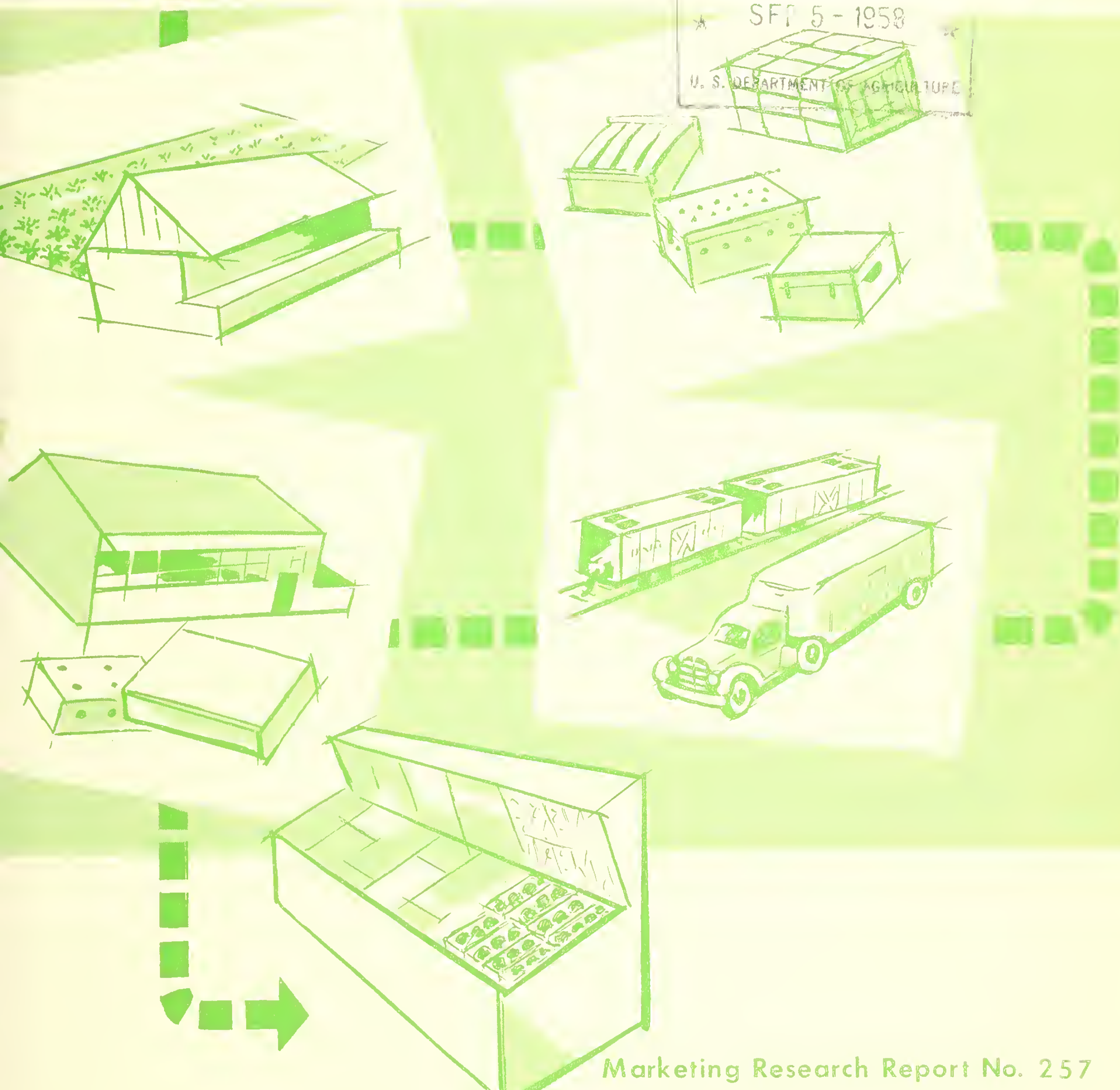
Efficiency and Potential Economies of Dual-Purpose Shipping Containers for Mature-Green Tomatoes



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HIGHLIGHTS

A study of several types of tomato shipping containers, packinghouse operations in California and Florida producing areas, and repacking plant operations in various terminal markets disclosed that use of dual-purpose containers can bring substantial savings in the cost of packing, transportation, and repacking of the ripened fruit. With this method the containers used to carry the mature-green fruit from the producing areas to the repacking plants are reused as master containers to carry small tubes, or trays, of ripened fruit from the repacking plant to wholesale and retail outlets, instead of using separate containers for each operation.

The cost savings resulting from use of dual-purpose containers for the shipment and repacking of tomatoes are shared by the shipper and the repacker; the relative proportion accruing to each depends upon the type of containers being replaced and the conditions under which they are used. Most California tomatoes are shipped in 30-pound wooden lugs. For shipments from Stockton, Calif., to New York, N. Y., packed in the 50-pound full-telescope dual-purpose fiberboard boxes, savings in container, packing, and loading costs were found to average $263.24 per carload. Also compared to the wooden lugs, potential savings to the shippers were $246.24 for 60-pound wirebound crates, $212.28 for 40-pound dual-purpose fiberboard boxes, and $103.65 for 32-pound fiberboard lugs. Potential savings in transportation costs from California to New York City averaged $17.14 per carload for the 50-pound dual-purpose fiberboard box, $11.55 for the 60-pound wirebound crate, $9.96 for the 32-pound lug, and $9.70 for the 40-pound dual-purpose fiberboard box.

Savings in repacking costs, as compared with fruit received in 30-pound wooden lugs and repacked in new 10-tube master containers, averaged $241.10 per car for 50-pound full-telescope dual-purpose fiberboard boxes reused as 20-tube master containers, $178.54 for 60-pound wirebound crates, $172.21 for 40-pound fiberboard boxes, and $161.07 for fiberboard lugs when the fruit received in these containers was repacked in new 20-tube master containers. If the fruit received in the 30-pound wooden lugs was repacked in new 20-tube master containers instead of 10-tube master containers, the potential saving averaged $169.06 per carload.

For shipments of Florida tomatoes, in which the 60-pound wirebound crate is the predominantly used shipping container, potential savings in container, packing, and loading costs of alternative types of containers were considerably smaller than for shipments of California fruit. For the 50-pound full-telescope dual-purpose fiberboard boxes shipped from Homestead, Fla., to New York, N. Y., the total potential saving per carload, as compared with the 60-pound wirebound crates, was only $18.81. On the other hand, 40-pound fiberboard boxes cost $22.84 more per carload to pack and load, and 30-pound wooden lugs $208.89 more, than when the same quantity of fruit was packed in 60-pound wirebound crates. Differences in prevailing wage rates between California and Florida accounted for part of the differences in comparative packing costs and potential savings for the same type of containers between the two producing areas.

Shipping tests by rail and by motortruck from Florida and California to various markets in the Northeast indicated that the 40- and 50-pound dual-purpose fiberboard containers protected the fruit adequately during transportation. When the fiberboard boxes were properly loaded and handled during transit, the comparative damage to containers, temperatures of fruit in transit, and ripeness of fruit upon arrival were about the same as those for wirebound crates and wooden lugs. Shipments of 32-pound fiberboard lugs by rail from California sustained slightly more damage than comparable shipments of wooden lugs and 40- and 50-pound fiberboard containers.

Inspection of the fruit at destination by Federal inspectors revealed that when 40- and 50-pound fiberboard boxes were properly packed, loaded, and handled during shipment, there was no more serious bruising of fruit shipped in them than of fruit in comparable shipments in 30-pound wooden lugs and 60-pound wirebound crates. Shipments of wrapped and place-packed California tomatoes in 32-pound fiberboard lugs, however, showed somewhat more bruising than comparable fruit shipped in wooden lugs or the other types of fiberboard containers.

Controlled shipping experiments by rail from California to New York City in which recording thermometers were used revealed that the in-transit cooling rates of the tomates packed in 40- and 50-pound fiberboard boxes and 32-pound fiberboard lugs did not differ greatly from the cooling rate of the fruit shipped in the standard wooden lugs. These tests indicated that the same type rail protective service currently used for long-distance rail shipments of California fall-crop tomatoes in the wooden lug will also be suitable for shipment of the fruit in the different types of fiberboard containers used in these shipping tests.

Observations by Agricultural Marketing Service personnel in following the master containers of repacked fruit from the repacking plants to the retail stores showed that the dual-purpose fiberboard boxes reused as master containers for the tubes of ripened fruit provided adequate protection for the fruit during this stage of its distribution.

EFFICIENCY AND POTENTIAL ECONOMIES OF DUAL-PURPOSE SHIPPING CONTAINERS FOR MATURE-GREEN TOMATOES

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BACKGROUND OF STUDY

For many years commercial production of tomatoes for the fresh market has primarily involved the shipping of mature-green tomatoes to repackers at terminal markets for most months of the year. Florida and California together supply over half the commercial production of tomatoes for the fresh market. Tomatoes are shipped to market from 1 of these 2 States every month in the year. A substantial volume is also shipped from several producing areas in Texas to various northern and eastern markets, especially during the spring and early summer months. At the terminal markets the mature-green tomatoes are sorted, ripened, repacked into small consumer-size tubes or trays, and distributed to the wholesale and retail trade in various types of fiberboard master containers.

Many different shipping containers have been used to carry the fruit in bulk, jumble-packed, or wrapped and place-packed, from the production points to the repackers. Their dimensions and problems of disposal make most of these containers unsuitable for reuse as master containers. Separate master containers of various types are used to carry the tubes or trays of ripened fruit from the repacker to the trade outlets. The tomatoes are, in effect, packed twice, not counting the operation of placing the fruit in the trays or tubes after ripening. It has been recognized for some time that this situation afforded an opportunity to achieve economies by using the same container to carry the bulk fruit from the producing areas to the repacking plant and as a master container for the tubes of ripened and repacked fruit.

The problems and potential economies inherent in the use of dual-purpose tomato containers for shipping and handling mature-green fruit in bulk and for repacked fruit have received some attention from the Department of Agriculture, tomato shippers and repackers, and container manufacturers for a number of years. In 1952 the Department and the Western Growers Association, in cooperation with tomato shippers and container manufacturers, experimented with a modified wooden lug designed for reuse as a master container for repacked fruit. A wirebound container incorporating the reuse feature was also used on a somewhat limited scale about the same time. Neither container, however, was in use at the time this study was made. In recent years several

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1/ Mr. Enger transferred from U. S. Department of Agriculture to U. S. Department of Defense in January 1958.

different types of fiberboard dual-purpose containers have been used to varying extents by tomato shippers and repackers.

It was the purpose of this study to measure the potential economies that might be afforded to tomato shippers and repackers by the use of several of the more widely used dual-purpose fiberboard containers and to evaluate their performance in relation to the predominantly used containers for shipping the mature-green fruit from the 2 major producing areas to repackers at various terminal markets. Shipping experiments were begun during the 1954 fall shipping season in California and continued during the 1955 winter and spring shipping seasons in Florida, the 1955 fall season in California, and the 1956 spring season in Florida; they were completed during the 1956 fall season in California. These 2 States were chosen as the locale for this work because of their positions as major producing areas for the fruit and because of the diversity of containers and packing operations used in each area. However, most containers included in this study are also used to some extent in Texas and some other shipping areas, and most of the findings of this study should therefore be applicable in somewhat different degrees to shipments from those areas. The work at the repacking plants at destination in New York, Chicago, Boston, and Philadelphia was conducted in conjunction with the shipping experiments and covered the same period of time.

PACKING, SHIPPING, AND REPACKING METHODS

Objectives of Study

The main objective of this research was to determine the feasibility of shipping mature-green tomatoes in various types of comparatively new containers, especially those designed for reuse, and to measure the potential savings that might be realized from their use. One of the primary considerations was to determine whether bulk fruit packed in each type of container would reach the repacker in good condition as compared to the most commonly used containers. This included measuring the comparative quality, ripeness, bruising, and decay of the fruit as related to the transportation, refrigeration, and handling involved in packing and shipping in several different types of containers. Various loading patterns were tested to determine which methods would provide adequate circulation of air for desirable fruit temperatures. Another purpose of this research was to find out which size, type, and design of container would produce the most economies in packing, shipping, and repacking operations.

To measure the potential savings that use of any container might afford, a study of the costs of labor and material was begun at the shipping point. It started with the makeup of the containers, packing the fruit, weighing, closing, stamping, handling, and ended with loading the truck or railroad car. Costs of containers, wraps, labels, bracing, strips, spacers, and other materials were also included in order to get accurate cost comparisons. At destination markets it was necessary to obtain costs of labor and material for unloading the truck or car, opening the containers, dumping the bulk fruit on grading conveyors, converting the containers for reuse or making up new master containers, and packing the tubes of ripened fruit in the master containers. Only those labor costs which would vary directly with the type of shipping container used were covered by the time-study observations for purposes of comparing one container with another. Other shipping and repacking operations such as sorting and grading the tomatoes and placing them in the tubes, which were not affected by the type of shipping container used, were not covered in these labor-cost studies.

Shipping Containers Used

It is difficult to obtain accurate figures on the percentage of tomatoes marketed in each type of container. A list of the principal types of containers used for fruit shipped from Florida from December 5, 1955, to May 1956, with the relative percentage of the crop shipped in each type, is shown below (2): 2/

	Percent
Wirebound crates, new and used	67.8
Fiberboard boxes, new and used	13.2
Field boxes	12.7
Wooden lugs	3.0
Other containers	3.3
Total	100.0

Corresponding data for shipments of California tomatoes are not available.

Thirty-pound wooden lug.--A major shipping container used for tomatoes for many years has been the 30-pound wooden lug in which the fruit is individually wrapped and place-packed (fig. 1). California markets the greater part of its fruit in this type of container, which measures 7-1/8 by 13-1/2 by 16-1/8 inches, inside dimensions. Because of its predominance in packing and shipping of California tomatoes, the wooden lug is the "control container" with which the other containers in this study are compared for shipment of the California fruit. The lugs are usually packed with cardboard liner guards along the top edges, and often with a fiberboard pad covering the bottom. In Florida the wrapped and place-packed lug for tomatoes is used on a limited scale, and the lug has slightly different measurements than the one used in California. The lug label generally reads "min. net weight 30 pounds" although the usual practice gives a pack containing several more pounds of fruit (table 1). The size and grade of the fruit determine the number of tomatoes placed in a lug and the pattern of the pack to conform with the United States Standards for Fresh Tomatoes. A bulge in the veneer cover slats develops as the unitized cover is nailed in place. The limit on the pack for railroad shipment specifies that the bulge must not be higher than the height of the top cleats on the ends of the cover.

2/ Underlined numbers in parentheses refer to Literature Cited, p.69 .

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Figure 1.--A 30-pound wooden lug of tomatoes, showing how fruit is wrapped and place-packed in rows and layers.

Table 1.--Sample weights of tomato containers and contents shipped from Florida and California during 1955-56 1/

Container and type of pack	Label weight	Gross weight	Tare weight	Fruit weight
	Pounds	Pounds	Pounds	Pounds
Wirebound crate (bulk packed)	60	67.4	4.8	62.6
Full telescope fiberboard box (bulk packed)	50	53.1	2.3	50.8
Cap-cover-type fiberboard box (bulk packed) 2/	40	43.5	2.3	41.2
Wood lug (wrapped and place-packed)	30	41.2	5.8	35.4
Fiberboard lug (wrapped and place-packed) 3/	32	38.3	2.3	36.0

1/ These weights are actual weights found in the shipping tests from Florida and California but are not necessarily average weights for the entire tomato industry.
2/ Florida shipments only.
3/ California shipments only.

Sixty-pound wirebound crates.-- In recent years the major shipping container for Florida tomatoes by truck and rail has been the wirebound crate holding approximately 60 pounds of bulk-packed tomatoes (fig. 2). California also uses wirebound crates, but usually only in truck shipments. The crate as regularly packed contains a minimum of 60 pounds of fruit (table 1) and measures 11-15/16 by 11-15/16 by 19-7/8 inches, inside dimensions. A ventilated cardboard liner is generally used to cover inner surfaces of the container to protect the fruit. The lid is forced down and fastened on one side by connecting the 4 wires from the side of the blank through 4 wire loops on the lid and bending them back against the side of the crate. As this crate is the predominant container for Florida tomatoes, it is the "control container" with which all other containers were compared for Florida shipments.

Thirty-two-pound fiberboard lug.--One of the fiberboard containers included in this study was designed for wrapped and place-packed fruit (fig. 3). It consisted of a 2-piece, full-depth telescope type box with inside dimensions of 7-3/4 by 13-1/2 by 16-1/8 inches, the same as those of a wooden lug, except for 1/2-inch greater depth. This container holds the same quantity of fruit as the wooden lug and is packed without an appreciable bulge, due to its greater depth. No liners are used as the box is, in effect, its own liner. As this container has inside dimensions conforming closely to those

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Figure 2.--A 60-pound bulk-packed wirebound crate.

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Figure 3.--A 32-pound fiberboard lug, showing how fruit is wrapped and place-packed in rows and layers.

of the wooden lug, it was not specifically designed and consequently not well adapted for reuse as a master container for tubes of ripened fruit. In spite of that fact, the box had some limited reuse by a few repackers. The bonding agent used in making it up was different from regular glue used in the manufacturing and closing other types of containers as it had the unique property of cohering only to itself. Spots of this adhesive were matched on corresponding flaps during manufacture and when the flaps were folded for assembly, the spots of adhesive came in contact and automatically sealed with the application of only moderate pressure. Hand holes were incorporated in the end panels for ease of handling. This container was only used and tested in California shipments and was labeled as holding 32 pounds of fruit (table 1).

