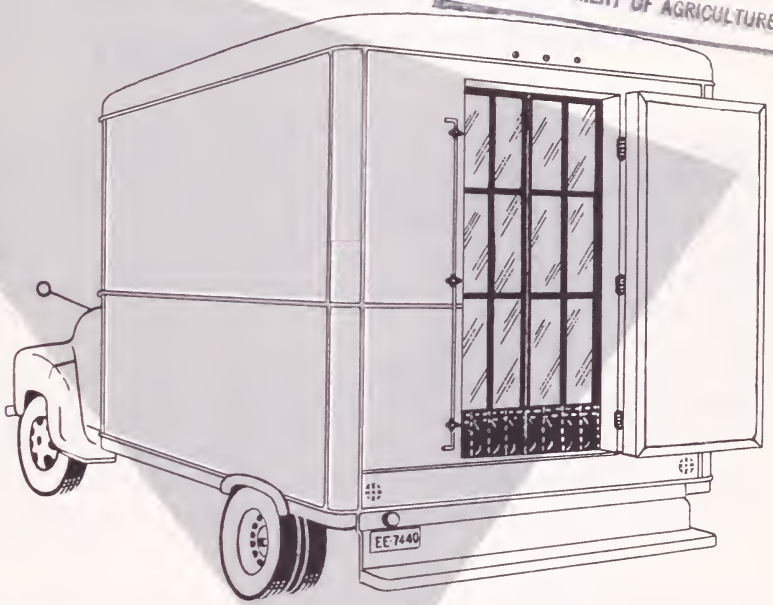
Marketing Research Report No.176

A CURTAIN TO HELP MAINTAIN TEMPERATURES IN LOCAL REFRIGERATED DELIVERY TRUCKS



U. S. DEPARTMENT OF AGRICULTURE

Agricultural Marketing Service Marketing Research Division

Washington, D. C.

ACKNOWLEDGMENTS

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Appreciation is expressed to the DuPont Company for furnishing the Mylar polyester film used in the curtains. R. H. Hinds and C. A. Pinkus of the Transportation and Facilities Branch, Marketing Research Division, observed and recorded the temperature data contained in this report. Credit is also due the truck drivers for their helpful participation in the project.

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A CURTAIN TO HELP MAINTAIN TEMPERATURES IN LOCAL REFRIGERATED DELIVERY TRUCKS

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SUMMARY

In the summer of 1955, the Department of Agriculture conducted a study of the operation of refrigerated trucks used for local delivery of frozen foods. These studies were made in the cities of Atlanta, Ga., Washington, D. C., and Baltimore, Md. Frost melting on the "cold plates" caused considerable dripping inside most of the trucks. Also, the product temperature was considerably higher at the time of delivery than when loaded into the truck.

One of the major reasons for higher temperatures inside refrigerated trucks in summer is that warm air enters each time the truck door is opened at a delivery stop. Various types of canvas curtains have been installed inside the rear door by operators of refrigerated trucks in an attempt to reduce this in-flow of warm air. However, because a canvas curtain prevents entry of light and often becomes wet or frozen stiff, it has never proved practicable.

The curtain described in this report was developed as a practical solution to difficulties encountered with previous curtains. It consists of 2 weighted halves and is made of a commercially available transparent and tough polyester plastic film reinforced with neoprene coated nylon. A curtain was installed in each of 5 trucks and was tested under actual operating conditions during the summer of 1956.

Temperature evaluation tests conducted on 2 of the 5 trucks showed that use of the curtain resulted in a 3.2° F. smaller rise in product temperature and a 7.2° colder inside air temperature as compared with operation without the curtain. Dripping from "cold plates" was eliminated except for slight wetting near the truck door. It also eliminated the need for dry ice, which one operator had been using on another 2 of the 5 trucks as a supplement to the cold-plate refrigeration, resulting in a saving of over $3.00 per truck per day. The 5 curtains were examined at the end of the summer and they were all found to be in good condition.

The curtains were tested on trucks hauling frozen food and meats. However, there is reason to believe that they would also be of benefit on

trucks used for local delivery of milk, ice cream, produce, or other perishables. Although all of the test trucks had the "cold-plate" type of refrigeration system the curtain should also be useful in trucks which have other refrigeration systems.

INTRODUCTION

During the summer of 1955, the Department conducted a study of the operation of trucks used for local delivery of frozen foods in Atlanta, Ga., Washington, D. C., and Baltimore, Md. This study showed that in warm weather there was considerable dripping inside most of the trucks due to melting of frost from the "cold plates." In addition, the product in many instances was delivered at a temperature several degrees higher than its temperature was when loaded into the truck.

