down boxes are bound 10 per bundle, each bundle weighing about 60 pounds.

[2] One rectangular sheet of paper inserted lengthwise of box.

Labor requirements for transferring the equivalent of 1,000 boxes of poultry from chill tanks onto a packing table or other receptacle:

Time item	Crew size	Base time	Fatigue and personal allowances	Productive time
	Men	*Man-hours*	*Man-hours*	*Man-hours*
Position a full tank of poultry beside packing table [1]	2	0. 32	0. 06	0. 38
Push empty tank aside en route to next full tank	2	0. 16	0. 02	0. 18
Manually empty tank loads of birds onto packing table	2	10. 25	3. 08	13. 33
Obtain and position tank of poultry on hydraulic tank tipper rack [2]	1	0. 52	0. 15	0. 67
Push empty tank off tank tipper en route to full tank	1	0. 17	0. 03	0. 20
Raise, dump tank of birds, and lower tank with tank tipper	1	0. 51	0. 05	0. 56

[1] A tank of chilled birds weighs about 1,200 lbs. gross. Tank is obtained from 10-foot radius of packing table.

[2] Based on smooth, even floors with good tank casters. Tank of birds obtained from within 10-foot radius of tipper.

Labor required to pack 1,000 boxes [1] of poultry using various methods and types of equipment:

Time item	Crew size	Base time	Fatigue and personal allowances	Productive time
	Men	*Man-hours*	*Man-hours*	*Man-hours*
Push full box aside on conveyor, position empty box for packing [2]	1	1. 94	0. 29	2. 23
Pack poultry in box from standard packing table using straight line product flow	1	8. 46	2. 12	10. 58
Pack poultry in box from standard packing table using right angle product flow	1	8. 20	2. 05	10. 25
Pack birds in box from integrated packing line using right angle product flow	1	6. 58	1. 65	8. 23

[1] 1,000 boxes represent 25,000 birds.

[2] Boxes conveyed to packing area with lids open and liners in place.

Labor required to perform various operations in weighing, icing and closing 1,000 boxes of poultry:

Time item	Crew size	Base time	Fatigue and personal allowances	Productive time
	Men	*Man-hours*	*Man-hours*	*Man-hours*
Push full box of birds off scale along conveyor, position another on scale	1	1. 96	0. 29	2. 25
Read scale, mark identifying data on card	1	2. 60	0. 26	2. 86
Staple card to end of box	1	1. 50	0. 15	1. 65
Read scale, mark identifying data on end of each box	1	2. 56	0. 26	2. 82
Scoop 30–35 pounds of crushed ice from bin into each box	1	2. 15	0. 65	2. 80
Push empty chill tank aside	1	0. 08	0. 01	0. 09
Position full tank of ice (1,000 lbs.) from 10-foot radius	1	0. 15	0. 04	0. 19
Close box lid and secure with 4 wire loops	1	5. 32	1. 33	6. 65
Stack 100-pound boxes in 5-high stacks	1	1. 04	0. 31	1. 35
Close box lids, secure, and stack boxes in 5-high stacks	2	5. 00	1. 00	6. 00

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