Fifty-pound dual-purpose fiberboard container.--Of the several types of 50-pound bulk tomato fiberboard boxes manufactured, 2 minor variations of one type were included in this study. The box shown in figure 4 has been used on a limited commercial basis for the past 3 years. Both of the containers

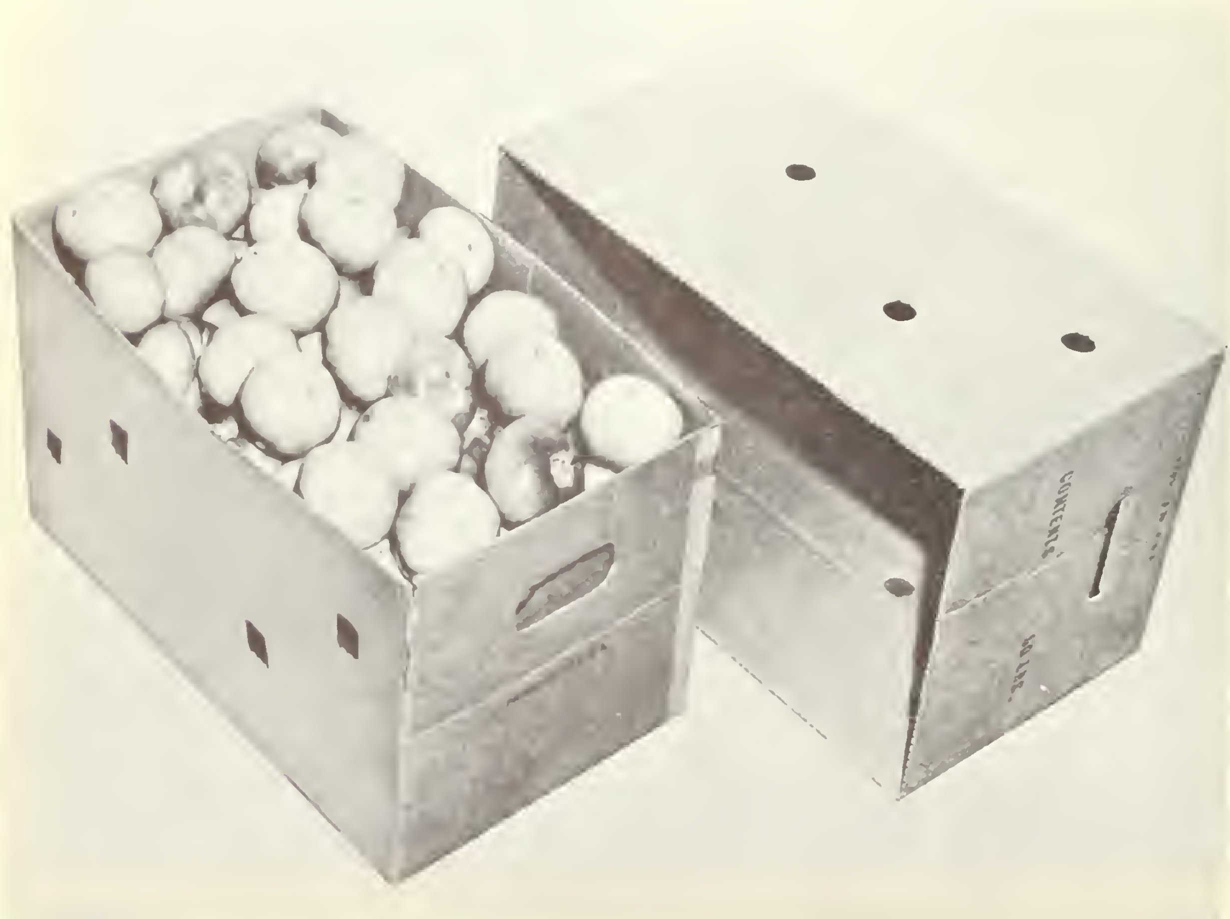

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Figure 4.--A 50-pound dual-purpose fiberboard container of bulk-packed tomatoes.

studied had the same inside dimensions and were of a 2-piece, full-depth telescope design with the top section fitting tightly over the entire bottom section. The bulk of the test shipments in this type of container were made from Florida. In the 50-pound boxes used in the Florida shipments, the inner flaps met and made a flat bottom surface while the outer flaps met together to form a flat top surface. On the other hand, the container used in the test shipments from California had bottom flaps overlapping. The inside dimensions of the bottom piece of the container were 10-3/4 by 10-7/8 by 19 inches. The flaps of the boxes were either stapled or glued, except for the corner closure or manufacturer's joint on the container blanks, which was taped to facilitate cutting down the corners at the terminal markets for reuse. The boxes were designed so that the repackers could convert the top and bottom pieces into separate master containers for holding 20 tubes of tomatoes, simply by slitting down the 4 corners half way and bending in the sides and ends of each piece at the score 3/ to produce 4 cover flaps. This box also had handhold openings in the end panels to facilitate handling. The filling was done through the unstapled or unglued bottom unit which had been placed inside the stitched or glued top prior to the start of the filling operation. After the boxes were filled, the bottom flaps were stitched or glued. This procedure eliminated the problem that originally developed upon filling the made-up bottom piece and then trying to fit the made-up tight cover over the sides of the bottom piece, which bulged outward because of the weight of the fruit.

Forty-pound dual-purpose fiberboard boxes.--There were originally 4 types of 40-pound bulk fiberboard shipping containers included in this study. Before the shipping test program was completed, however, 2 types were eliminated as commercial shipments were too few to permit an adequate number to be observed. The remaining 2 types, shown in figures 5 and 6, were considered sufficiently alike in design that they could be treated as one general type. The box shown in figure 5 was used for most of the test shipments from Florida. Test shipment observations showed that damage to these 2 containers and to the fruit in transit was about the same, and time studies of packing and repacking operations revealed only insignificant differences in labor requirements.

The 40-pound fiberboard container used in most of the test shipments was a box with inner liner that divided the container into 2 equal sections (fig. 5). This container had inside dimensions of 8-1/2 by 12-1/16 by 18-7/8 inches. The cap-type cover fitted over the bottom section with an overlap of approximately $2\frac{1}{2}$ inches and was secured by means of a metal clip imbedded in the top edge of each end of the bottom piece. These clips were placed through matching slots in the ends of the cover, then bent down and under the cover end flap for closure. The reuse feature of this box was of value to repackers who used 30-tube master containers, for its dimensions were such that it could be used for that purpose.

The second 40-pound container was designed so that both the top and bottom could be assembled without stapling or gluing by a unique arrangement

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3/ A score is an impression, or a crease, in the corrugated fiberboard to facilitate folding.

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Figure 5.--One type of 40-pound dual-purpose fiberboard box.

of interlocking parts of container blanks (fig. 6). The cover overlapped the bottom part of the carton by $3\frac{1}{2}$ inches; for closure, a flap of fiberboard on each end of the cover locked into corresponding slots on the top edges of the ends of the bottom section. Three separate thicknesses of fiberboard were used in the sidewalls. The inside dimensions of this box were 9 by $10\frac{1}{2}$ by 20 inches.

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Figure 6.--One type of 40-pound dual-purpose fiberboard container for bulk shipment of fruit to repackers.

Test Procedure and Scope of Study

Packing and shipping operations in 6 tomato packing plants in California and 6 in Florida were studied to determine the variable, or direct, costs associated with the use of the different types of containers included in this study. Information was developed on the cost of each type of container and related items such as pads and liners, car bracing and stripping material, and various other supplies required in packing and loading each type of container. Time studies were made of the amount of labor required in container assembly, filling or packing, closing, and car or truck loading and bracing.

Shipping tests were made with fruit of good quality and condition that was shipped from California and Florida by rail and by truck to several northeastern markets. Impact registers, which record the number and severity of lengthwise impacts transmitted to the lading during transit, were placed in as many rail shipments as the supply permitted to determine the comparability of transit handling received by the test shipments and the control, or check, shipments. Two-way ride recorders, which record vertical accelerations and decelerations as well as the number and severity of lengthwise shocks, were also used for the same purpose in many of the test and check shipments by motortruck. Pulp temperatures of the fruit were taken at the time it was loaded at the shipping point and again upon arrival of the shipments at destination. Recording thermometers, which gave a record of temperatures prevailing in different locations in loads during transit, were also used in a number of test and check shipments by rail and truck from both producing areas.

Upon arrival of the test and check shipments at destination markets, the loads were inspected by Department of Agriculture personnel. The suitability and performance of the loading method used in each shipment was studied and the amount of damage to the container and type of failure, if any, were observed. The fruit in most of the tests was inspected by regular Department of Agriculture inspectors to determine the ripeness, quality, and different degrees of bruising in various locations within the containers in different locations in the load. Time studies to determine the number of man-hours required to unload a given quantity of fruit in each type of container were also made at 7 different repacking plants at 3 different markets.

In the same 7 repacking plants time studies were made of the comparative man-hour requirements to open and dump the different containers of fruit into the sorting and repacking line. Cost data were obtained on the different types of master containers used to carry the tubes of ripened and repacked fruit to wholesale or retail outlets. Time studies were also made of the man-hour requirements and costs of assembling, packing, and sealing the different types of master containers. Observations were made on different types of master containers of repacked fruit as they were transported from the repacking plants to wholesale and retail outlets to determine the relative degree of protection each type of container afforded its contents.

RESULTS

Truck Shipments

Truck shipping of mature-green tomatoes has now become the principal transportation method from Florida and to some extent from California, to out-of-state points, and almost the exclusive transportation method for intrastate movement. The only practical limit placed on the load carried is the maximum weight allowance of the States through which the trucks pass.

Load patterns.--The average load observed in Florida and California contained approximately 460 wirebound crates giving a gross load weight of 31,000 pounds. 4/ The loading pattern varied widely, but a typical load had 17 stacks of containers lengthwise of the load, 4 or 5 layers high. The fifth layer was usually the variable layer and its distribution was determined by where the additional weight was necessary to give the correct axle weight distribution for the truck. The lower 3 layers usually had only 6 rows across the width of the truck, with several inches between the center rows and between the outer rows and side walls of the trailer to facilitate the circulation of air through the load. The fourth and fifth layers contained 7 rows across the width of the truck and produced a fairly tight-fitting load, as their weight helped to hold the containers in lower layers in row alinement.

The 50-pound full-telescope fiberboard boxes averaged around 550 per load for a weight of 29,200 pounds. A typical load had 17 stacks of containers lengthwise of the trailer, 5 layers high. The lower 2 layers and the fourth layer usually had 6 rows across the width of the truck with several inches between the center rows of boxes and between the outer rows and the side wall of the trailer for air circulation. The third and fifth layers from the bottom usually had 7 rows across the width of the truck, and the containers in the outer rows were fitted tightly against the side walls. As with most truck shipments, the load patterns were varied where necessary to secure proper weight distribution.

For the most frequently used type of 40-pound cap-cover type fiberboard boxes an average load consisted of 700 containers with a gross weight of 30,500 pounds. Usually there were 17 stacks of boxes lengthwise of the trailer, 7 layers high. With a load of this height the containers in each layer were loaded 6 rows wide across the width of the truck. Some loads were crosswise offset by layers with all crosswise slack being concentrated at one side wall in alternate layers. Other variations of the crosswise offset pattern were so constructed as to have the crosswise slack distributed more or less evenly between the rows of each layer (fig. 7). Crosswise offsetting of the boxes in alternate layers caused the slack distribution to be varied by layers. The overhanging cap-type covers created narrow channels between the rows, even when the containers in adjacent rows were loaded in tight contact with each other.

4/ Based on actual weights of containers shown in table 1.

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Figure 7.--Cross-section view at rear door of trailer load of 40-pound dual-purpose fiberboard cartons of tomatoes. This is a lengthwise-on-bottoms load with the load crosswise offset by layers.

Transit time.--Truck transit time from southern Florida points to New York varied from 48 to 72 hours. Running time from central California to New York varied from 96 up to 192 hours. The wide differences in running time depended on many variables, among which were number of drivers, type and condition of trucking rig, weather, road conditions, deadlines given for arrival, breakdown of equipment, and the route traveled.

Refrigeration and protective services.--The refrigeration practices and protective services used differed considerably from one test to another. Most of the trucks used in the tests were insulated, and equipped with mechanical refrigeration, while a few used water ice and salt, or dry ice, as refrigerants. Different types of blowers or air-circulating fans were used to distribute the cool air throughout the trailer. The temperature of the tomatoes at time of shipment and the prevailing weather throughout the trip determined the amount of refrigeration necessary. The maintenance of proper temperatures sometime required continuous mechanical refrigeration or frequent re-icings all the way from the shipping point to the terminal market. Often, upon picking up a load of tomatoes, the driver received instruction, if the truck was equipped with mechanical refrigeration, to keep the thermostat at a certain setting. At other times the load was refrigerated upon leaving the shipping point and then later needed protection from cold weather before it reached destination. In the winter, heaters of a portable type, using alcohol or propane for fuel, were used to keep the fruit from chilling or freezing.

Wall strips and floor racks are advisable to insure adequate circulation of air around and under the load (3). The recommended transit temperatures for tomatoes are 55-70° F. The most satisfactory shipping results are obtained with thermostatically controlled refrigerating and heating devices. When used properly, heaters help prevent chilling injury which occurs when the tomatoes are transported at temperatures under 50° F. "The lower the temperature and the longer the time the fruit is held at temperatures below 50° F., the more susceptible the fruit is to decay. Mild chilling injury does not show in transit or on arrival but it shows up later in ripening with more culls and less 'pack out' " (6).

Rail Shipments

Rail shipment is an important factor in the transportation of mature-green tomatoes from California and Florida. Special features of rail transportation such as diversion and reconsignment, lower minimum weights which permit smaller loads, and scheduled, dependable delivery have considerable value to the tomato industry. The minimum weight for rail shipment is usually 20,000 pounds of tomatoes, containers, liners, and wraps. The shipping containers, loading methods, patterns, and bracing listed in tariffs of container and loading rules issued by the railroads, vary considerably between Florida and California. For California, from which tomatoes move mostly in wooden lugs, 10 different loading methods are authorized in the Container and Loading Rules Tariffs for divided loads and only one method for a solid load. For Florida, with very little lug movement, only one divided and one solid loading method are authorized.

Load patterns.--The typical shipment of California tomatoes in 30-pound wooden lugs was loaded crosswise with a center gate in the doorway area (fig. 8) and with either horizontal stripping on each layer, or gate frames with vertical strips used to hold the containers in row alinement and maintain the ventilation channels (fig. 9). This allowed the air to circulate through the entire load. The average divided carload consisted of 650 lugs with a weight of 26,800 pounds. The lugs are loaded crosswise on bottoms across the width of the car, 5 rows wide, 5 layers high (fig. 9). The standard load is 26 stacks long with 13 stacks in each end of the car. The loads are divided in the doorway area by a center gate about 24 to 30 inches wide. All lengthwise slack is taken up by squeezing the load with a mechanical device before installation of the center-gate bracing in the doorway area.

BN-6038

Figure 8.--Doorway view of a refrigerator carload of California tomatoes in 30-pound wooden lugs, showing center gate in place.

BN-6039

Figure 9.--Cross-section of a crosswise-on-bottoms load of 30-pound wooden lugs of California tomatoes, showing gate frames to hold lugs in row alinement being installed at the shipping point.

In Florida shipments, in which the 60-pound wirebound crates are used extensively, lengthwise loads, solid and divided, with or without horizontal stripping, are authorized (fig. 10). Most shipments, however, consist of through, or solid, loads with no center gate. For shipments in the wirebound containers from California, only through loads are authorized, with or without horizontal stripping. Almost all the loads observed were of the solid type without stripping, containing 399 crates per car with gross weight of 27,000 pounds. The crates are loaded lengthwise in the car, on bottoms, 7 rows wide, 3 layers high, 19 stacks long, in a car of standard length.

The rail shipments of the full-telescope 50-pound fiberboard boxes from both States consisted predominantly of through, chimney-type loads (fig. 11), although several tests were run on split-T type and crosswise-lengthwise loads. The typical chimney load held 456 containers, made up of 36 chimney

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Figure 10.--Cross-section of a refrigerator carload of 60-pound wirebound crates at the shipping point.

stack units of 12 boxes each and 2 crosswise stacks of 12 boxes each. The crosswise stacks were separated from each other by chimneys or vertical ventilation flues to facilitate air circulation. This load had a gross weight of 24,200 pounds with 3 layers of containers.

The loads of the 40-pound fiberboard boxes with the cap-type covers were mainly of the solid type and contained 556 boxes, having a gross weight of 24,200 pounds. The loading pattern was 4 layers high, 4 boxes crosswise, and 1 container lengthwise, making a total of 5 rows across the width of the car. The crosswise rows were 30 boxes long and the lengthwise rows were 19 long. This solid load worked well for most of the 40-pound containers, as the overhang of the cap-type covers made narrow channels for ventilation between the rows and stacks of boxes and between the outer rows of boxes and the side walls.

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Figure 11.--Doorway view of chimney load of 50-pound full-telescope fiberboard boxes in refrigerator car at the shipping point.

The 32-pound fiberboard lug for placed and wrapped tomatoes was loaded in solid or through loads, which contained 628 containers with a gross weight of 24,050 pounds. Each stack had 4 rows of boxes loaded crosswise and 2 rows of boxes loaded crosswise and 2 rows loaded lengthwise of the car, 4 layers high. In the ends of the car there were a total of 24 crosswise stacks and 20 lengthwise stacks with the doorway area filled out with 3 stacks of containers loaded crosswise, 7 rows wide. The lugs were separated by 31-inch-long "X" type separators of fiberboard that fitted between the corners of 4 adjoining containers. Because the slight bulge of the boxes took up most of the ventilation space between the rows, the separators appeared to be of little value.

Transit time.--The usual transit time for rail shipments from southern Florida to New York was 4 to 5 days. The direct schedule from central California to the same city was 8 days, with the total time before unloading, including handling time by consignees at destination, averaging from 9 to 11 days. Differences in transit time by rail depended on the routing and how soon the receiver wanted the car delivered. Otherwise, the actual elapsed time in transit would usually not have varied more than 1 day. Some rail shipments of tomatoes were not unloaded until 2 or 3 days after their arrival at destination. The unloading was usually delayed if a large percentage of fruit in the shipment was green in order to give it time to ripen in the car, or if the repacker had a considerable amount of other fruit on hand waiting to be run over the sorting line. In contrast, however, most truck shipments were unloaded the day they arrived, regardless of the ripeness of the fruit.

Refrigeration and protective services.--The protective services necessary for tomato shipments by rail depend primarily upon the average temperature of the fruit when loaded and the weather at time of shipment. Protective services used for the test and check shipments by rail included in this study were representative of those used for the majority of commercial shipments of tomatoes from each major producing area. The services, in general gave satisfactory results, but in a few shipments temperatures in the doorway area were found to be a little on the low side during cold weather. Recommended initial icings for fall-grown tomatoes shipped from California to eastern markets are (6):

Average temperature of fruit when loaded	Initial ice for cars shipped with vents closed
Above 80° F.	$2\frac{1}{2}$ tons in each bunker (full)
Between 75° and 80°	2 tons in each bunker
Between 65° and 75°	$1\frac{1}{2}$ tons in each bunker 1/
Between 60° and 65°	1 ton in each bunker 1/
Between 55° and 60°	$\frac{1}{2}$ ton in each bunker 1/
Between 50° and 55°	None

1/ On half-stage racks

Shipments from Florida have somewhat different requirements because of the different tomato shipping areas in that State and the different shipping seasons in these areas. Usually the temperature of the fruit at time of loading is higher than in California and requires immediate refrigeration to reduce it to the desired level for transit. This tabulation should be helpful in determining icing requirements for fruit shipped from different areas, provided the necessary adjustments are made for prevailing conditions.