One of the main causes of higher truck air and product temperatures in the summer is the entry of warm outside air when the truck body door is opened at each delivery stop. Even when the driver conscientiously closes the door immediately after removal of each order, the door is open as much as a total of 2 hours on an 8-hour delivery run. The total time that a door is open may be greater than 2 hours in those instances where a driver is careless and leaves the door open while he is carrying the order in to the customer.

All of the truck owners and drivers questioned said that they had, at some time, installed canvas curtains of various kinds in the rear door opening of their trucks. The purpose of the curtain was to form a barrier when the door was open to reduce the amount of warm outside air which enters the truck. The canvas curtain never was successful, however, and in all instances was either thrown to the side and not used or was removed. The canvas curtain always was objectionable on two counts. First, it did not permit entry of light into the truck and the driver had difficulty in identifying the markings on the orders. Second, the canvas became wet during the daily delivery run and the wetness annoyed the driver as he moved back and forth through it. Further, in the morning, after all night refrigeration in the truck, the canvas would be frozen stiff and this proved to be a nuisance to the driver.

The curtain described in this report was designed and developed by the author as a practical solution to the difficulties encountered with previous type curtains. The design makes use of a commercially available transparent, and especially tough, plastic film.

Following the preliminary study of the problem in the 1955 season, many experimental curtains were made and tested to find the right combination of materials and design that would offer the least interference with the duties of the truck operator, yet be durable enough to withstand the strains of daily use. For example, the first curtains tested were single sheets of Mylar plastic, weighted at the bottom to prevent billowing in the wind when the door was opened. They proved to be satisfactory as far as inside truck temperatures

were concerned, but after several weeks' use even this exceptionally tough material showed a tendency to develop a crease near the top of the center opening where the curtain was folded back as the driver passed through. The crease soon became a tear which destroyed the curtain. This led to the "window" design, with neoprene coated nylon to prevent tearing at the edges and to lend stability to the curtain as a whole.

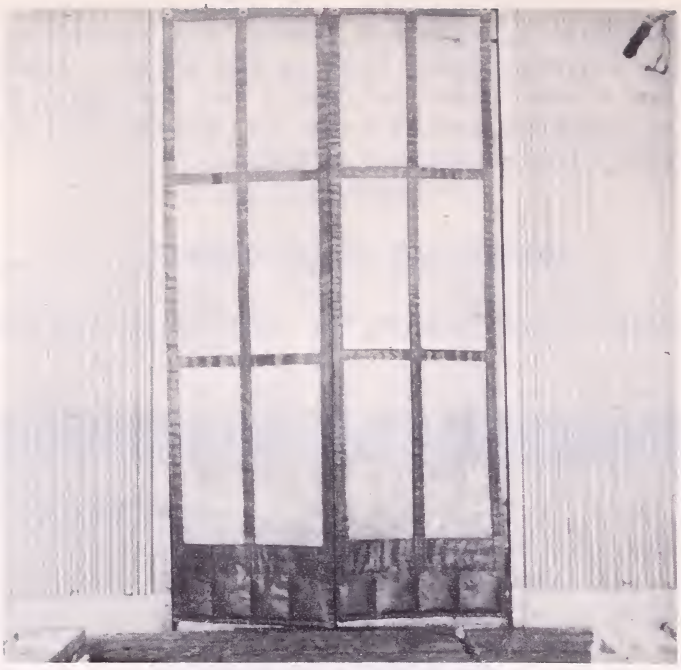
DESCRIPTION OF THE CURTAIN

Views of the curtain from outside and inside the truck are shown in figures 1, 2, and 3.

NEG. BN-3924

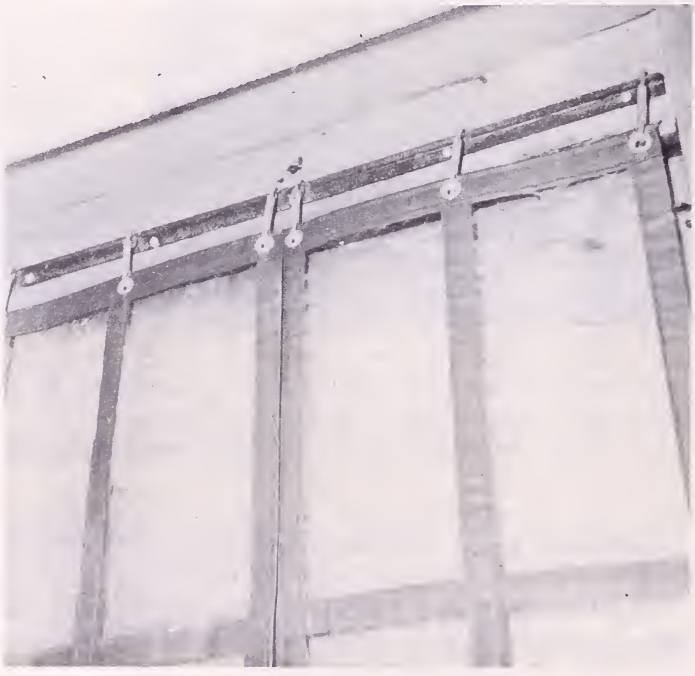
Figure 1.--View of curtain from outside the truck.