A light re-icing at one-half to 1 ton in each bunker may be desirable for long-distance shipments in unseasonably warm weather. Moderate and uniform temperatures can best be maintained in cars equipped with air-circulating fans.

COMPARATIVE LABOR REQUIREMENTS BY TYPE OF CONTAINER

Packing Shed Operation

All 6 packing sheds in Florida and California covered in this study had both railroad spurs and truckloading docks for shipping tomatoes. The packing methods used varied somewhat between the 2 States, partly because of the different containers packed. The time studies for labor requirements started with the moving of materials required for the containers, makeup, or assembly, and followed through all the other packing operations until the packed containers were loaded in the rail car or truck. No time and cost studies were made of other phases of packinghouse operations, such as receiving, dumping, sizing, and grading fruit, which were not affected by the type of shipping container used.

Florida

As bulk containers are used to market most of the tomatoes produced in Florida, most packing sheds in the State are equipped primarily for bulk packing. Many of the sheds are of more than one level, with the second story being used for the storage and assembly of container blanks. Assembly operations include stitching of fiberboard containers or the makeup and inserting of liners in wirebound crates. The containers are then fed by gravity chute or conveyor to the first floor packing line. Many houses pack fiberboard boxes, crates, and field boxes simultaneously on the same line. The one-story buildings have makeup facilities in a separate area away from the working area of the actual packing operations, and the assembled containers are fed to the packing lines by manually pushing them down a roller conveyor or by a powered belt conveyor.

The operation of "catching," or filling the containers, requires from 1 to 3 men per filling station, depending upon the size of the fruit being graded at that point and how fast the grading belt is being operated. The extremely large and small sizes of fruit usually do not grade out in as large quantities as medium sizes and therefore do not require as many men to keep up with the grading belt. The elements of work in the actual "catching" operation for wirebounds take place in the following sequence: Reach for an empty container, open it, adjust the liner, stamp fruit size on the container, place it next to the container being filled, push it under the filling chute (simultaneously pushing the full crate out), level out the amount of fruit in the filled container, and move the full container to the powered conveyor line for transportation to the lidding station. In team operation the workers usually change positions with one another several times in the day to help relieve the monotony of the job.

The filled containers are then moved down the conveyor, usually to a weighing station. Some of the sheds, however, have omitted this operation and instead fill each container to capacity. In both operations the packs are leveled out on top, sometimes adding a few more tomatoes or removing some. The paper or cardboard liners are folded inward, the lid bent down in a partially closed position, and the 4 wireloops on the side bent into an upright position. The 60-pound wirebound crates then go into the semiautomatic closing machine that, with the aid of the operator, pushes the 4 wires on the side of the crate through 4 loops on the lid, closes the lid, and bends down the 4 wire ties tightly against the crate.

In the full-telescope 30-pound box, the top flaps were first stitched shut (fig. 12). The bottom piece of the container was then placed inside the inverted top piece and the bottom flaps bent outward away from the center of the box so that they would not interfere with filling (fig. 13). After filling, the containers are moved to the weighing station, if any. The fruit is then leveled out, and as the boxes move through a gluing machine, the bottom flaps are folded and sealed, or if a stapling gun is used, the flaps are closed and stitched. Filling this type of container through the bottom eliminated the difficulties that were encountered when the bottom pieces were filled separately and the top piece was then forced over the bottom piece. The weight of the fruit bulged the sides of the piece outward, making it difficult to slide the top piece over it.

The 40-pound fiberboard containers had separate covers that fitted 2 or 3 inches down over the sides of the bottom part of the carton. The fruit was poured into the bottom part of the carton, which then followed the same operations of weighing and leveling as the other containers. The lidding operation simply consisted of placing the covers on the bottom of the box, engaging the metal clips, if any, through the slots in the covers, and bending them downward to secure the covers.

The filled containers were then transported into the truck or refrigerator car by 2-wheel clamp-style hand trucks. A few of the packinghouses had powered belt conveyors for carrying the containers into the cars or trucks. The loaders removed the containers from the hand trucks or conveyor and placed them in the load according to the loading pattern used.

Only a few of the packinghouses in Florida were equipped for packing placed and wrapped tomatoes in 30-pound wooden lugs, and in those that were so equipped the lug packing facilities were secondary to the primary bulk-packing lines.

California

Tomato packinghouse methods in the main producing areas of this State differed greatly from those used in Florida. The lines and packing areas in the packing sheds were basically designed for handling place-packed and wrapped tomatoes in wooden lugs. In recent years facilities have been added for bulk-packing operations in most sheds. Some of the sheds are of the multistory type with lug makeup or assembly on the second floor. In other sheds the containers were assembled elsewhere in the shed and supplied to the lines by means of powered or manually operated conveyors. Some of the sheds even had the container makeup men outside in an area near the plant building.

The wood parts of the lugs were assembled by automatic nailing machines of which there were several different types in use. Some of the plants had labeling machines to label the ends of the lugs before assembly. From the assembly area the assembled lugs were moved by manually operated roller conveyors, powered belt conveyors, or chain trolley conveyors, parallel to the packing line.

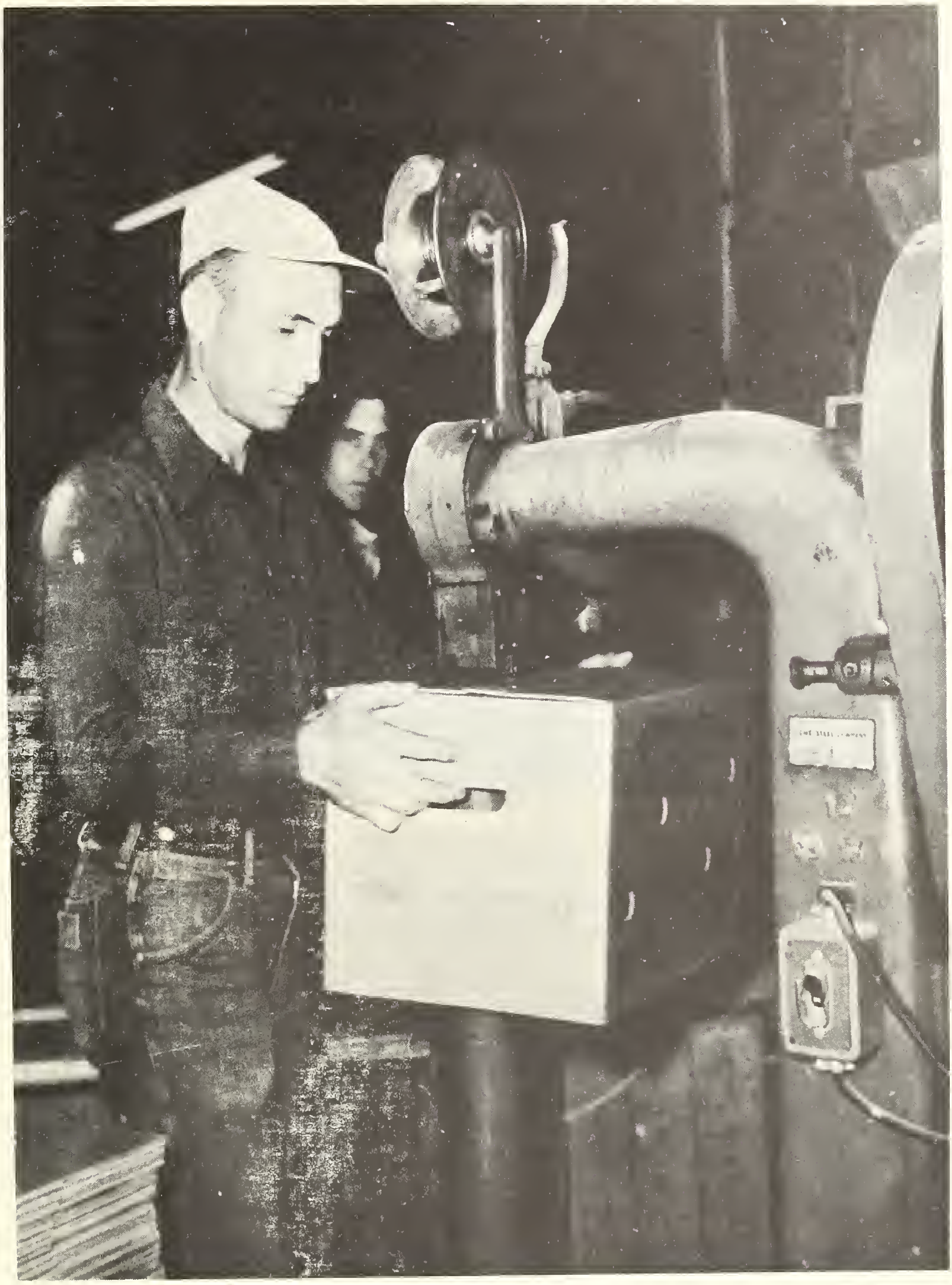

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Figure 12.--Stitching flaps of one section of 50-pound full-depth telescope, dual-purpose fiberboard box.

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Figure 13.--Folding in flaps on bottom section of the full-telescope 50-pound dual-purpose fiberboard box.

Varying with the size of the packing shed, the packing line or lines had many stations for packers located extremely close to one another. At these packing stations the packer grasped the sized and graded fruit from the bin, wrapped it with tissue wrap, and place-packed it in the lug, lining up the individual fruits in rows and layers. United States Standards for Fresh Tomatoes cover the size and arrangement of the fruit in the 30-pound wooden lug. The shipper has the option of several types of packs but each pack has stringent requirements for pattern, fruit size, and wrapping. The bulk of the shipments in lugs observed in the shipping tests were of the U. S. Double Wrap Pack in which the tomatoes in the top layer or "face" were packed with only 1 tomato in a wrapper and the lower layer, or layers, of fruit were packed not more than 2 tomatoes in a wrapper.

The full lugs were then placed on a powered conveyor belt and moved to the lidding machine. This is an automatic nailing device that securely nails the cover to the ends of the lug. The packed lugs were transported into the truck-trailer or refrigerator car by 2-wheel clamp-type hand trucks, or by powered or gravity conveyors. The car loaders removed the containers and placed them in the load, nailed down the spacing strips or gate frames, squeezed the slack from the load by means of a hydraulic squeeze, and installed the doorway bracing.

The packing of the 60-pound wirebound crates varied considerably between different sheds. Some of the newer sheds were built with ample room and advance planning for bulk-packing operations. Many of the older houses had to revise their layout to add the bulk facilities wherever space permitted. The crates were usually assembled much nearer to the filling operation than the lugs were. The assembly and filling operation for wirebound crates in general, however, followed quite closely the previously described method of operation used in Florida.

The methods used in packing the 32-pound fiberboard lugs were exactly the same as those used for the 30-pound wooden lugs, except for the makeup and closure of the container. This container was manufactured with matching spots of pressure-sensitive adhesive on the top and bottom flaps. The bottom piece of the lug was assembled by folding together the flaps and pressing the spots of adhesive together. The top was then placed around the outside of the bottom piece with the cover flaps unsecured. After the lug was packed with fruit, the cover flaps were folded into position and the matching spots of glue caused the flaps to stick together with the application of a moderate amount of pressure on the top of the container.

Labor Requirements

As this study was designed to compare some experimental containers with the predominantly used containers in Florida and California, one important step was the development of a comparison of the costs and labor requirements of packing and shipping fruit in the different containers. Industrial engineering studies were made of all packing-shed operations that were affected by the type of tomato shipping containers used. The same or similar work elements were observed for all containers included in this study. The time requirements for work elements secured by time studies were supplemented with allowances to cover worker fatigue and personal time. Productive labor only was included in the study, as many of the containers studied were often assembled and filled on an experimental basis, with more delay than would occur if the packing sheds were properly equipped to pack and handle them on a regular commercial basis. In addition, as most unproductive labor results from the type of supervision the workers receive, it should occur with approximately the same frequency with any type of container being used at any given plant on a production basis. Table 2 includes a general grouping of the work elements studied and the average time plus allowances that was actually spent on productive work. Packinghouse operations such as grading the fruit and picking out culls were not included in the labor study as they were not affected by the shipping container used.

Table 2.--Packing-shed productive labor required for packing tomatoes, by type of operation and container, California and Florida, 1955-56 1/

Work operations studied	Average man-minutes per 100 pounds of tomatoes in--				
	Wood 30-pound lug 2/	Wire-bound 60-pound crate 2/	Fiber-board 50-pound box 2/	Fiber-board 40-pound box 2/	Fiber-board 32-pound lug 2/
	Man-minutes	Man-minutes	Man-minutes	Man-minutes	Man-minutes
Make up container, place in liners, deliver to packing line	.96	.78	.90	1.83	1.58
Get container, stamp, adjust liners, fill or wrap and pack, place full container on conveyor	8.67	2.11	1.62	1.90	8.75
Weigh, adjust tomatoes in container, stamp, label, bend down lid, lid or seal, set off or pull off the line	1.13	1.12	1.31	1.55	.97
Transport to car or truck and return	.36	.27	.33	.35	.36
Load in truck or railroad car, make and install bracing, strips, gates, spacers, etc.	.67	.31	.34	.21	.56
Total, all operations	11.79	4.59	4.50	5.84	12.22

1/ Includes personal and fatigue allowances.
2/ Label weights used for container identification. Actual container and fruit weights from table 1 were used in the calculations.

Data in table 2 show that most of the difference in labor requirements by type of container occurred in the filling of the containers, with the wrap and place-pack in the 30-pound wooden lug and the 32-pound fiberboard lug taking 4 to 5 times as much labor time as the bulk packs in the other containers. As the time requirements for each of the work operations shown in table 2 are expressed on the basis of 100 pounds of fruit, the containers of smaller capacity have greater labor requirements since it is necessary to assemble, pack, and handle more of them than the larger containers for an equivalent quantity of fruit. The 50-pound full-telescope fiberboard box required only 1.62 man-minutes per 100 pounds of fruit for the filling operation, as compared with 1.90 man-minutes for the 40-pound fiberboard box, 2.11 for the 60-pound wirebound crate, 8.67 for the wooden lug, and 8.75 for the fiberboard lug.

For all assembling, packing, and loading operations, the labor required for 100 pounds of fruit was 4.50 man-minutes for the 50-pound full-telescope fiberboard box, 4.59 for the 60-pound wirebound crate, 5.84 for the 40-pound fiberboard box, 11.79 for the wooden lug, and 12.22 for the fiberboard lug.

Repacking Operations and Methods

The 7 repacking plants studied at different markets were all equipped with facilities for receipt of tomatoes by truck. In addition, most, but not all, were located on railroad spurs. In the larger terminal markets the smaller repackers without railroad spurs often bought tomatoes at auction and trucked them to their plants, or received them directly by truck, or trucked them from a car located on railroad team tracks.

Several basic methods were used for unloading the fruit from the trucks and railroad cars at the 7 different repacking plants covered in this study. Most of the more modern plants used a portable powered belt conveyor to transport the containers from the truck or car. Still others used a gravity roller conveyor for the same purpose. In most plants the containers were stacked on pallets outside the car for further transfer to temporary storage or the dumping line by forklift trucks. Some plants still used the manual 2-wheel clamp truck for the same purpose. The most modern plant layout studied tied in a powered conveyor within the plant to the powered conveyor from the car and transported the containers directly to the dumping position. The plants that did not use conveyors in unloading usually employed a 4-wheel hand platform truck, with or without pallets, or skids, or 2-wheel hand trucks. The size of unloading crews varied from 1 to 5 men, the average being a 2-man crew. Temporary storage was usually necessary for part of the car or truck load as the unloading function was faster than the sorting and repacking of the fruit. As the fruit was needed by the dumping crews, it was drawn from the temporary storage which was usually located as close to the dumping operation as the amount of available floor space permitted. In many plants the storage facility was on a different floor than the packing and grading line.

The size of the dumping crew varied with the types of containers being dumped, and with the ripeness and condition of the fruit being handled. Containers with a high proportion of ripe and turning-ripe fruit had to be dumped slowly to allow the sorters to separate it correctly. Lugs required a large crew because of difficulty encountered in opening them, their small capacity (requiring opening more containers than for the same amount of fruit in containers of larger capacity), and the job of loosening the paper wraps. Usually the dumping operation required 2 to 4 men in the crew, exclusive of additional operators required for loosening or removing paper wraps. Many of the containers, after being emptied of their contents, were stacked on skids and taken to the loading dock area for disposal or sale to used-container vendors. The wooden lugs often went farther down the repacking line and were used for temporary storage of green or turning ripe tomatoes in the ripening rooms.

In several plants the fiberboard boxes incorporating reuse features were taken directly to the tube-packing station at the end of the grading and packing line and used as master containers for the tubes of ripe tomatoes. In many of the repacking plants that also repacked a variety of vegetables and vegetable products in prepackaged form, almost any carton was reused as a master container for soup mixes, cole slaw, spinach, or any other item prepacked in film bags. The majority of prepackaged tomatoes in tubes are packed out in master containers holding 10 tubes of tomatoes each (1). A substantial quantity is also packed out in containers holding 20 tubes each. The small remainder is packed out in master containers holding 12, 15, 24, 30, or 40 consumer packages (4). The master containers of 10-tube capacity are usually self-closing, and those of 20-tube capacity are sealed by means of gummed paper tape.

Time studies were made of all repacking operations that were directly affected by the type of shipping containers in which the fruit was received. Allowances for fatigue and personal time were added to the time required for the actual productive work elements. Table 3 shows the general grouping of the separate elements of work studied in the various operations and includes the average time actually spent on productive work, with applicable allowances. Repacking operations such as sorting the fruit and picking out overripe fruit and culls, were not included in the labor study as they were not affected by the type of shipping container in which the fruit was received.

Table 3 shows that the greatest difference in labor requirements of the various operations studied is found in the opening of containers, dumping, and removing paper wraps, with the wrapped and place-packs requiring 3 to 4 times as much labor per 100 pounds of fruit for these work elements as was required for the same quantity of fruit received in bulk-packed containers.