The curtain is flexible and consists of 2 identical halves, each of which contains 2 pounds of lead shot in the bottom to hold the curtain in place against the wind. The main material used in the curtain is Mylar transparent polyester film, type D, 0.0075 inches (7.5 mil.) thick, which is very tough and remains flexible at low temperatures.



NEG. BN-3925

Figure 2.--View of curtain from inside the truck.



NEG. BN-3926

Figure 3.--View of curtain from inside the truck showing suspension arrangement.

Each half of the curtain is reinforced with strips of 16-ounce, neoprene coated nylon which is also tough and flexible at low temperatures. Each half of the curtain is suspended at the top by means of 3 double eye harness snaps. The harness snaps provide a strong yet flexible method of suspension which allows the curtain to part easily when the driver passes through.

Figures 4, 5, 6, and 7 show the curtain as it is being used during the daily operations of a delivery truck. Figure 4 shows the curtain thrown up on the roof while the truck is being loaded. At each delivery stop, and after opening the door, the driver enters through the curtain (fig. 5). The curtain returns to its normal hanging position after the driver has passed through.

NEG. BN-3927

Figure 4.--Curtain thrown up on roof while the truck is being loaded.

While inside the truck the driver stacks the order on the floor near the door and then emerges from the truck (fig. 6). While standing outside the truck the driver places the curtain behind the order and removes the order (fig. 7).

NEG. BN-3928

Figure 5.--Driver entering the truck at a delivery stop.

NEG. BN-3929

Figure 6.--Driver emerging from truck after he has placed an order on the floor near the door.

NEG. BN-3930

Figure 7.--Driver removing order after he has placed curtain behind the order.

THE TEST TRUCKS

A total of 5 trucks (2 in Washington, D. C., and 3 in Baltimore, Md.) were used to test the curtains. These trucks were not especially made but rather were of the type generally used for local delivery of chilled or frozen products. All 5 of the trucks used the "cold-plate" type of refrigeration system with a 2-horsepower, 230-volt, single-phase motor-driven compressor mounted on the lower left side of the body. The floor, wall, and ceiling insulation of each truck varied but in all instances was between 4 and 6 inches thick.

After completion of each day's delivery run, the electric power cable on the truck is plugged in at the plant (fig. 8). The compressor then operates through the night. Refrigerant from the compressor is circulated through coils in "cold plates" located inside the truck adjacent to the ceiling (fig. 9). These "cold plates" are actually flat shaped, sealed tanks which contain a eutectic solution surrounding the coils. The cold plates are thus chilled to a temperature in the range of 0° F. to -10° F., and they in turn lower the temperature inside the truck. Each morning the power cable is disconnected and stored in the truck compressor compartment. The "cold plates," having been chilled during the night, help to keep the product at a low temperature by absorbing heat which comes in through the truck walls and door opening during the delivery run.

NEG. BN-4140

Figure 8.--Electric power cable plugged in at the plant for operation of the truck refrigeration system.

NEG. BN-4141

Figure 9.--View through the truck rear door opening showing "cold plates" located inside, adjacent to the ceiling.