The opening and dumping operation for the full-telescope 50-pound fiberboard box (fig. 14) required only 1.25 man-minutes per 100 pounds of fruit as compared with 1.52 for the 60-pound wirebound crate, 1.74 for the 40-pound fiberboard box, 4.21 for the fiberboard lug, and 5.66 for the wooden lug (table 3). Differences in labor requirements as between the different types of shipping containers for the various other repacking operations studied were relatively insignificant. However, there was a slight difference between the 50-pound full-telescope fiberboard box and the other containers in the makeup, packing, and sealing of the master containers. A slightly greater amount of time was required to convert each 50-pound shipping container to 2 master containers and to seal the covers than to assemble, fill, and close new master containers for the fruit received in the other shipping containers. The total differences in labor requirements for all selected repacking operations for the fruit received in different types of shipping containers are summarized in table 3 according to the size of master container used for

Table 3.--Productive labor for selected repacking operations by type of shipping container and size of master container, 7 tomato repacking plants, 1955-56 1/

Work operations studied	Average man-minutes per 100 pounds of tomatoes received in--				
	Wooden lug, 30 lb. 2/	Wirebound crate, 60 lb. 2/	Fiberboard box, 50 lb. 2/	Fiberboard box 40 lb. 2/	Fiberboard lug, 32 lb. 2/
	Man-minutes	Man-minutes	Man-minutes	Man-minutes	Man-minutes
Unloading truck or railroad car	0.77	0.42	0.48	0.54	0.72
Transport fruit to temporary storage and/or dumping point	0.62	0.49	0.53	0.62	0.62
Open container, dump tomatoes, remove wraps, take empties to storage or point of utilization	5.66	1.52	1.25	1.74	4.21
Make up master container for 20 tubes, pack tubes, seal master container, and stack on skid	4.69	4.69	4.72 4/	4.69	4.69
Total labor required for 20-tube master container	11.74	7.12	6.98 4/	7.59	10.24
Make up master container for 10 tubes, pack tubes, seal master container, and stack on skid	6.62	6.62	6.62	6.62	6.62
Total labor required for 10-tube master container 3/	13.67	9.05	8.88	9.52	12.17

1/ Includes personal and fatigue allowance. Does not include delay. 2/ Label weights used for container identification. Actual container and fruit weights from table 1 were used in calculations. 3/ Total of lines 1, 2, 3, and 6. The type of master container used for the repacked fruit does not affect the time requirement for the performance of the operations described on lines 1 through 3. When 10-tube master containers are used it is necessary to assemble, pack, seal, and handle twice as many containers for the same quantity of fruit as is required when 20-tube capacity containers are used. 4/ Shipping container converted to and reused as two 20-tube master containers.

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Figure 14.--Dumping tomatoes onto grading or sorting line at repacking plant from 50-pound full-telescope fiberboard boxes.

carrying the tubes of repacked fruit from the repacking plant to wholesale and retail outlets. The comparison is made on this basis because of the differences in cost of makeup and packing between the two sizes of master containers. Time differences in labor required for the dumping operations account for most of the differences in total labor requirements between the various containers.

COMPARATIVE COSTS BY TYPE OF CONTAINER

Cost comparisons were made for the various tomato containers used in the shipping tests. These costs are separated into broad groups associated with different segments of the packing, transportation, and repacking of mature-green tomatoes. Costs for the same containers used for shipments from Florida and California are compared separately due to the substantial differences in labor costs and methods of operation found between these two producing areas. It was necessary to establish a basis for comparison to allow for differences in carload weights for the various tomato containers in use. The standard carload of tomatoes from California consists of approximately 23,000 pounds of wrapped fruit packed in wooden lugs; the average rail shipment from Florida contains approximately 25,000 pounds of fruit packed in wirebound crates. Averaging the standard loads from each State gives a load of 24,000 pounds of fruit upon which all cost calculations in this report are based.

Costs to Shippers and Potential Savings

California.--The labor-time ingredients of the separate work elements involved in packing and loading the various shipping containers used in California (see table 2) were found by extensive time studies. These time measurements were translated into labor costs by using the values from the 1956 Tomato Wage Scale in California, applying the piece rate where applicable and the hourly rates for operations not covered by piece rates. Costs of materials, such as containers, car bracing, paper wraps, crate liners, car loading strips, and center gates, charged to the shipper, were also secured. The basic purpose of this part of the study was to compare direct costs of containers, labor, and material. It was assumed that costs such as overhead, fruit grading, power, lights, water, depreciation, and insurance would not vary with the type of shipping container used. As the wooden lug is the predominant shipping container for California tomatoes, it is used as a basis of comparison for packing, loading, transportation, and repacking costs for California fruit.

Table 4 shows the various costs for packing operations studied with respect to containers, from makeup or assembly for filling through loading out of the car for shipment from California. Similarly, the potential savings 5/ are listed for each item covered. Use of the standard wooden lug involves total average packing costs of $512.01 per carload of 24,000 pounds of wrapped and place-packed fruit. The container which offered the greatest potential savings in packing and loading costs was the 50-pound full-telescope fiberboard box, with a total cost of only $248.77. As compared to the standard wooden lug, the total saving was $263.24 per carload. The potential savings were $246.24 for the 60-pound wirebound crate and $212.28 for the 40-pound cap-cover type fiberboard box. 6/ The potential savings are smaller for the fiberboard lug box of wrapped and place-packed fruit, being only $103.35 per car. The greatest part of the potential savings is realized from differences in costs of containers, liners, labels, and other materials. Labor productivity may be increased by pouring the fruit into the containers designed for bulk packs, rather than placing tomatoes individually.

5/ The term "potential savings" as used in this report refers to the average savings that might be realized if one type of container were substituted for another. They are necessarily based on the average costs at the packing and repacking plants at which the time and cost studies were made.

6/ Although this container was not used for shipment of California tomatoes during the period covered by this study, calculated costs and potential savings that might derive from its use are shown here. They are based on the delivered cost of this type of container in California and on man-hour requirements for assembling, filling, lidding, and loading, which were developed in studies in Florida packinghouses with packing facilities and methods similar to those in California and were converted to labor costs by using the 1956 California Tomato Wage Scale.

Table 4.--Costs of container, assembly, packing, and loading, per railroad carload of tomatoes, by type of container, California, 1956 1/

Cost item	Wooden lug, 30 lb.	Wirebound crate, 60 lb.		Fiberboard box, 50 lb. 2/		Fiberboard box, 40 lb.		Fiberboard lug, 32 lb.	
	Costs	Costs	Difference 3/	Costs	Difference 3/	Costs	Difference 3/	Costs	Difference 3/
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Labor--container make-up, packing, closure, loading out 4/	158.48	91.05	67.43	97.71	60.77	113.16	45.32	155.83	2.65
Containers, liners, labels, and other materials	330.13	174.72	155.41	151.06	179.07	186.57	143.56	243.22	86.91
Car bracing, strips, gates, spacers (materials and labor)	23.40	None	23.40	None	23.40	None	23.40	9.61	13.79
Total costs	512.01	265.77	- -	248.77	- -	299.73	- -	408.66	- -
Total difference as compared to 30-pound wooden lug	- -	- -	246.24	- -	263.24	- -	212.28	- -	103.35

1/ Calculations based on carload of 24,000 pounds of fruit using weights from table 1 against a standard car of fruit wrapped and place-packed in standard wooden lugs.

2/ This container not covered by 1956 Tomato Wage Scale so the rate was assumed to be $0.1413 for filling 50-pound container, as this was half-way between rates of "Filling 60-lb. Container - $0.16 per Crate" and "Filling 40-pound Container - $0.1225 per Crate," which were included.

3/ As compared with costs for 30-pound wooden lug shown in column 1.

4/ Labor operations studied are covered in detail in table 2. Costs based on rates in 1956 Tomato Wage Scale for California.

Florida.--The same procedure was followed in Florida, except that the average wage rate of $1.25 per hour was used for figuring labor costs as there was no uniformity of wage rates in tomato shipping areas in this State. As the fiberboard lug for wrapped and place-packed tomatoes was not used in Florida, that container is omitted from table 5. The standard container in Florida is the wirebound crate holding approximately 60 pounds of fruit. The total cost of packing a carload of 24,000 pounds of fruit in this container was found to be $189.97. A slight saving of $18.81 resulted from the use of the 50-pound full-telescope fiberboard box; on the other hand, use of the 40-pound fiberboard box would have resulted in a loss of $22.84. Actually, these 3 containers were quite close to each other for cost purposes. The wooden lug, when used, had costs of $398.86 per carload, which is $208.89 more than the cost for the standard wirebound crate. This substantial cost for packing the wooden lugs probably accounts, in part, for the rapid rise in the use of bulk containers in Florida.

Rail Transportation Costs

As representative freight rates were difficult to secure for truck shipments, and for rail shipments they are a matter of public record, rail charges are included for comparative purposes. Truck rates for the same quantity of fruit are believed to be somewhat lower.

California.--Charges for refrigeration and protective services were assumed to be the same for all shipments from this State, as the net weight of fruit per carload was approximately the same for the shipments in different types of containers studied. Loads of the wooden lugs had approximately 2,720 pounds more tare weight of wood, paper, etc., exclusive of bracing and stripping, to cool than the 50-pound fiberboard box, which might be expected to use slightly more refrigeration.

Rail freight charges were calculated for shipments from Stockton, Calif., to both Chicago, Ill., and New York, N. Y., for the containers included in the tests, based on estimated weights from the applicable tariffs for the 30-pound wooden lug and the 60-pound wirebound crate and on the actual weights listed in table 1 for the fiberboard containers. Freight charges are slightly less on all other containers than on the standard wooden lug (table 6).

Florida.--Rail freight charges were calculated from Homestead, Fla., to Chicago, Ill., and New York, N. Y., for the experimental tests, based on the actual load weights given in table 1. For all other containers, as shown in table 7, there are slight savings in freight charges over the standard 60-pound wirebound crate.

Costs and Potential Savings in Repacking Plants

The actual operations in ripening and repacking of tomatoes do not differ much with the various types of containers used, or with the locality from which the tomatoes are received, so long as the quality is good. The kind of shipping

Table 5.--Container, assembly, packing, and loading costs from rail shipments of tomatoes by type of container, Florida, 1956 1/

Cost item	Wirebound crate, 60-lb.	Fiberboard box, 50-lb.		Fiberboard box, 40-lb.		Wooden lug 30-lb.	
	Costs	Costs	Difference 2/	Costs	Difference 2/	Costs	Difference 2/
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Labor--container makeup, packing, closure, loading out 3/	22.93	22.48	0.45	29.16	6.23	58.91	35.98
Containers, liners, labels, and other materials	167.04	148.68	18.36	183.65	16.61	316.55	149.51
Car bracing, strips, gates, spacers (materials and labor)	None	None	None	None	None	23.40	23.40
Total costs	189.97	171.16	- -	212.81	- -	298.86	- -
Total difference as compared to 60-pound wirebound crate	- -	- -	+18.81	- -	-22.84	- -	-208.89

1/ Calculations based on carload of 24,000 pounds of fruit using weights from table 1 against a standard car of fruit wrapped and place-packed in standard wooden lugs.
2/ As compared with costs for 60-pound wirebound crate shown in column 1.
3/ Labor operations studied are covered in detail in table 3. Costs based on $1.25 per hour.

Table 6.--Rail freight charges per carload for tomatoes shipped from Stockton, Calif., to Chicago, Ill., and New York, N. Y., by type of container, 1956 1/

Container shipped 2/	To Chicago, Ill., 3/		To New York, N. Y. 4/	
	Charges 5/	Difference 6/	Charges 5/	Difference 6/
	Dollars	Dollars	Dollars	Dollars
Wooden lug, 30-pound....	538.70	--	647.50	--
Wirebound crate, 60-pound..............	529.10	9.60	635.95	11.55
Fiberboard box, 50-pound..............	524.44	14.26	630.36	17.14
Fiberboard box, 40-pound..............	530.63	8.07	637.80	9.70
Fiberboard lug, 32-pound..............	530.41	9.29	637.54	9.96

1/ Based on carload of 24,000 pounds of fruit, using weights from table 1 for experimental containers and estimated weights from Transcontinental Freight Bureau Tariff 44-M for 30-pound wooden lug and 60-pound wirebound crate for freight charge purposes.
2/ Label weights used for container identification.
3/ Rate of $2.03 per 100 pounds to Chicago, Ill.
4/ Freight rate of $2.44 per 100 pounds to New York, N. Y.
5/ Costs include 3 percent Federal tax.
6/ As compared to the 30-pound wooden lug.

containers in which the fruit is received, however, is important to many repackers because of their resale or reuse value, which varies from one market to another. Table 8 shows certain repacking costs where tomatoes are packed out in 10-tube master containers, which is the size used by most repackers (fig. 15). A large part of these costs is accounted for by the original cost of the 10-tube master containers used by most repackers to carry the fruit from the repacking plant to the wholesale or retail outlets. The cost of the master containers averaged $278.51 per carload of packed-out fruit. Allowances are included in the cost calculations for resale or reuse value of the various original shipping containers received. These allowances are representative market values of the containers that prevailed at the time this study was made; they vary considerably with plant locations and with the time of the year.

Some repackers, who run auxiliary produce operations such as packing spinach and soup mixes, can use almost any suitable containers as master containers for these products. At some locations repackers may have to pay to

Table 7.--Rail freight charges per carload for tomatoes shipped from Homestead, Fla., to Chicago, Ill., and New York, N. Y., by type of container, 1956 1/

Container shipped 2/	To Chicago, Ill., 3/		To New York, N. Y., 4/	
	Charges 5/	Difference 6/	Charges 5/	Difference 6/
	Dollars	Dollars	Dollars	Dollars
Wirebound crate, 60-pound	490.15	--	479.49	--
Fiberboard box, 50-pound	475.35	14.80	465.02	14.47
Fiberboard box, 40-pound	480.97	9.18	470.51	8.98
Wooden lug, 30-pound	488.28	1.87	477.66	1.83

1/ Based on carload of 24,000 pounds of fruit, using weights from table 1 for all containers, except wooden 30-pound lug, for which estimated weight is 36 pounds, and the 60-pound wirebound crate for which the estimated weight is 67 pounds, from Tariff No. 783-C, Southern Freight Tariff Bureau.
2/ Label weights used for container identification.
3/ Rate of $1.84 per 100 pounds to Chicago, Ill.
4/ Rate of $1.80 per 100 pounds to New York, N. Y.
5/ Costs include 3 percent Federal tax.
6/ As compared to the 60-pound wirebound crate.

get rid of some containers after emptying them. The wooden lugs have a definite value in the ripening operation or for resale, and the wirebound crates are frequently resold. The fiberboard boxes are usually less valuable. A repacker may substitute the appropriate value of his own shipping container in table 8 to make more accurate comparisons for his own operations.

Some of the containers included in the study were designed for reuse as 30-tube master containers. These cartons were found not to have much use as master containers, as most repackers did not want to pack tubes of ripe tomatoes 3 layers deep.

Table 8 shows that the only substantial economy that could be made by a repacker who wishes to put his fruit in a 10-tube master container would be through the use of the 40-pound fiberboard box which can be reused as a 10-tube, 20-tube, or 30-tube master container (fig. 16). Reuse of this box as a 10-tube master container would result in a saving of $108.15 for the use of this particular container. However, the number of 40-pound fiberboard boxes in a carload of tomatoes will not provide enough 10-tube master containers for the entire carload of ripened fruit repacked in tubes (24,000 pounds less the average shrinkage of 11.7 percent). It is therefore necessary to use

Table 8.--Container and labor costs per carload for unloading, dumping, assembling, and repacking new 10-tube master containers and net savings as compared with 30-pound wooden lug, by type of shipping container, 7 repacking plants, 1956 1/

Items covered	Wooden lug, 30-lb.	Wirebound crate, 60-lb.	Fiberboard box, 50-lb.	Fiberboard box, 40-lb.: Not repacked as master container	Fiberboard box, 40-lb.: Repacked as master container	Fiberboard lug, 32-lb.
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Labor--Unloading, dumping, removing paper wraps, make-up, and pack master container 2/	82.02	54.25	53.24	57.09	57.09	73.03
Master container 3/ costs	278.51	278.51	278.51	278.51	4/ 144.44	278.51
Total costs	360.59	332.76	331.75	335.60	201.53	351.54
Allowance for resale or reuse value of shipping container 5/	-50.93	-32.64	-23.60	-29.15	-134.07	-33.95
Net costs	309.66	300.12	308.15	306.45	6/ 201.53	317.59
Savings or loss as compared with column 1	- -	9.54	1.51	3.21	108.15	-7.93

1/ Calculations based on carload of 24,000 pounds of fruit using weights from table 1 and assuming 11.7 percent of fruit not repacked in tubes.

2/ Labor operations studied are covered in detail in table 4. Costs based on $1.50 per hour.

3/ New 10-tube master container cost - 11½ cents each.

4/ Original shipping containers used as master containers. The shipping containers so used, however, provided only enough master containers for part of the carload of fruit (24,000 pounds less the average shrinkage of 11.7%) and $144.44 worth of new 10-tube master containers were used for the remaining amount of repackaged fruit.

5/ Allowances for resale or reuse value of original shipping containers: lug, 7½¢; 60-pound wirebound, 8½¢; fiberboard boxes, 5¢ each except where 40-pound fiberboard boxes reused as 10-tube master container valued at 11½¢ each.

6/ This figure is not the difference between lines 3 and 4 for this column, as the allowance for the value of the shipping containers converted to master containers is covered by the difference between the figures in line 2 of this column and the comparable figures on the same line of the other columns of this table.

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Figure 15.--Ten-tube master fiberboard container showing arrangement of tubes of ripened tomatoes in package.

some new 10-tube master containers to accommodate the difference. All other containers not having a reuse feature or resale value would have no potential savings as compared to the wooden lug, but might actually cost more to use if the repacker would have to pay to dispose of them, as was frequently the case with the 32-pound fiberboard lug.