TESTING THE CURTAIN

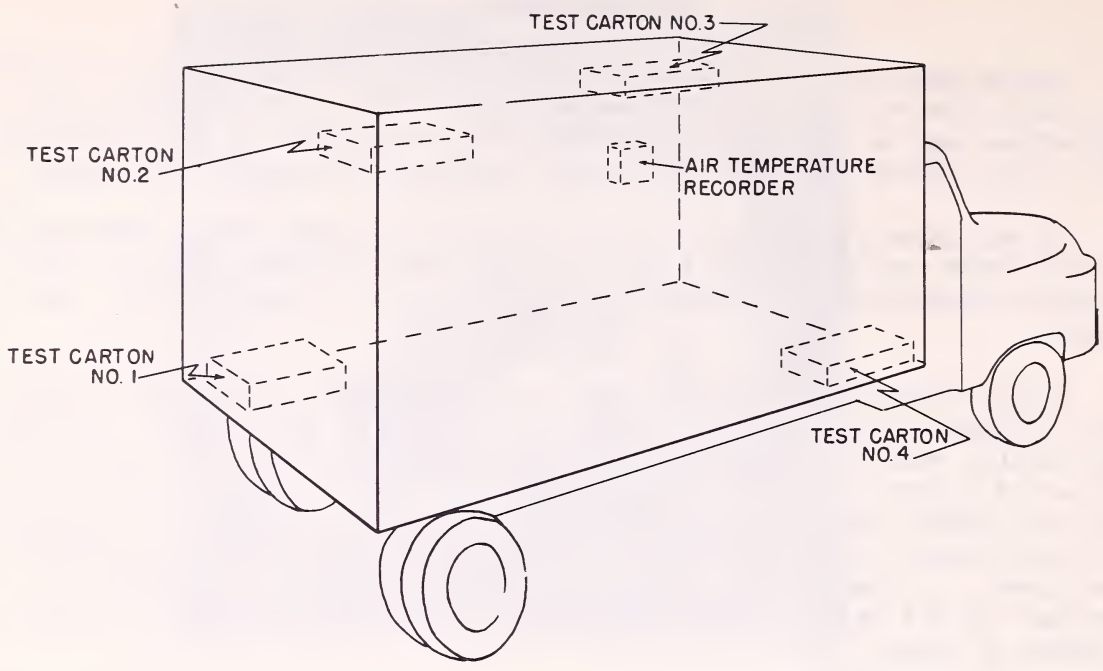
During May and June of 1956, the curtains were installed in 1 chilled meat and 4 frozen food local delivery trucks. The purpose of these installations was to determine the durability and utility of the curtain as well as its effect upon air and product temperatures inside the trucks.

To determine the effect of the curtain on air and product temperatures 20 tests were conducted with 2 of the frozen food delivery trucks. The 2 trucks selected were identical in manufacture and their delivery runs were similar.

An air temperature recorder with circular chart was mounted in each truck to give a continuous record of the inside air temperature. Outside air temperatures were obtained from U. S. Weather Bureau records. Four test cartons of frozen orange juice were placed in each truck before a test run. The test cartons were placed in fixed metal brackets each time to prevent shifting during the test and, in addition, were protected by an expanded metal cover. A view of one of the test cartons is shown in figure 10. The locations of the test cartons and the air temperature recorder in each truck is shown in figure 11.

NEG. BN-4142

Figure 10.--A view inside the truck showing one of the test cartons in place and protected by an expanded metal cover.



Test Carton No. 1 - Rear, left corner, floor.
Test Carton No. 2 - Rear, right corner, ceiling.
Test Carton No. 3 - Front, left corner, ceiling.
Test Carton No. 4 - Front, right corner, floor.
Air Temperature Recorder - Right side, halfway between front and rear, 1 foot below ceiling.

Figure 11.--Locations of test cartons and air temperature recorder in each truck.

The product temperature of the center package in each test carton was obtained at the start and at the finish of each test run. Product temperatures were obtained by means of a dial thermometer which was precooled before inserting it into the test can. 1/

On each test, one truck was used with its curtain in place and the other truck was used with its curtain removed (fig. 12). To compensate for possible effects on the results of such factors as differing driver habits, number of stops, type of stops, etc., the "with curtain" truck and "without curtain"

1/ Method used is described in USDA Marketing Research Report No. 150, December 1956, entitled: Suggested Methods for Checking Temperatures of Fresh and Frozen Food Shipments.

NEG. BN-4143

Figure 12.--One truck with curtain and one truck without curtain as used during the test delivery runs.

truck were alternated after every 5 tests. Referring to the 2 trucks as truck "A" and truck "B", the alternating was accomplished as follows:

Test No.	Truck with curtain	Truck without curtain
1 - 5	A	B
6 - 10	B	A
11 - 15	A	B
16 - 20	B	A

TEST RESULTS

The delivery runs of the 2 trucks during the 20 temperature evaluation tests were very much alike, as shown by the following:

Average number of stops per day, truck with curtain..... 32.4
" " " " " " " without curtain..... 33.4
Average trip time, truck with curtain..... 8 hr.--22 min.
" " " " without curtain..... 8 hr.--28 min.

The data obtained during the 20 tests is shown in table 1. Even though the weather was relatively cool during the test runs (80.1° F. av.) the truck with the curtain had a 3.2° F. less product temperature rise and a 7.2° F. colder inside air temperature than the truck without the curtain.