On the other hand, as shown by the repacking cost data in table 9, a repacker may realize a substantial saving in costs of containers and labor by packing out the tubes of ripened fruit which he may receive in any type of shipping container if he uses a 20-tube master container instead of a 10-tube master container. The first column in table 9 shows the total costs to the repacker for a carload of 24,000 pounds of fruit received in wooden lugs and repacked in 10-tube master containers purchased new for this purpose. The total costs shown on line 3 include the costs of unloading the car and dumping the fruit on the grading or sorting conveyor, in addition to the cost of the

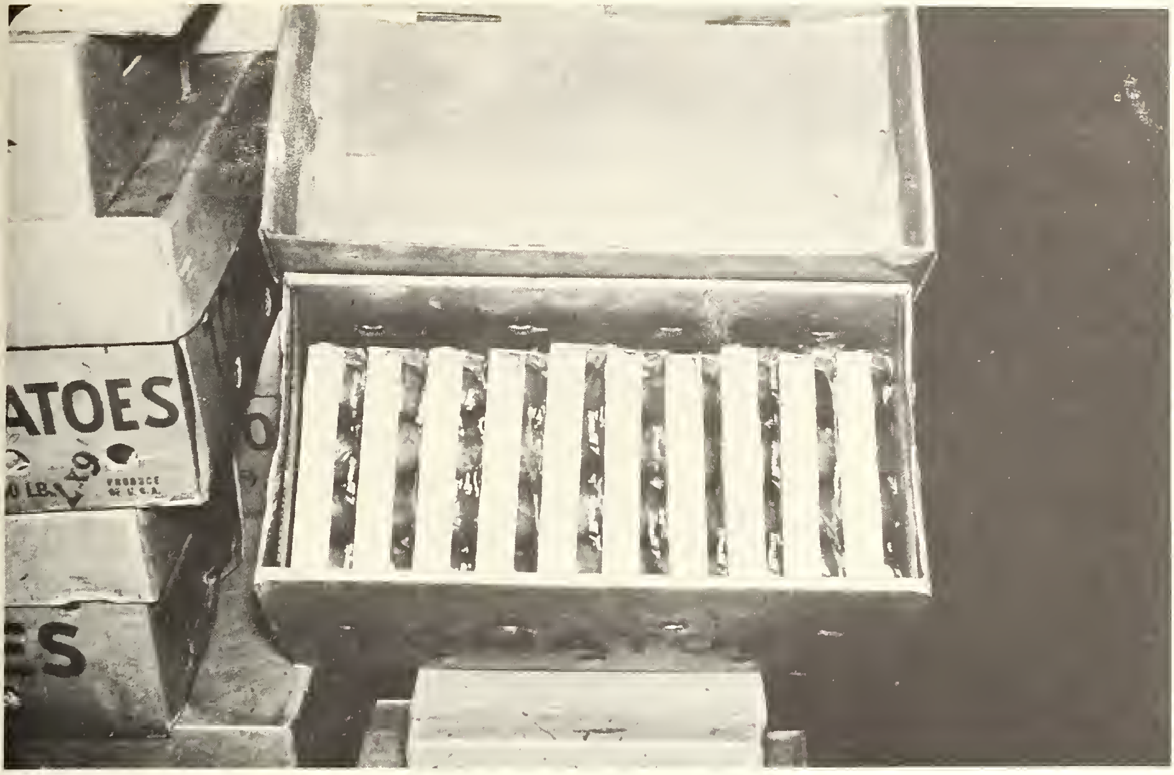

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Figure 16.--40-pound dual-purpose fiberboard box showing reuse as 10-tube master container.

new 10-tube master containers delivered and the labor costs for assembling and packing them. The net cost shown on line 4 is obtained by deducting the resale or reuse value of the original shipping container from the total costs shown in line 3. For a carload of fruit received in wooden lugs and with the tubes repacked in 10-tube new containers, the net cost shown in line 4 is $309.66.

The costs in the first 4 lines of the remaining columns of table 9 are calculated in the same way as those in column 1. The remaining columns of this table, except column 4, show the total costs incident to receiving the fruit in different types of shipping containers and packing out the ripened fruit in new 20-tube master containers. Line 5 shows the net savings that the repacker may realize by using the new 20-tube master containers for the fruit received in each type of shipping container, except for the one in column 4, instead of using a 10-tube master container. These savings derive from lower labor costs required to assemble, pack, and close only half as many 20-tube master containers for a given quantity of fruit as when the 10-tube master containers are used. Also, the 20-tube master containers cost less than the 10-tube containers as they are of somewhat simpler design and only half as many are required for a given quantity of fruit.

Table 9.--Comparative repacker costs and savings per carload from using various types of shipping containers as 10-tube and 20-tube master containers for delivery of tomatoes to retail stores, 7 repacking plants, 1956 1/

Cost item	Wooden lug, 30-lb.: Repacked in new 10-tube master	Wooden lug, 30-lb.: Repacked in 20-tube master	Wirebound crate, 60-lb.: Repacked in 20-tube master	Fiberboard box, 50-lb.: Not repacked as master container	Fiberboard box, 50-lb.: Repacked as master container	Fiberboard box, 40-lb.: Repacked as 20-tube master container	Fiberboard lug, 32-lb.: Repacked in 20-tube master container
	Dollars (1)	Dollars (2)	Dollars (3)	Dollars (4)	Dollars (5)	Dollars (6)	Dollars (7)
Labor--Unloading dumping, removing paper wraps, makeup, and master container 2/	82.02	70.44	42.67	41.86	41.86	45.51	61.45
Master container costs 3/	278.51	121.09	121.09	121.09	4/ 26.70	121.09	121.09
Total costs	360.59	191.53	163.76	162.95	68.56	166.60	182.54
Allowances for resale or reuse value of shipping container 5/	-50.93	-50.93	-32.64	-23.60	-94.39	-29.15	-33.95
Net costs	309.66	140.60	131.12	139.35	6/ 68.56	137.45	148.59
Total savings as compared with column 1	- -	169.06	178.54	170.31	241.10	172.21	161.07

1/ Calculations based on carload of 24,000 pounds of fruit using weights from table 1 and assuming an average of 11.7 percent of fruit not repacked in tubes.

2/ Labor operations studied are covered in detail in table 4. Costs based on prevailing wage rate of $1.50 per hour.

3/ Cost of 20-tube master container, 10 cents each; cost of 10-tube master container, 11½ cents each.

4/ Original shipping cartons converted and used as master containers. The shipping containers so converted, however, provided only enough master containers for part of the carload of fruit (24,000 pounds, less the average 11.7 percent shrinkage) and $26.70 worth of new 10-tube master containers were used for the ramining amount of repacked fruit.

5/ Allowances for original shipping container: lug, 7½¢; 60-pound wirebound, 8½¢; cartons, 5¢ except 50-pound fiberboard boxes reused as 20-tube master containers, valued at 10¢ each.

6/ This figure is not the difference between lines 3 and 4 for this column, as the allowance for the value of the shipping containers converted to master containers is covered by the difference between the figure in line 2 of this column and the comparable figures on the same line of the other columns of this table.

In column 4 of table 9 the costs are shown for the 50-pound fiberboard shipping container when it is reused as a 20-tube master container (figs. 17 and 18). As compared with the cost shown in column 1 for fruit received in the wooden lug and repacked in new 10-tube master containers, the saving realized by using the 50-pound cartons was $241.10. This saving was considerably larger than the potential savings shown for using new 20-tube master containers for the fruit received in other types of shipping containers. As was the case with the 40-pound fiberboard box, a carload of the 50-pound fiberboard containers when converted and reused as 20-tube master containers did not provide quite enough master containers for an entire carload of ripened and repacked fruit. Although both the top and bottom sections of the full-telescope box were converted to 20-tube master containers and therefore provided considerably more master containers than the 40-pound fiberboard box, $26.60 worth of new 20-tube master containers were required for the remainder of the repacked fruit.

Total Potential Savings

California

Table 10 shows total potential savings per carload and per net pound of fruit that may be realized from the use of the several different types of fiberboard containers for packing and shipping mature-green tomatoes from Stockton, Calif., to New York, N. Y., and Chicago, Ill., as compared with the costs of packing and shipping them in wooden lugs to the same destinations. However, the potential savings of $169.06 per carload or 0.7 cent per pound shown in line 1 for the wooden lug are only the savings in repacking costs that may be achieved by repacking the tubes of ripened fruit in 20-tube instead of 10-tube master containers. Potential savings from this alternative repacking method were shown in table 9.

Total potential savings shown for the wirebound crate and 3 types of fiberboard boxes are the aggregate of the savings in original cost of the shipping containers, and in costs of assembling, packing, loading, freight, unloading, dumping, and repacking the tubes of ripened fruit in new 10- and 20-tube master containers. The potential savings in using the converted 50-pound fiberboard full-telescope shipping container as a 20-tube master container for the repacked ripened fruit is also included. The potential savings are quite substantial, ranging from $103.71 per carload, or 0.4 cent per pound, for shipments of fiberboard lugs to Chicago, Ill., to $521.48 per car, or 2.2 cents per pound, for shipments of 50-pound full-telescope fiberboard boxes to New York, N. Y.

Florida

Table 11 presents similar data on the total potential savings for rail shipments of mature-green tomatoes from Homestead, Fla., to New York, N. Y., and Chicago, Ill. For the Florida shipments, however, the 60-pound wirebound crate, the predominant container for shipments of green tomatoes from that State, is used as the basis of comparison instead of the 30-pound wooden lug. The potential savings shown for the wirebound crate in line 1 of table 11 are the savings in repacking costs only that may be realized from use of new

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Figure 17.--One section of a 50-pound full-telescope, dual-purpose fiberboard shipping container being converted to a 20-tube master container.

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Figure 18.--20-tube master containers of tomatoes stacked on pallet in repacking plant.

Table 10.--Total potential savings in container, packing, transportation, and repacking costs for rail shipments of tomatoes from Stockton, Calif., to New York, N. Y., and Chicago, Ill., by type of shipping container and size of master container used for repacking fruit, 1956 1/

Type of container 2/	From Stockton, Calif., to New York and repacked in--				From Stockton, Calif., to Chicago, Ill., and repacked in--			
	10-tube master		20-tube master		10-tube master		20-tube master	
	Savings per carload	Savings per pound	Savings per carload	Savings per pound	Savings per carload	Savings per pound	Savings per carload	Savings per pound
	Dollars	Cents	Dollars	Cents	Dollars	Cents	Dollars	Cents
Wooden lug, 30-pound, wrapped and place-packed	- -	- -	3/ 169.06	.7	- -	- -	3/ 169.06	.7
Wirebound crate, 60-pound, bulk-packed 4/	267.33	1.1	436.33	1.8	265.38	1.1	434.38	1.8
Full-telescope fiber-board box, 50-pound, bulk packed 4/	281.89	1.2	521.48	5/ 2.2	279.01	1.2	518.60	5/ 2.2
Fiberboard box, 40-pound, bulk-packed 4/	330.13	6/ 1.4	394.19	1.6	328.50	6/ 1.4	392.56	1.6
Fiberboard lug, 32-pound, wrapped and place-packed 4/	105.38	.4	274.38	1.1	103.71	.4	272.71	1.1

1/ Total potential savings for different operations shown in tables 4, 6, 8, and 9.
2/ Label weights used for container identification. For actual weights see table 1.
3/ Potential savings in repacking costs only given in table 14 for repacking tubes of ripened fruit received in wooden lugs in 20-tube master containers as compared with costs of repacking the tubes in 10-tube master containers.
4/ Total potential savings in container, packing, transportation, and repacking costs as compared with fruit shipped in wooden lugs and repacked in 10-tube master containers.
5/ Shipping container reused as 20-tube master container.
6/ Shipping container reused as 10-tube master container.

Table 11.--Total potential savings in container, packing, transportation, and repacking costs for rail shipments of tomatoes from Homestead, Fla., to New York, N. Y. and Chicago, Ill., by type of shipping container and size of master container used for repacked fruit, 1956 1/

Type of container 2/	From Homestead, Fla., to New York and repacked in--				From Homestead, Fla., to Chicago, Ill., and repacked in--			
	10-tube master		20-tube master		10-tube master		20-tube master	
	Savings per carload	Savings per pound	Savings per carload	Savings per pound	Savings per carload	Savings per pound	Savings per carload	Savings per pound
	Dollars	Cents	Dollars	Cents	Dollars	Cents	Dollars	Cents
Wirebound crate, 60-pound, bulk-packed	- -	- -	3/ 169.00	3/ .7	- -	- -	3/ 169.00	3/ .7
Full-telescope fiberboard box, 50-pound: bulk-packed 4/	18.25	.1	258.84	5/ 1.1	18.58	.1	259.17	5/ 1.1
Fiberboard box, 40-pound, bulk-packed 4/	78.73	6/ .3	142.81	.6	78.93	6/ .4	143.01	.6
Wooden lug, 30-pound: wrapped and place-packed 4/	-222.60	-.9	-53.54	-.2	-222.56	-.9	-53.50	-.2

1/ Total potential savings for different operations shown in tables 5, 7, 8, and 9. In addition to $6.00 per car advantage to the 60-pound wirebound crate for refrigeration, saving due to heavier load is used to offset savings by other containers to that amount.

2/ Label weights used for container identification. For actual weights see table 1.

3/ Potential savings in repacking costs only from tables 13 and 14 for ripened fruit received in 60-pound wirebound crates repacked in 20-tube master containers as compared with the cost of repacking tubes in 10-tube master containers.

4/ Total potential savings, or loss in container, packing, transportation, and repacking costs as compared with fruit shipped in 60-pound wirebound crates and repacked in 10-tube master containers.

5/ Shipping container reused as 20-tube master container.

6/ Shipping container reused as 10-tube master container.

20-tube instead of new 10-tube master containers for the ripened fruit previously presented in table 9. The total potential savings shown for the 40-pound and 50-pound bulk-packed fiberboard boxes shipped from Homestead, Fla., to New York, N. Y., as compared with the shipments in 60-pound wirebound crates with the ripened fruit repacked in new 10-tube master containers, ranges from $18.25 per carload, or 0.1 cent per pound, to $258.84, or 1.1 cents per pound. The latter figure is for the 50-pound full-telescope fiberboard boxes which are converted to 20-tube master containers by the repacker.

Line 4 of table 11 shows that the additional cost of using the 30-pound wooden lug as a shipping container, as compared to the cost of the 60-pound wirebound crate, ranges from $53.54 per car, or 0.2 cent per pound, to $222.56 per car, or 0.9 cent per pound.

No potential savings are shown in table 11 for the fiberboard lug as it was not used for Florida shipments of mature-green tomatoes when this study was made.

Comparative Efficiency of Containers

Experimental shipments, both truck and rail, of tomatoes from California and Florida were observed during the 1954, 1955, and 1956 seasons to provide a basis for determining the relative efficiency of several types of dual-purpose fiberboard containers for shipping mature-green tomatoes and of the predominantly used shipping container from each area. The information developed for each of the containers included data on damage to the container and on bruising, ripeness, decay, and transit temperatures of the fruit. A further comparison was made as to container specifications, their type and size, and loading patterns which will best suit the movement of fresh tomatoes under normal transit conditions. Consideration was also given to the adequacy of container ventilation.

Included in the overall sample of 91 rail shipments of tomatoes on which complete data were obtained, were 26 cars from California and 65 from Florida. Complete data were developed on only one of the truck shipments from California although there were 31 truck shipments from Florida. In addition to the 123 test loads by rail and truck on which complete data were obtained, there were 13 rail shipments and 7 truckloads which were not included because the data on the results were not complete.

Container Damage During Shipment

Because of the dissimilarity in shipping practices and containers used in California and in Florida, it was not possible to combine the data for an overall evaluation of results for all shipments from both areas. Furthermore, since it was intended particularly to compare bulk-packed dual-purpose fiberboard boxes with the standard wooden containers, shipments of the bulk-packed cartons are treated separately from the wrapped and place-packed wooden lug and fiberboard lug shipments.

California tomato packers and shippers generally favor the wooden lug, identified as Container No. 1028 in the railroad container tariffs, in which the fruit is wrapped and place-packed. During the past 2 years California shippers have made some experimental use of a lug-type fiberboard box holding approximately the same quantity of tomatoes as the wooden lug box.

The comparative damage to containers found at destination in test shipments of different containers by rail from California and Florida is shown in table 12. These data reveal that 14 cars containing the new 2-piece fiberboard lugs of full-depth telescope construction, with the fruit wrapped and place-packed, averaged 12 cartons damaged or 1.9 percent of all containers in the cars from California; in 7 cars of wood lugs packed in the same way, damaged lugs averaged 7.4, or 1.1 percent of all containers in the cars. The showing for irreparable packages was even less favorable for the fiberboard lugs, with an average of 7.4 containers, or 1.2 percent, as against 0.4 wooden lug per car or 0.1 percent of total containers in the cars.

The 40-pound fiberboard boxes used in the California shipping experiments were of the same full-telescope design as the 50-pound box used in both Florida and California, but not like the 40-pound cap-cover type box used in Florida. For this reason the data on efficiency of this container developed in the California shipping tests is not comparable to the data for the 40-pound cap-cover container used in the shipping experiments from Florida. Because of the similarity in design, handling, and loading, the data for the 40-pound full-telescope fiberboard box is actually more comparable to that for the 50-pound full-telescope box. There were only 3 test shipments of the 40-pound and 2 test shipments of the 50-pound full-telescope fiberboard boxes by rail from California. The 40-pound size had only 0.7 percent damaged and no bad-order boxes (damaged beyond repair), while the 2 cars of the 50-pound size container sustained 4.1 percent damaged and 2 percent bad-order boxes.

Shipments of mature-green tomatoes from Florida until the last several years have moved largely in 60-pound wirebound crates. A few buyers still use their own bulk-packed, unlidded field crates for truck shipments to their repacking plants. Table 12 shows the results of rail test shipments of Florida tomatoes during the 1955 and 1956 seasons. There were 15 check cars loaded with the standard 60-pound wirebound crates which sustained an average damage rate of 6.3 crates per car, or 1.6 percent of total containers in the loads, and an average of 1.3 crates per car, or 0.3 percent of total bad order, or irreparable. The 40-pound cap-cover fiberboard containers compared favorably with the wirebound crates in terms of damage during shipment, with 11 cars of the 40-pound cap-cover type boxes having no damage. Damage was also comparatively light in shipments of the 50-pound full-telescope fiberboard box, but its record was not as good as that of the 40-pound cap-cover type box.

The results of these shipping tests indicate that the fiberboard containers studied are capable of withstanding damage under normal rail transit conditions.

Table 12.--Comparative container damage in rail test shipments of tomatoes from California and Florida, by type of container, 1954, 1955, and 1956

State of origin and type of container 1/	Test cars	Total packages	Average packages per car	Average container damage per carload: Damaged containers		Average container damage per carload: Irreparable containers	
	Number	Number	Number	Number	Percent	Number	Percent
California:							
Wooden lug, 30 pounds, wrapped and place-packed	7	4,550	650	7.4	1.1	0.4	0.1
Fiberboard lug, 32 pounds, wrapped and place-packed	14	8,834	631	12.0	1.9	7.4	1.2
Full-telescope fiberboard box, 40 pounds, bulk-packed	3	1,810	603	4.0	0.7	0	0
Full-telescope fiberboard box, 50 pounds, bulk-packed	2	894	447	18.5	4.1	2.0	0.4
Florida:							
Wirebound crate, 60 pounds, bulk-packed	15	5,927	395	6.3	1.6	1.3	0.3
Cap-cover type fiberboard box, 40 pounds, bulk-packed	11	6,116	556	0	0	0	0
Full-telescope fiberboard box, 50 pounds, bulk-packed	39	17,581	451	5.6	1.2	0.6	0.1

1/ Label weights used for container identification.

A number of test and check shipments by motortruck were made from Florida during 1955 and 1956 (table 13). Damage to wirebound crates and fiberboard boxes in the truck shipments was comparatively light. Twenty-one truck loads of Florida tomatoes in fiberboard boxes were studied for comparison with 10 check shipments of wirebound crates. Eleven of the test shipments were of 40-pound cap-cover fiberboard boxes, and 10 of them were of 50-pound boxes, full-telescoped. All were bulk-packed.

Inspections at destination showed that damage in the trucks loaded with 60-pound wirebound crates and 40-pound cap-cover fiberboard boxes was relatively insignificant. Damage in the shipments of the larger 50-pound full-telescope type, although nominal, still was considerably heavier than in the 40-pound boxes. On an overall basis, including all 21 truck loads, the fiberboard boxes averaged 1.9 transit-damaged containers per load, or 0.3 percent of the total per truck. The 10 check shipments of wirebound crates had an average rate of only 0.2 crate damaged per load, and less than 0.1 crate beyond repair.

Despite some slight creasing, crushing, or buckling of the corners (designated as transit damage) in the relatively few fiberboard containers, all of the boxes were accepted by consignees and none were delivered in bad order subject to loss and damage claims.

Only one test shipment of tomatoes in cartons was made by truck from California to New York City. No container damage was found in this transcontinental shipment of 40-pound full-depth telescope boxes.

Most of the damage in both the fiberboard boxes and the wirebound crates was found in the last few stacks at the rear of the load over the tandem axle area. The most severe vertical shock and vibration are concentrated in this area of the trailer body.

Bruising of Fruit in Relation to Ripeness, Temperatures, and Ventilation

Probably the most important requirement of a good shipping container for mature-green tomatoes is the ability to protect its contents against excessive bruising from pressure during transportation and marketing. Bruising, particularly severe bruising, not only seriously detracts from the marketable appearance of the fruit, but also usually leads to subsequent deterioration. The comparative ability of a shipping container to deliver a high percentage of undamaged fruit to the ripening and repacking plant is therefore a good measure of its efficiency.

The susceptibility of tomatoes to bruising varies directly with the degree of ripeness. The higher the degree of ripeness in a given lot of fruit, the higher will be its susceptibility to bruising. This relationship was taken into account in making comparisons of the relative amounts of bruising of the fruit in the different types of shipping containers included in this study. It was also necessary to take into account the bruising that occurs in packing the fruit in different types of containers.

Table 13.--Comparative container damage in truck shipments of tomatoes from Florida by type of container, 1954, 1955, and 1956

State of origin and type of container 1/	Truck test load	Total packages	Packages per load	Average container damage per truckload: Damaged containers		Irreparable containers	
	Number	Number	Number	Number	Percent	Number	Percent
Wirebound crate, 60 pound, bulk-packed....................	10	4,586	459	.2	2/	0	0
Cap-cover type fiberboard box, 40 pound, bulk-packed...........	11	7,517	683	.5	.1	0	0
Full-telescope fiberboard box, 50 pound, bulk-packed...........	10	5,488	549	3.3	.6	0	0

1/ Label weights used for container identification.
2/ Less than 0.1 percent.

Table 14 presents the data on bruising in various types of containers during test shipments by rail and motortruck from Florida and California to eastern markets. The data shown in this table were developed from inspection of the fruit at destination by Department of Agriculture inspectors. The fruit used in most tests came from the same packing sheds and went to the same destination markets. The quality and maturity of the fruit at time of shipment, as determined by Federal-State inspection at the shipping point, were fairly comparable.

In the rail shipments from California the 50-pound full-telescope fiberboard box compared favorably with the standard wooden lug in protecting the fruit from serious damage by bruising. Although there is considerable variation between the different containers in amounts of slight bruising, not much significance is attached to this type of bruising as it is not sufficient to affect the grade of the fruit. Much of the slight bruising consists of flattened areas on a small part of the surface of the tomato, some of which may have occurred in handling and packing the fruit before shipping.

Only one test shipment of fiberboard containers was made by motortruck from California. As is shown in the table, this test load consisted of 40-pound full-telescope bulk-packed boxes, with a low percentage of damage by bruising.

Bruising damage in the 13 rail shipments of the fiberboard lugs, in which the fruit was wrapped and place-packed, was high. Most of the bruising, which was slight, was caused by a combination of the method of packing and the container itself. In place-packing the tomatoes are packed tightly together in straight, uniform rows and are not free to move or seek their own level in the package, as the fruit in bulk-packed containers is. Consequently, pressure on any face of a flexible fiberboard package resulting from overhead weight and loading or handling, or from load shifting and various other causes, is transmitted directly from one fruit to another, causing bruising. Bruising from this source is also in addition to that incurred in packing the fruit and lining it up in rows. The comparison suggests that flexible containers are not suitable for wrapped and place-packed tomatoes and that the best results can be obtained with fiberboard containers when the fruit is bulk-packed or jumble-packed in them.

As the shipping season in Florida is somewhat longer than in California, more tests by rail and truck were made from the Homestead and Fort Pierce areas in Florida. In the Florida shipping tests the 40-pound and 50-pound bulk-packed fiberboard containers were satisfactory in both rail and truck shipments. Fruit in the 50-pound full-telescope fiberboard boxes, as the data in table 14 show, had slightly less bruising than that in the 40-pound cap-cover fiberboard boxes. However, as only 8 cars of the 40-pound boxes were shipped by rail as compared with 38 cars of the 50-pound size, not much significance can be attached to the differences in bruising. As compared with the results for the 60-pound wirebound crates, however, the fiberboard boxes, and particularly the 50-pound size, were found to protect the fruit adequately from moderate and serious damage by bruising in both rail and truck shipments.

Table 14.--Bruising of mature-green tomatoes in rail and truck shipments from California and Florida, by type of container, 1954, 1955, and 1956

State of origin and type of container	Rail shipments				Truck shipments			
	Test cars	Slight bruising 1/	Damage by bruising	Serious bruising	Test trucks	Slight bruising 1/	Damage by bruising	Serious bruising
	Number	Percent	Percent	Percent	Number	Percent	Percent	Percent
California:								
Wooden lug, 30 pounds, wrapped and place-packed..	7	18.1	3.0	.1	-	-	-	-
Fiberboard lug, 32 pounds, wrapped and place-packed..	13	30.8	6.5	1.0	-	-	-	-
Full-telescope fiberboard box, 50 pounds, bulk-packed..................	2	12.5	4.0	1.0	-	-	-	-
Full-telescope fiberboard box, 40 pounds, bulk-packed..................	2	10.8	1.5	0	1	4.0	0	0
Florida:								
Wirebound crate, 60 pounds, bulk-packed..............	12	13.9	1.1	.2	6	8.2	1.0	.2
Full-telescope fiberboard box, 50 pounds, bulk-packed..................	38	16.2	.6	.2	9	11.6	.9	0
Cap-cover type fiberboard box, 40 pounds, bulk-packed..................	8	17.9	.8	0	10	23.3	1.2	.3

1/ Not affecting grade.

Ripeness of Fruit by Type of Container

Data on ripeness averages and decay of fruit in the different types of containers in the rail and truck shipments from Florida and California are given in table 15. Ripeness on arrival at the market depends upon the maturity of the tomato when picked, the transit temperature, and the period of time the fruit is held in the car or truck. Many tomato repackers prefer to have a fairly large percentage of the fruit ripe upon arrival of the shipment. If a fairly large percentage of the fruit is firm ripe, or almost ripe, upon arrival, it is possible to pack out a large proportion of it on the first run of the fruit over the grading and packing line, putting little of it into the ripening rooms. Thus, less handling and less storage space are required to ripen the fruit. However, the fruit does not always ripen at a uniform rate and, in most shipments having a large percentage of firm ripe fruit upon arrival, there is also likely to be a certain percentage of soft ripe, or overripe fruit, not suitable for repacking. A preponderance of green tomatoes upon arrival increases the cost of handling and also the danger of loss from decay because of the extra time required to ripen the fruit. The repacker, therefore, usually runs some risk of having losses from overripeness and spoilage with shipments arriving with a high degree of ripeness, and losses from extra handling cost and decay with shipments arriving too green. Moreover, a high degree of ripeness in the fruit during shipment greatly increases its susceptibility to bruising.

For the rail test shipments from California, the data in table 15 show that a somewhat greater percentage of the fruit was ripe and turning color in the fiberboard lug than in the other containers studied. However, this amount of ripeness is preferred by many repackers. There was also more decay in the fiberboard lug shipments than in shipments of the other containers but not more than is acceptable commercially. These differences may have been due to differences in maturity of the fruit at time of shipment rather than to the containers. There was only one test shipment by truck from California, which consisted of 40-pound full-telescope fiberboard boxes. Results from these limited tests showed that the fiberboard lugs did not cause the fruit to ripen excessively.

Ripeness of Florida fruit upon arrival at the market was not as far advanced in all types of containers studied as that of the fruit in the California shipments. This was probably due in a large measure to the shorter time in transit for the Florida shipments as compared with the transcontinental California shipments. Truck shipments from Florida averaged fewer ripe and turning-ripe tomatoes than the rail shipments from that State, also partly reflecting the shorter time in transit for the truck shipments as compared with the rail shipments. The Florida fruit shipped in 40-pound and 50-pound fiberboard boxes was somewhat riper than the fruit shipped in 60-pound wirebound crates, but the difference was not great. Although the fruit in the 40-pound fiberboard boxes was riper than that in the full-telescope fiberboard boxes in the rail shipments, the fruit in the 50-pound boxes was riper than that in the 40-pound boxes in truck shipments. The significance of these ripeness comparisons is somewhat limited by the difference in the number of shipments of each type of container by each method of transportation. However, the results indicate that the 40-pound and 50-pound bulk-packed fiberboard containers had enough ventilation to prevent the fruit from ripening too quickly.

Table 15.--Ripeness and decay of tomatoes in rail and truck shipments from California and Florida, by type of container, 1954, 1955, and 1956

State of origin and type of container	Rail shipments					Truck shipments				
	Test cars	Mature green	Turning color	Firm ripe	Decay	Test cars	Mature green	Turning color	Firm ripe	Decay
	Number	Percent	Percent	Percent	Percent	Number	Percent	Percent	Percent	Percent
California:										
Standard wooden lug, 30 pounds, wrapped and place-packed	7	59.3	30.0	10.7	1/	-	-	-	-	-
Fiberboard lug, 32 pounds, wrapped and place-packed	13	31.5	53.5	15.0	3.4	-	-	-	-	-
Full-telescope fiberboard box, 50 pounds, bulk-packed	2	57.5	30.0	12.5	1/	-	-	-	-	-
Full-telescope fiberboard box, 40 pounds, bulk-packed	2	52.5	37.5	10.0	1/	1	70.0	25.0	5.0	1/
Florida:										
Standard wirebound crate, 60 pounds, bulk-packed	12	75.3	19.3	5.4	1.6	6	90.0	10.0	0	1/
Full-telescope fiberboard box, 50 pounds, bulk-packed	38	70.0	23.1	6.9	1.3	9	84.4	15.6	0	1/
Cap-cover type fiberboard box, 40 pounds, bulk-packed	8	58.8	34.2	7.0	1/	10	88.8	10.7	1/	1/

1/ Less than 1.0 percent.

Fruit Temperatures by Type of Container

Just as the comparative ripeness of the tomatoes during shipment influences their susceptibility to bruising during shipment and handling, so temperature of the fruit during shipment influences the degree of ripeness upon arrival at destination. Transit temperatures much above 65° F. for extended periods greatly increase the rate of respiration and ripening of the fruit. As the field temperatures of tomatoes are usually high at time of loading (sensible heat) and the fruit also generates comparatively large amounts of heat in its process of respiration (vital heat), adequate provision must be made for ventilation of the fruit in the packages so that most of this heat may be removed (7). It is therefore necessary that the containers in which the fruit is shipped have sufficient ventilation openings and that the containers be loaded in a pattern that will permit sufficient air circulation during transportation.

Average temperatures of fruit pulp at destination in both rail and truck shipments of tomatoes from Florida and California to eastern markets in the different types of containers studied are given in table 16. The recommended temperature range for the transportation of mature-green tomatoes is from 55° to 65° F. Prolonged exposure of the fruit to temperatures below 50° F. will cause chilling injury, with the result that the fruit will not ripen satisfactorily (5). Table 16 shows that temperatures of the fruit upon arrival at destination were, on the whole, fairly satisfactory. The lowest temperatures in loads of this commodity were usually obtained in the bottom layer of the load at the doorway of the car. Temperatures in other parts of the load were found to range from 4 to 10 degrees higher. Exceptionally high temperatures apparently did not prevail in any type of container upon arrival at destination and all types studied appeared to provide satisfactory ventilation of the fruit.

The bulk-packed 40-pound and 50-pound fiberboard boxes appeared to have sufficient openings in the side and ends of the containers to provide adequate ventilation for the tomatoes during transit when they were properly loaded and when proper protective services were furnished. In most of the fiberboard containers the ventilation openings consisted of circular holes about 1 inch in diameter. The number varied from 4 to 7 openings on each side and from 2 to 3 on each end of the package. The 60-pound wirebound crates were adequately ventilated with openings of about 1/2 to 3/4 inch wide between the veneer slats on the tops, sides, and ends of the containers. The cardboard liners used in these crates were equipped with many slotted openings to permit the free movement of air into and out of the package. While the wooden lugs also had considerable open space for ventilation of the fruit, mostly between the top edges of the side slats and the covers and between the individual cover slats, this advantage was partly offset by the wrapping and tight packing of the fruit. However, because of the comparatively large amount of open ventilation space between the lugs in the horizontally stripped and gate frame loads, air circulation through the load was adequate and fruit temperatures were favorable.

Table 16.--Temperatures of tomatoes in rail and truck shipments on arrival at destination from California and Florida, by type of container, 1954, 1955, and 1956

State of origin and type of container	Rail shipments			Truck shipments		
	Test cars	Doorway position		Test trucks	Doorway position	
		Top of load	Bottom of load		Top of load	Bottom of load
	Number	Degrees F.	Degrees F.	Number	Degrees F.	Degrees F.
California:						
Standard wooden lug, 30 pounds, wrapped and place-packed	7	54.4	52.1	-	-	-
Fiberboard lug, 32 pounds, wrapped and place-packed	13	59.1	56.6	-	-	-
Full-telescope fiberboard box, 50 pounds, bulk-packed	2	54.0	50.5	-	-	-
Full-telescope fiberboard box, 40 pounds, bulk-packed	2	50.0	46.0	1	53.0	47.0
Florida:						
Standard wirebound crate, 60 pounds, bulk-packed	12	60.7	51.4	6	58.2	57.7
Full-telescope fiberboard box, 50 pounds, bulk-packed	38	61.2	55.1	8	57.5	52.9
Cap-cover type fiberboard box, 40 pounds, bulk-packed	8	55.0	49.5	10	54.9	53.2

The combination lengthwise-crosswise load used for the 40-pound one-piece fiberboard boxes with the cap covers was satisfactory in preventing damage to the containers and in facilitating ventilation of the fruit. Although these boxes were loaded together fairly tightly and the space between the containers in adjacent rows and stacks created by the overhang of the cap-type cover was small, this disadvantage was partly offset by the fact that this container had more ventilation holes in the sides and ends than any other fiberboard container included in this study.

For the 40-pound and 50-pound full-depth telescope, bulk-packed fiberboard boxes, the chimney-type load was found to be the most satisfactory. In this pattern the containers are loaded lengthwise and crosswise on bottoms and the individual boxes in the chimney units are arranged around vertical ventilation shafts which are continuous from the bottom to the top of the load.

Another loading pattern known at the "modified T" load was tried for these containers and was found to be unsatisfactory. Although this pattern provided more ventilation space between the individual boxes, the ventilation and fruit temperatures were not improved enough, as compared with the chimney-type loads, to compensate for the additional container damage incurred with the use of this pattern.

The standard horizontally stripped and gate-frame loads, which have been used for a number of years for the 30-pound wooden lug, were both satisfactory for this container. Similarly, the standard lengthwise-on-bottoms, crosswise-offset load was satisfactory for the 60-pound wirebound crate.

Figure 19 shows the average fruit temperatures during transit, as obtained by recording thermometers, for a number of test and check shipments by rail from Florida to several northern markets. Although there were some differences in the comparative cooling rates of the fruit in the 3 different containers, temperatures in transit were, on the whole, satisfactory. Temperatures at the end of the first day in transit indicate that temperatures of the fruit at time of loading varied considerably between the containers included in this part of the study. In spite of this difference, the cooling rate during transit was fairly uniform until about the fifth day. The 60-pound wirebound crate had the steadiest cooling rate of the 3 types of containers covered in this phase of the study. After the sixth day in transit, the fruit temperatures rose fairly rapidly because most of the cars were not unloaded on the same day they reached their destination markets. Most of the shipments were in fan cars, and as the fans are powered by the moving car wheels, they were running and circulating the air through the load only when the cars were moving. Consequently, after the cars had reached destination and were awaiting unloading, a rise in temperatures could be expected.