Table 1.--Data from the 20 tests showing average air temperatures and product temperatures at the start and at the finish of the delivery run

Test No.	Date 1956	Outside air temperature 1/	Truck with curtain				Truck without curtain			
			Product temperature start 2/	Product temperature finish 2/	Product temperature rise 3/	Truck inside air temperature 4/	Product temperature start 2/	Product temperature finish 2/	Product temperature rise 3/	Truck inside air temperature 4/
		°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
1	Aug. 7	77.2	-10.0	4.5	14.5	19.6	-10.0	12.3	22.3	29.8
2	" 8	82.6	-10.0	7.8	17.8	19.1	-10.0	11.8	21.8	26.0
3	" 9	87.1	-8.0	10.8	18.8	26.2	-8.0	12.5	20.5	33.6
4	" 10	87.5	-9.8	10.5	20.3	25.8	-10.0	10.3	20.3	30.3
5	" 14	80.6	-9.8	11.0	20.8	21.6	-9.5	11.0	20.5	22.9
6	" 15	84.0	-8.8	10.0	18.8	19.6	-9.8	9.5	19.3	18.1
7	" 16	87.3	-7.8	8.5	16.3	10.7	-6.8	11.0	17.8	21.8
8	" 17	88.2	-7.3	6.3	13.6	8.8	-8.0	12.3	20.3	26.3
9	" 21	67.4	-10.2	3.8	14.0	5.4	-9.8	8.0	17.8	19.3
10	" 22	73.0	-9.5	5.3	14.8	7.8	-9.8	7.3	17.1	16.1
11	" 23	74.9	-8.8	8.5	17.3	15.9	-9.5	9.3	18.8	21.5
12	" 24	76.4	-8.3	9.0	17.3	5/	-9.0	10.3	19.3	5/
13	" 29	84.9	-8.0	11.3	19.3	23.5	-9.8	10.5	20.3	27.7
14	" 30	86.6	-8.3	10.8	19.1	20.9	-8.8	11.8	20.6	29.8
15	" 31	87.8	-7.5	10.0	17.5	21.5	-8.3	11.5	19.8	30.7
16	Sept. 6	79.8	-9.0	5.3	14.3	15.8	-9.5	9.5	19.0	25.5
17	" 7	70.6	-8.5	5.0	13.5	5/	-9.5	12.5	22.0	5/
18	" 11	69.8	-9.0	5.3	14.3	9.6	-9.5	10.5	20.0	12.5
19	" 12	75.0	-9.8	5.8	15.6	12.1	-9.8	9.0	18.8	15.7
20	" 13	80.3	-9.5	7.3	16.8	18.1	-9.5	12.3	21.8	25.0
Average		80.1	-8.9	7.8	16.7	16.8	-9.2	10.7	19.9	24.0

1/ Average of Weather Bureau hourly readings for test period.
2/ Average of 4 test packages in each truck.
3/ Difference between starting and finishing temperatures.
4/ Average of half-hour readings during each test.
5/ Temperature charts incomplete and therefore not used.

During the latter part of the delivery run there frequently was dripping from the cold plates in the truck without the curtain. There was no dripping and only occasional small wet spots on the cold plate near the door of the truck with the curtain.

The driver of the truck without a curtain kept the rear door partially closed while searching for an order inside the truck. This was done in an effort to help prevent the entry of warm outside air. With this method it was necessary to use an electric light inside the truck to find the order. The driver of the truck with the curtain kept the rear door open while he was inside. The natural lighting provided by the transparent curtain was better than that provided by the artificial light and therefore, the electric light was no longer used.

The drivers of 3 of the 4 frozen food delivery trucks advised that they believed the benefits of the curtain compensated for the inconvenience in using it. The driver of the fourth frozen food delivery truck believed the curtain was a bother and of no benefit. The driver of the chilled meat delivery truck believed that use of the curtain definitely kept the truck colder inside. However, he reported difficulty in moving through the curtain with a large quarter of beef on his shoulder.

One owner reported that he eliminated the use of dry ice as a supplement to the refrigeration unit in the trucks, thereby saving more than $3.00 per day per truck during the summer months.

All 5 curtains were examined in September after 4 months of continual use during the summer months. They were all found to be in good condition with no tears or other damage. The polyethylene plastic does develop scratch marks, but this in no way affects the use of the curtain.

HOW TO MAKE THE CURTAIN

It is important that the curtain be made the proper size for the truck door opening in which it is to be used. A curtain which is made too large will not have free movement. A curtain which is made too small will allow escape of more cold air than a curtain of proper size. When measuring the door opening caution should be taken to obtain the dimensions of the true door opening. The width of the door opening should be measured at the narrowest point--otherwise the curtain will not move freely back and forth. Likewise the height should be measured from the lowest point at the top of the opening to the highest point at the bottom of the opening. The height measurement should be taken from the top of the floor racks if the racks are higher than the bottom of the door opening. An illustration of height (H) and width (W) measurement is shown in figure 13.

The subsequent illustrations in this report show how to make a curtain for a 30" x 64" door opening (W=30, H=64). A curtain for any other door opening size would be made in the same manner, except that those dimensions involving W and H would be determined as shown in the illustrations. The major dimensions of a completed curtain are shown in figure 14--the full curtain (two halves) is the same width (W) and ½-inch shorter (H -½") in length than the door opening.

Descriptions of all parts used in the curtain are shown in figures 15 through 24. When making part No. 6 (fig. 18), it is a good idea to sew on the number of the truck in which the curtain will be used. Since the curtains are all custom made, the truck numeral will help to insure that the curtain is installed in the proper truck. Further, after winter storage, it will be much easier to install a curtain in the truck in which it was used previously.

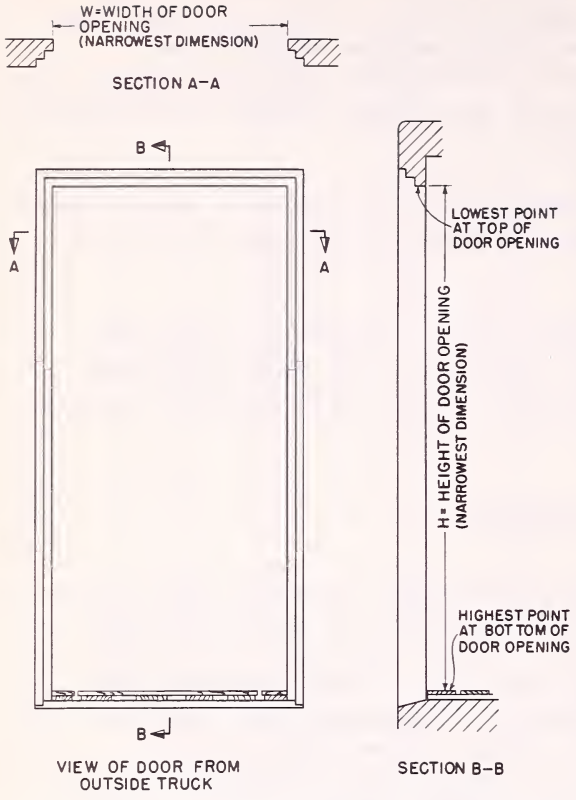
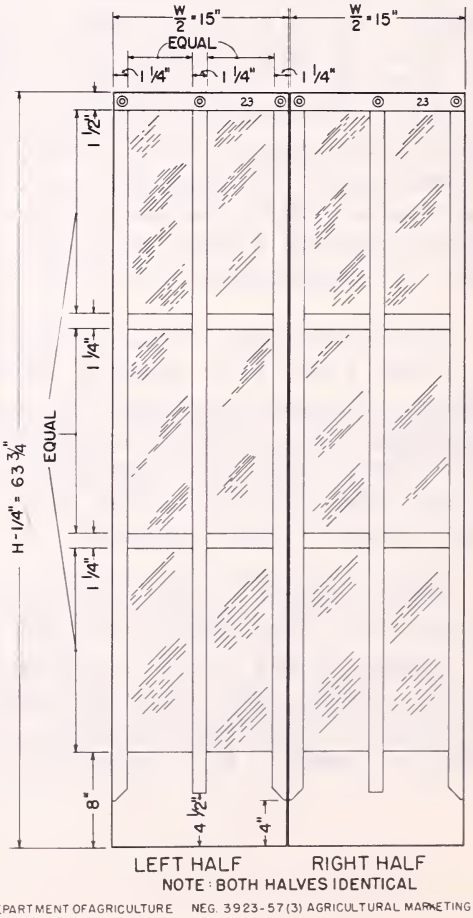


Figure 13.--How to measure the width and height of the truck door opening.

Figure 14.--Major dimensions of a curtain for use in a 30" x 64" door opening.



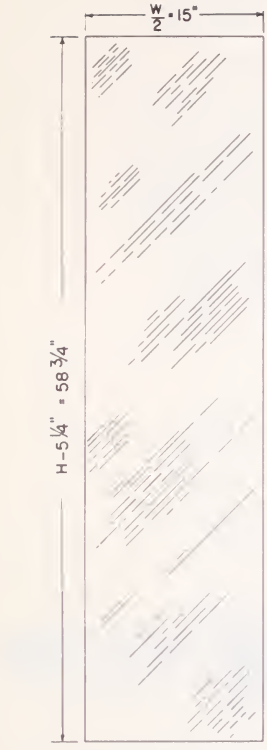


Figure 15.--Part No. 1 used in making a curtain for a 30" x 64" door opening.