Figure 20 presents the same comparative information on the cooling rates for motortruck shipments of the 3 different containers. There was less uniformity in cooling rates between the different containers in the truck shipments than in the rail shipments. However, after the second day in transit, fruit temperatures were well within the desirable range. As the truck shipments were unloaded shortly after they reached destination and the air was

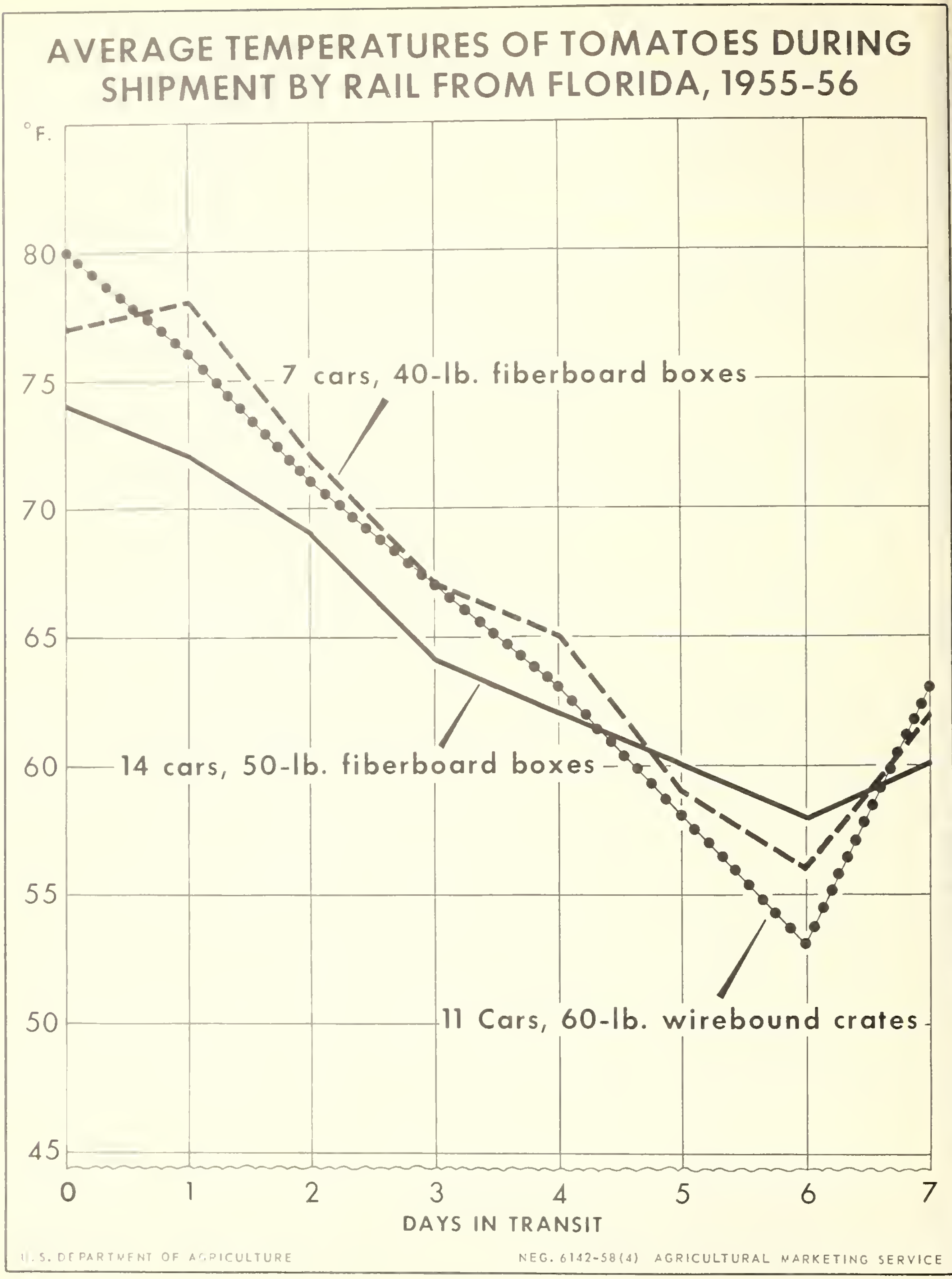
AVERAGE TEMPERATURES OF TOMATOES DURING SHIPMENT BY RAIL FROM FLORIDA, 1955-56
°F.
80
75
70
65
60
55
50
45
7 cars, 40-lb. fiberboard boxes
14 cars, 50-lb. fiberboard boxes
11 Cars, 60-lb. wirebound crates
0
1
2
3
4
5
6
7
DAYS IN TRANSIT
U. S. DEPARTMENT OF AGRICULTURE
NEG. 6142-58(4) AGRICULTURAL MARKETING SERVICE

Figure 19

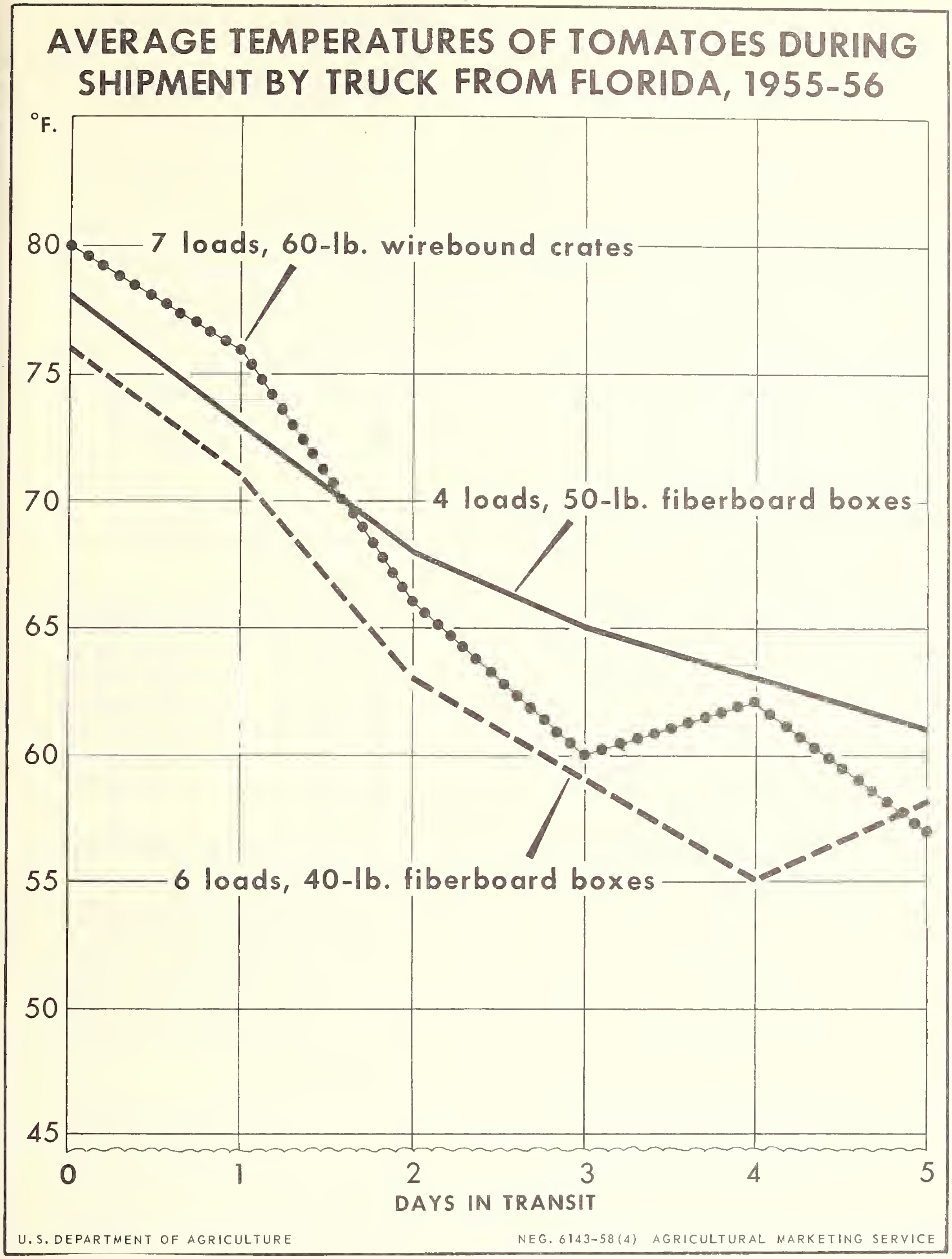
AVERAGE TEMPERATURES OF TOMATOES DURING SHIPMENT BY TRUCK FROM FLORIDA, 1955-56
°F.
80
75
70
65
60
55
50
45
7 loads, 60-lb. wirebound crates
4 loads, 50-lb. fiberboard boxes
6 loads, 40-lb. fiberboard boxes
0
1
2
3
4
5
DAYS IN TRANSIT
U.S. DEPARTMENT OF AGRICULTURE
NEG. 6143-58(4) AGRICULTURAL MARKETING SERVICE

Figure 20

usually circulated by motor-driven fans, fruit temperatures did not rise on the last day in transit as they did in the rail shipments. The fruit in the 40-pound cap-cover fiberboard boxes cooled at the most rapid rate, while that in the 50-pound full-depth telescope fiberboard containers cooled at the slowest rate.

COMPARATIVE EFFICIENCY OF MASTER CONTAINERS

Representatives of the Department of Agriculture followed sample lots of master containers of various types from repacking plants to retail outlets to determine if there were any significant differences in the comparative amounts of protection each one afforded its contents. Observations of the repacked tubes of ripened fruit after their removal from the different types of master containers at the retail stores showed no significant damage to the tubes or the fruit. These observations suggest that all types of master containers included in this study would provide adequate protection for the repacked fruit between the repacking plant and the wholesale and retail outlets when they were properly handled.

COMPARATIVE TRANSIT REFRIGERATION BY TYPE OF SHIPPING CONTAINER

The introduction and increased use of various types of fiberboard containers for the shipment of mature-green tomatoes from many producing areas to terminal market repacking plants in the past few years has raised an important question concerning the suitability of conventional protective service schedules for rail shipment of the fruit in fiberboard boxes. Specifically, the problem with which many tomato shippers have been faced is whether or not the new containers would require any changes from the protective services currently used for long-distance rail shipments of the fruit in the standard wooden lugs and wirebound crates.

To answer this question recording thermometers were used in a series of shipping experiments by rail from California to a large eastern market. As most California shipments to eastern markets move by rail and the shipments are in transit for 8 to 10 days, as compared with 4 to 5 days for Florida shipments, the California shipments provided the best basis for these tests. However, as comparatively few wirebound crates are used for California shipments and the wooden lug is the predominant container for the California fruit, this latter container was used as the control container in the following comparisons.

Shipping test procedure.--Five paired carloads of mature-green tomatoes were shipped from the Tracy district of California to New York City during October 1954 and October 1955 (table 17). A comparison of the transit cooling rates of fruit packed in fiberboard containers and wooden lugs was made in each pair of cars shipped under the same railway protective service. All cars contained air-circulating fans and were shipped with the fans in the "on" position with the car ventilators closed during the entire transit period.

Table 17.--Loading data and protective services for tomatoes shipped in conventional wooden lug boxes (30-pound wrap packs), in fiberboard boxes (40- to 50-pound bulk packs) and 32-pound fiberboard lugs (wrap packs) for test cars from Tracy district, California, to New York City 1/

Test no.	Date shipped	Type of container and method of packing	Type of load	Number of containers	Average temperatures of fruit at loading	Initial icing at shipping point 2/	Re-icing in transit 2/
				Number	Degrees F.	Short tons	Short tons
1-A....	10/6/54	Wooden lug, 30 pounds, wrapped and place-packed	Channel, divided	650	63	1-1/2 tons per bunker	1-1/2 tons per bunker at Chicago, Ill.
1-B....	10/6/54	Fiberboard box, 40 pounds, bulk-packed	Chimney, through	604	65	1-1/2 tons per bunker	1-1/2 tons per bunker at Chicago, Ill.
2-A....	10/7/54	Wooden lug, 30 pounds, wrapped and place-packed	Channel, divided	650	68	1-1/2 tons per bunker	1/2 ton per bunker at Kansas City, Mo., and Columbus, Ohio
2-B....	10/7/54	Fiberboard box, 40 pounds, bulk-packed	Channel, divided	650	68	1-1/2 tons per bunker	1/2 ton per bunker at Kansas City, Mo., and Columbus, Ohio.
3-A....	10/14/55	Wooden lug, 30 pounds, wrapped and place-packed	Channel, divided	650	75	3/ 1 ton per bunker	1-1/2 tons per bunker at Kansas City, Mo.
3-B....	10/14/55	Fiberboard box, 50 pounds, bulk-packed	Chimney, through	447	75	3/ 1 ton per bunker	1-1/2 tons per bunker at Kansas City, Mo.
4-A....	10/7/55	Wooden lug, wrapped and place-packed	Channel, divided	650	67	1 ton per bunker	1,200 pounds per bunker at Kansas City, Mo.
4-B....	10/7/55	Fiberboard lug, 32 pounds, wrapped and place-packed	Channel, divided	582	68	1 ton per bunker	1,200 pounds per bunker at Kansas City, Mo.
5-A....	10/10/55	Wooden lug, wrapped and place-packed	Channel, divided	650	58	1 ton per bunker	None
5-B....	10/10/55	Fiberboard lug, 32 pounds, wrapped and place-packed	Offset, channel, through	720	58	1 ton per bunker	None

1/ Cars shipped "fans on" with vents closed from initial icing station to destination.
2/ Ice placed on half-stage racks.
3/ Initial ice at Roseville, Calif., Oct. 15, 1955. Standard ventilation Patterson, Calif., to Roseville.

The wooden lugs contained tomatoes individually wrapped in tissue and place-packed in the box. The boxes were placed in the cars in the usual channeled conventional load, which consisted of 5 evenly spaced rows across the car. This load provided air channels approximately 2 inches wide between the rows which were maintained by prefabricated wooden gate frames set between each stack. These loads were divided at the car doorways by conventional center gates and bracing to take up the unused part of the loading space.

The large (40- and 50-pound) full-telescope fiberboard boxes used for tests 1, 2, and 3 were bulk-filled with unwrapped tomatoes. Two loading patterns were used, the channel and the chimney. In the channel load (car 2-B) the alinement was maintained with vertical fiberboard strips placed between the rows. This load was divided with a center gate at the car doorway like the wooden lug load. In the chimney loads (cars 1-B and 3-B) the fiberboard containers were placed alternately lengthwise and crosswise in the car in sets of 4, making hollow squares or units with "chimneys," or vertical ventilation shafts, in the center of each unit. No stripping or center gates were used and the resulting through loads were continuous from one end of the car to the other.

In tests 4 and 5 with the 32-pound fiberboard lug, the fruit was wrapped and packed in the same manner as in the wooden lugs. In car 4-B, the rows of fiberboard lugs were spaced and center gates were used, just as in the conventional load of wooden lugs. In car 5-B the fiberboard lugs were placed in an offset-channel pattern 6 wide, each stack consisting of 3 pairs of containers with channel space between each pair. In the first stack the first pair of fiberboard lugs was set against the side wall of the car, and in the second and each alternate stack, the pairs were set against opposite walls, resulting in a crosswise-offset pattern. No spacing or bracing material was used, and the load extended through the entire length of the car.

Temperatures of the tomatoes were obtained in transit with small recording thermometers placed in fruit packages in the middle and bottom layers of the load in all test cars and, in addition, in the top layers of the cars used in tests 1 and 2.

Marked packages containing tomatoes comparable in size and maturity from the same field lot were shipped in each pair of cars to determine the effect of the container on the temperature and ripening of the fruit in transit.

The selection of the icing schedules for each pair of cars (table 17) was influenced by the temperature of the tomatoes during loading, the anticipated weather enroute, and the wishes of the receiver. They were, however, substantially in accord with the recommendations shown in the tabulation on page 21.

Effect of container on transit temperatures.--Tests 1 and 2 (figs. 21 and 22) compared transit temperatures of wrapped and place-packed tomatoes in wooden lugs loaded in the usual manner with those in the bulk-filled 40-pound full-telescope fiberboard containers shipped in chimney and in channel loads.

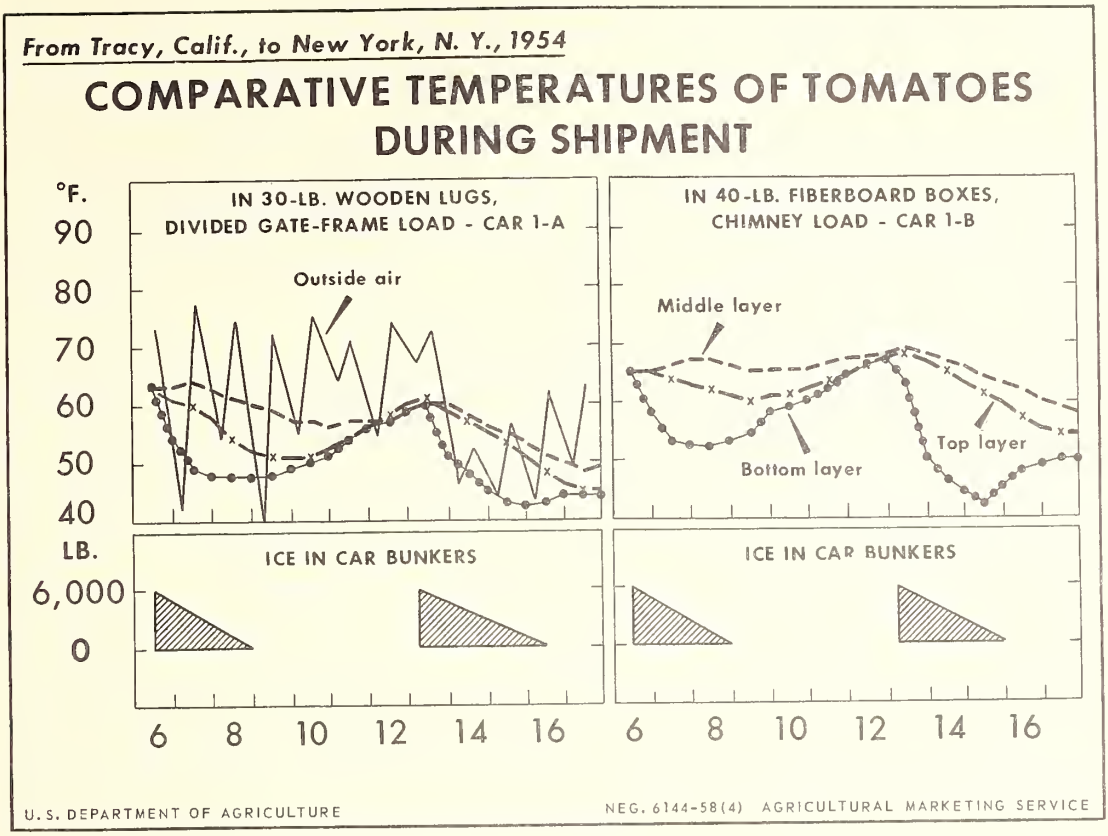

Figure 21

In both tests the middle layer of the load cooled more slowly in transit than the top and bottom layers. The middle layer in both loads of the 40-pound fiberboard boxes cooled slightly more slowly than similar layers of the conventional wooden lug loads. The middle layer of the chimney load of 40-pound boxes (car 1-B, fig. 21) cooled slightly more slowly than the middle layer of the channel load (car 2-B, fig. 22), indicating limited circulation of cold air through the chimneys, which were approximately 6 by 6 inches in this car. However, the transit refrigeration was adequate in all instances.

Figure 23 shows the transit temperature of tomatoes in a chimney load of 50-pound full-telescope fiberboard boxes and in a conventional load of 30-pound wooden lugs shipped under the same icing instructions. The dimensions of the chimneys were approximately 8 by 8 inches in this load. The rate of cooling of the middle layer in the fiberboard box load was faster than that in the wooden lug load, probably because air circulated more freely through the large chimneys of the fiberboard box load than through the channels in the lug load. The chimneys in this car were one-third larger than those in car 1-B (fig. 21) and, therefore, provided better cooling in the middle layer. Transit refrigeration was adequate in both cars, but somewhat less ice could have been added at the re-icing point.