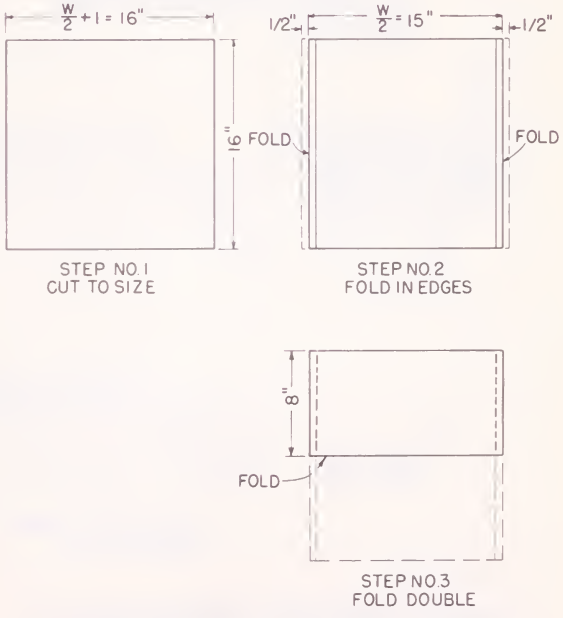


Figure 16.--Part No. 2 (bottom strip) used in making a curtain for a 30" x 64" door opening.

NOTE:
1 REQUIRED PER HALF CURTAIN
2 REQUIRED PER FULL CURTAIN
USE THE FOLLOWING MATERIAL, OR EQUAL:
FIBERTHIN (NEOPRENE COATED NYLON) 7150I, 16oz. MANUFACTURED BY U.S. RUBBER CO.
US DEPARTMENT OF AGRICULTURE NEG 3925-57(3) AGRICULTURAL MARKETING SERVICE

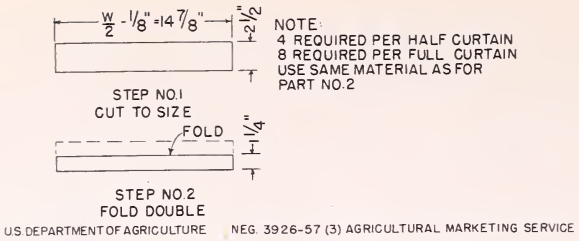


Figure 17.--Part No. 3 (horizontal center strips) used in making a curtain for a 30" x 64" door opening.

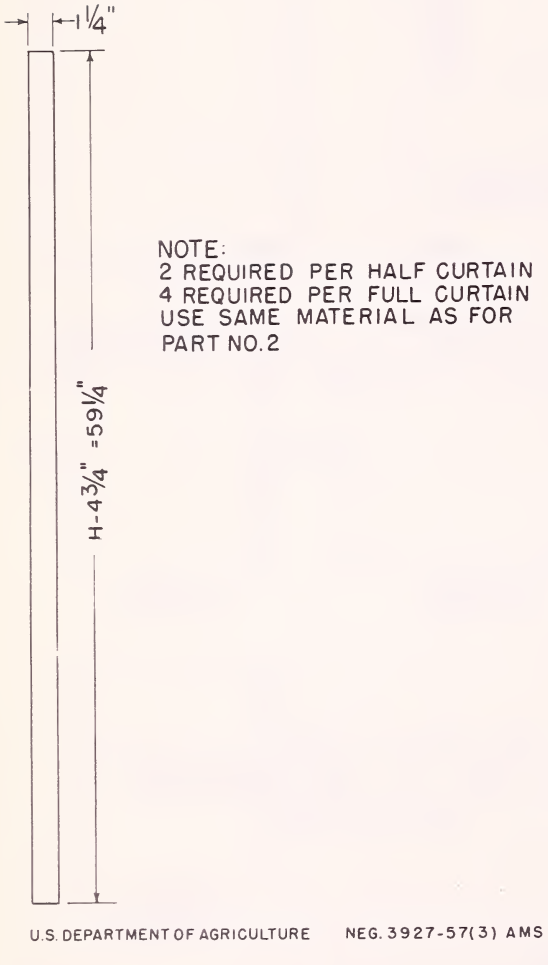


Figure 18.--Part No. 4 (center vertical strip) used in making a curtain for a 30" x 64" door opening.