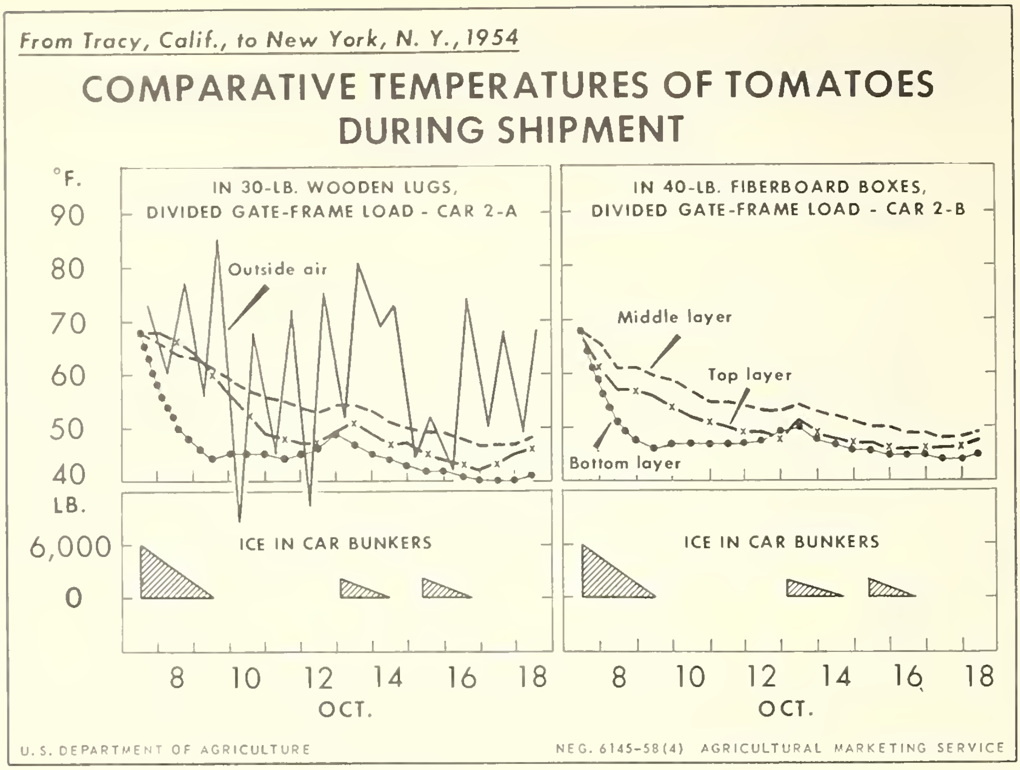

Figure 22

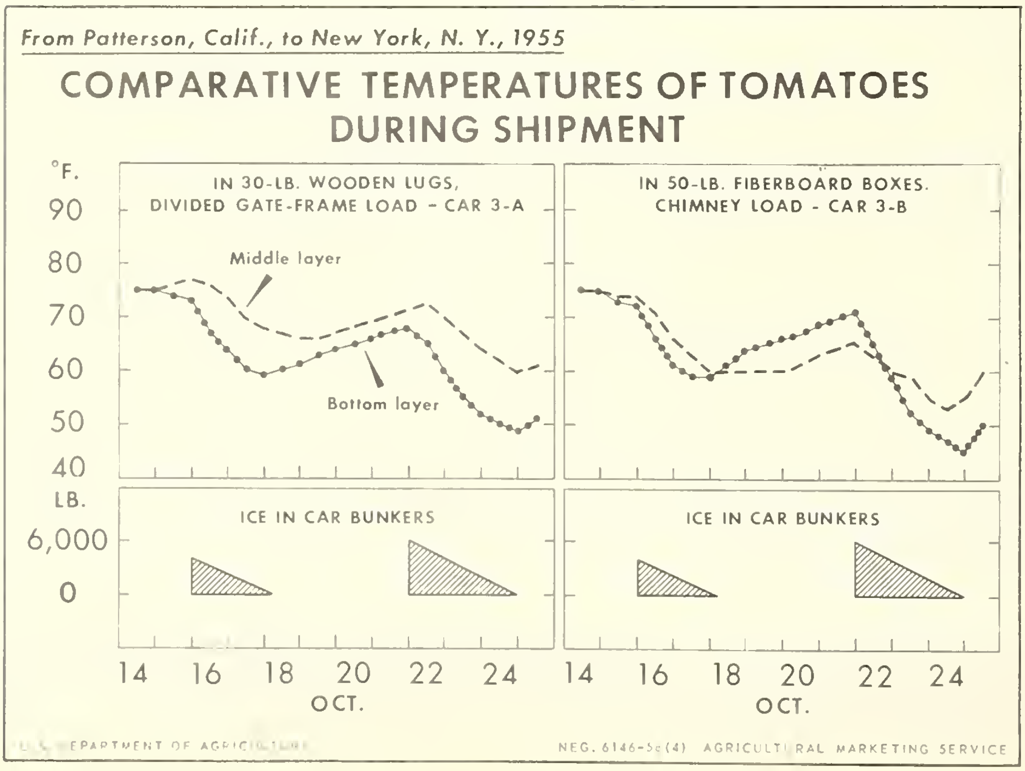

Figure 23

Figure 24 shows little difference in the transit temperatures of wrapped tomatoes shipped in 32-pound fiberboard lugs and in wooden lugs in similar channel loads under similar icing instructions. Transit refrigeration was adequate in both cars.

Figure 25 compares the transit temperature in 30-pound wrap-packed fiberboard lugs in a crosswise-offset load with that of lug boxes in a conventional channel load. Little difference occurred between loads. In this test, transit temperatures of tomatoes loaded at an average temperature of 50 to 55° F. were over-refrigerated with initial icing of 1 ton per bunker and no further icing.

Effect of container on ripening of tomatoes in transit.--Table 18 shows the condition of the tomatoes in the test samples from the middle and bottom layers of the loads on arrival at the market. The average temperature of each sample during the transit period and the length of time the fruit was in the car are also given in table 18, as these factors also influenced the amount of ripening that occurred.

In test 1, more ripening occurred in transit in the middle layer in the chimney load of 40-pound full-telescope fiberboard boxes than in the bottom layer of the same load or in either of these layers in the load of standard wooden lugs. This reflects the higher transit temperature that occurred in the middle layer of the load of fiberboard boxes. In test 2 (fig. 22), with a channel load used for both containers, there was practically no difference in ripening of fruit in the 40-pound fiberboard boxes and in the wooden lugs, as the average temperature in transit was about the same in the two cars.

In test 3, comparing 50-pound full-telescope fiberboard boxes in a chimney load with 30-pound fiberboard lugs in a conventional load (fig. 23), there was little difference in the rate of ripening of the tomatoes in transit. The fruit was adequately cooled in both loads.

In tests 4 and 5, in which 32-pound fiberboard lugs and wrapped packs, similar to the wooden lugs, were shipped in channel-type loads (figs. 24 and 25), the transit temperature and the ripening were about the same in the fiberboard containers as in the wooden lugs.

The average temperature of the tomatoes for the entire time in the cars ranged from 46° in the bottom layer of the coldest car (car 2-A) to 69° in the middle of the warmest car (car 3-A). Ripening in transit was increased at the higher temperatures but the shipments arrived at the market with a negligible amount of soft ripe fruit and little decay.

The results of these transcontinental shipping tests showed that, while there was some slight variation in the comparative rates of cooling of the fruit packed in the different containers during transit, the differences were not great. Cooling rates for the fruit in the different types of fiberboard containers studied and the comparative ripeness of the fruit at destination were, on the whole, satisfactory as compared to the fruit in the standard wooden lugs. These results indicate that the same schedules of protective service currently used for shipment of California tomatoes in the standard wooden lugs will also be satisfactory for the shipment of the fruit in the types of fiberboard containers used in these shipping experiments.

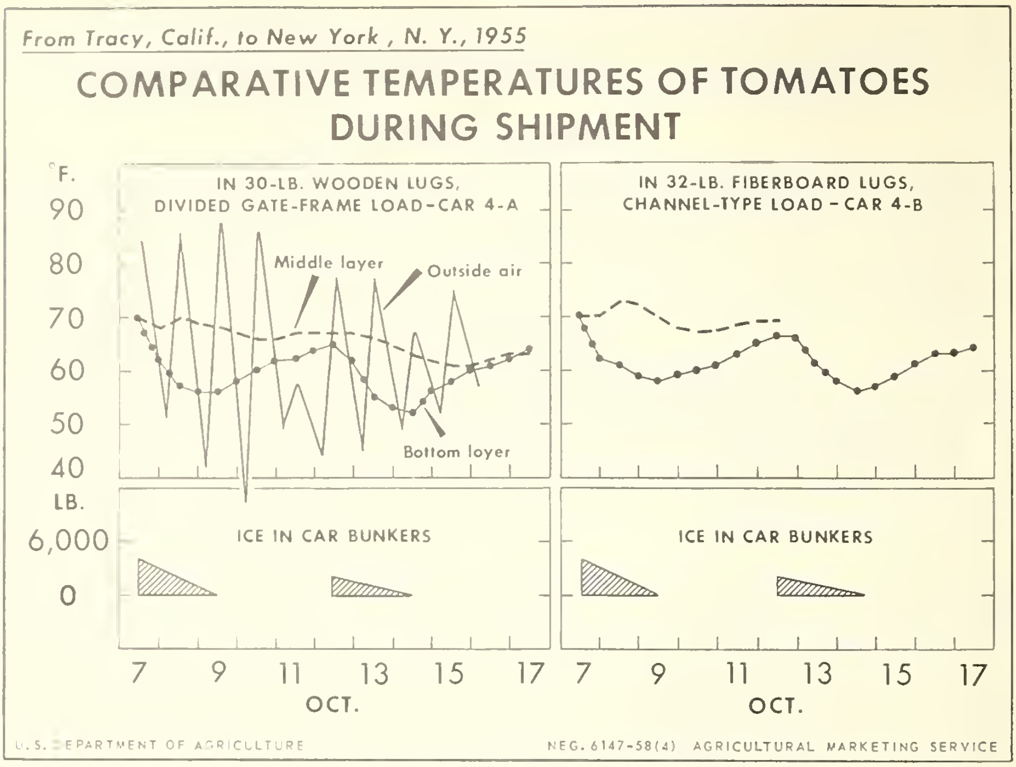

Figure 24

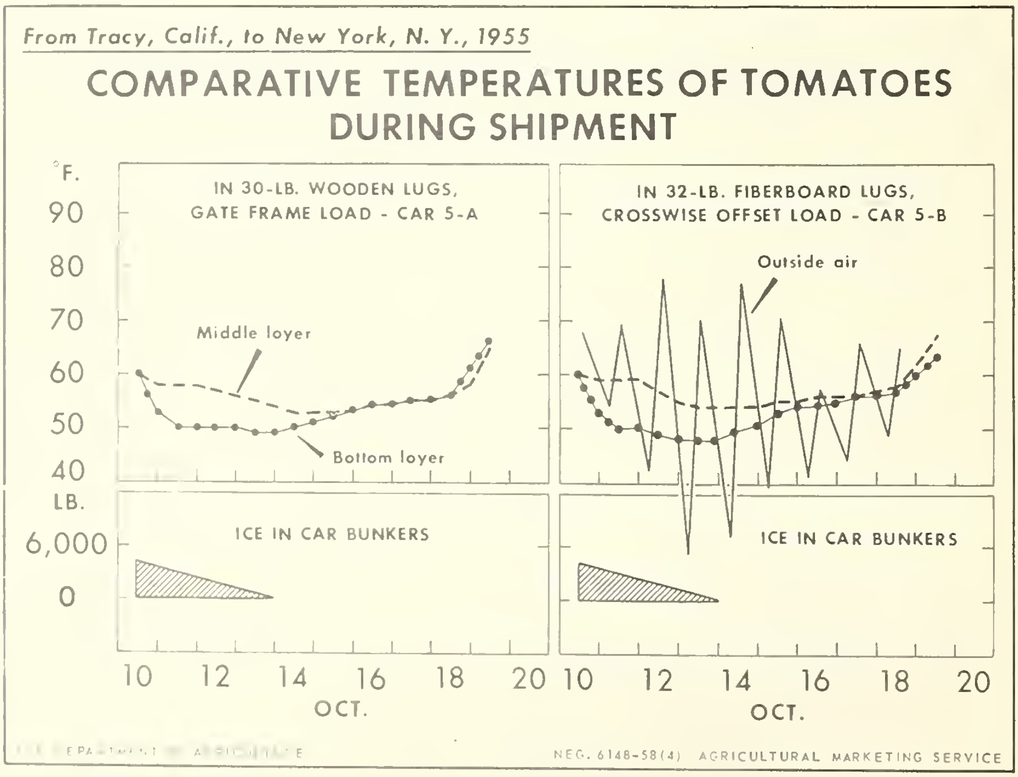

Figure 25

Table 18.--Comparative transit temperature and ripeness of California tomatoes in test lots on arrival at terminal market, by type of container, 1954-1955

Test no. 1/	Date shipped	Type of container	Layer of load	Average temperature of tomatoes: At loading	Average temperature of tomatoes: In transit	Time in car	Ripeness and condition of fruit: Green	Turning	Firm ripe	Soft ripe	Decayed
				° F.	° F.	Days	Percent	Percent	Percent	Percent	Percent
1-A	10/6/54	Wooden lug	Middle	63	57	11	73	24	3	0	0
	do.	do.	Bottom	63	50	11	69	31	0	0	0
1-B	do.	40-pound fiberboard box	Middle	65	65	11	13	63	18	1	5
	do.	do.	Bottom	65	55	11	52	42	6	0	0
2-A	10/7/54	Wooden lug	Middle	68	54	11	50	47	3	0	0
	do.	do.	Bottom	68	46	11	66	34	0	0	0
2-B	do.	40-pound fiberboard box	Middle	68	55	11	65	34	1	0	0
	do.	do.	Bottom	68	48	11	69	31	0	0	0
3-A	10/14/55	Wooden lug	Middle	75	69	11	3	69	24	0	4
	do.	do.	Bottom	75	63	11	10	71	14	0	5
3-B	do.	50-pound fiberboard box	Middle	75	63	11	3	68	27	0	2
	do.	do.	Bottom	75	63	11	13	61	21	0	5
4-A	10/7/55	Wooden lug	Middle	70	66	10	14	56	30	0	0
	do.	do.	Bottom	70	60	10	53	35	11	0	1
4-B	do.	32-pound fiberboard lug	Middle	70	67	10	16	58	25	0	1
	do.	do.	Bottom	70	62	10	35	50	15	0	0
5-A	10/10/55	Wooden lug	Middle	60	56	9	71	28	0	0	1
	do.	do.	Bottom	60	54	9	58	41	0	0	1
5-B	do.	32-pound fiberboard lug	Middle	60	57	9	77	21	1	0	1
	do.	do.	Bottom	60	54	9	50	50	0	0	0

1/ See table 17 for type of protective services used for each test.

CONCLUSIONS

Shippers and repackers of mature-green tomatoes may realize substantial savings in costs of containers, packing, loading, transportation, and repacking by using dual-purpose shipping containers for tomatoes. The potential economies were found to range from 0.6 cent per pound, or about $140.00 per carload of fruit, to 2.2 cents per pound, or more than $500.00 per car, depending upon the type of containers the dual-purpose containers replaced and in what producing area and under what circumstances they were used. Some repackers may realize further savings by using new 20-tube fiberboard master containers, instead of 10-tube containers, to carry tubes of ripened and repacked fruit from the packing plant to wholesale and retail outlets.

When the dual-purpose or reuse features of the 40-pound and 50-pound fiberboard containers covered by this study are utilized, part of the savings realized are derived from using one container for two operations, to carry the fruit from producing areas to the repacking plant and to carry the tubes of ripened tomatoes from the repacking plant to retail stores, instead of using separate containers for each operation. As the fruit is bulk-packed in these dual-purpose containers, labor costs for packing at the shipping point and for opening and dumping on the sorting belt at the repacking plants can be substantially lower than labor costs for shipping the tissue-wrapped and place-packed fruit in conventional wooden lugs. The wirebound crates and most fiberboard boxes hold more fruit than the wooden lugs, their tare weight is somewhat less per net pound of fruit, and they can be loaded in through loads without center bracing, car strips, or load-spacing devices; therefore, costs of carloading, transportation, and refrigeration for these containers are less than for the conventional wooden lugs.

Shipping tests have shown that the extent of damage to fiberboard shipping containers in transit compares favorably with that found in comparable shipments of wooden lugs and wirebound crates. Inspection of the fruit at destination markets showed that there was no more serious bruising in shipments of fiberboard shipping containers than in comparable shipments of the 30-pound wooden lugs and the 60-pound wirebound crates.

Controlled shipping experiments have revealed that the in-transit cooling rate for the fruit shipped in fiberboard containers did not differ greatly from that shipped in wooden lugs. The same schedule of protective services recommended for shipments of California fall tomatoes in lugs will also be suitable for the shipment of the fruit in the fiberboard containers covered in this study.

When properly packed and handled, the dual-purpose fiberboard boxes reused as master containers provide ample protection for the tubes of ripened and repacked fruit during its distribution from the repacking plants to retail stores.

LITERATURE CITED

(1) Arnow, W. A., and Bryan, J. E.
1952. Prepackaging Tomatoes, U. S. Dept. Agr., Agr. Mktg. Serv., Mktg. Res. Rpt. No. 20. October.

(2) Florida Tomato Committee.
1956. Statistical Bulletin No. 22.

(3) Johnson, H. D., and Breakiron, P. L.
1956. Protecting Perishable Foods During Transportation by Truck. U. S. Dept. Agr., Agr. Mktg. Serv., Agr. Handbook No. 105. December.

(4) Robertson, B. C.
1952. Types and Sizes of Containers Used for Prepackaged Tomatoes. U. S. Dept. Agr., Agr. Mktg. Serv., AMS-52. August.

(5) U. S. Agricultural Marketing Service.
1954. Transit and Ripening Studies with California Mature-Green Tomatoes, Fall 1953. U. S. Dept. Agr., Housing, Transportation & Storage Rpt. No. 317. July.

(6) ____________.
1956. Shipping Temperatures for Tomatoes. U. S. Dept. Agr., PA-290. July.

(7) ____________.
1957. Rail Transit Refrigeration of Mature-Green Tomatoes from the Lower Rio Grande Valley of Texas. U. S. Dept. Agr., AMS-188. June.

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