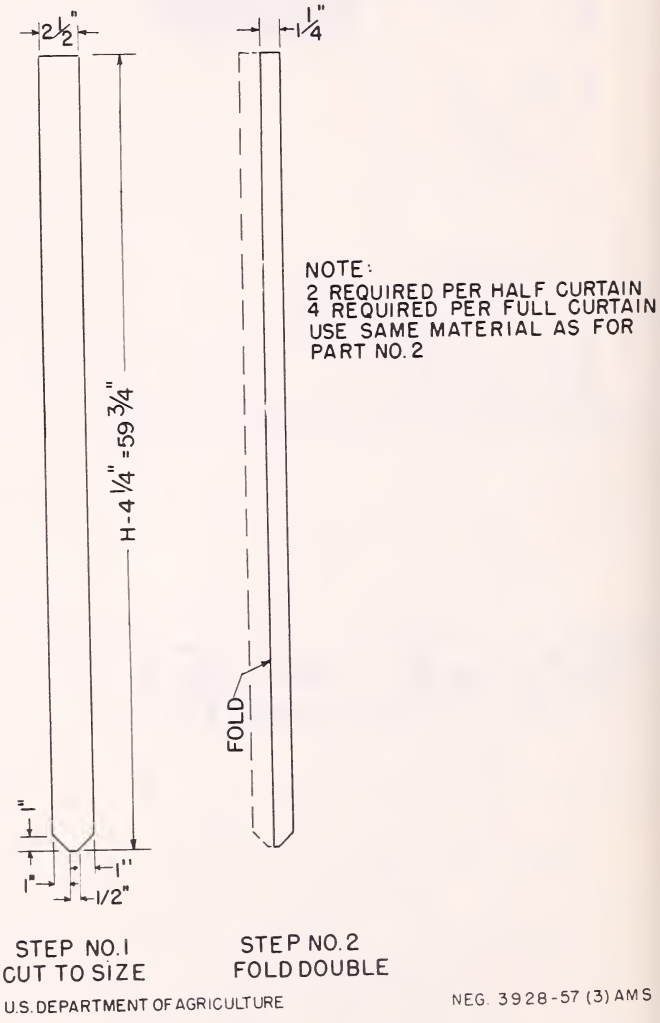


Figure 19.--Part No. 5 (edge strips) used in making a curtain for a 30" x 64" opening.

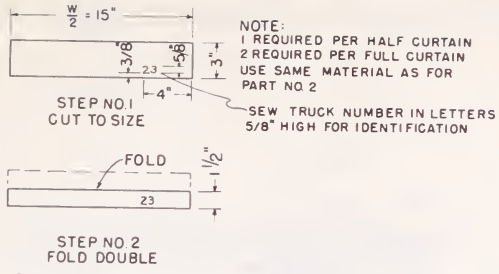


Figure 20.--Part No. 6 (top strip) used in making a curtain for use in a 30" x 64" door opening.

Figure 22.--Part No. 8 (grommet) used in making a curtain for use in a 30" x 64" door opening.

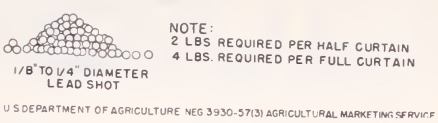


Figure 21.--Part No. 7 (lead weight) used in making a curtain for a 30" x 64" door opening.

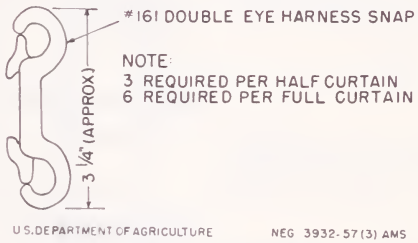


Figure 23.--Part No. 9 (harness snap) used in making a curtain for a 30" x 64" door opening.

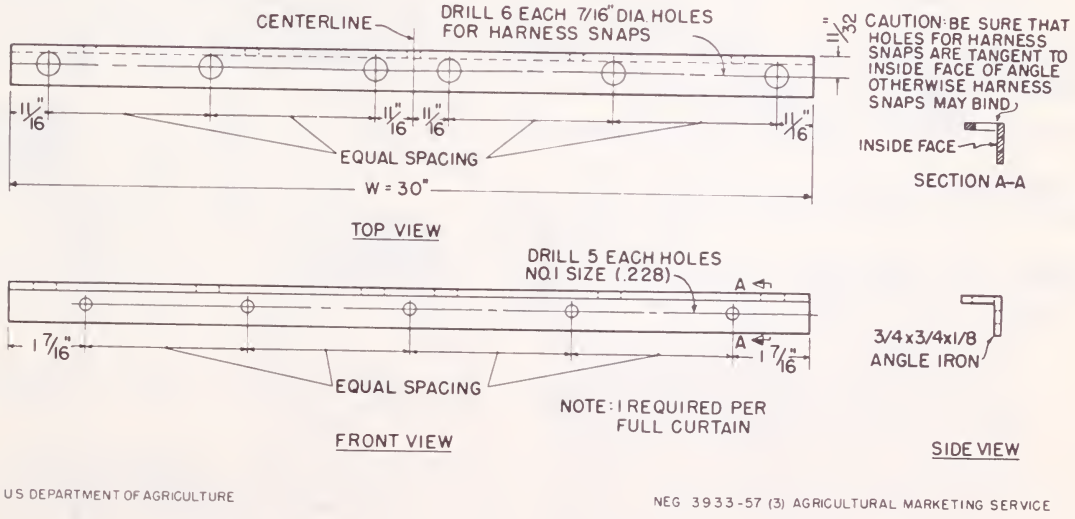


Figure 24.--Part No. 10 (suspension bar) used in making a curtain for a 30" x 64" door opening.

The method of assembling the curtain before sewing is shown in figures 25, 26, 27, and 28. The parts can be held in place by means of an ordinary stapler prior to sewing.

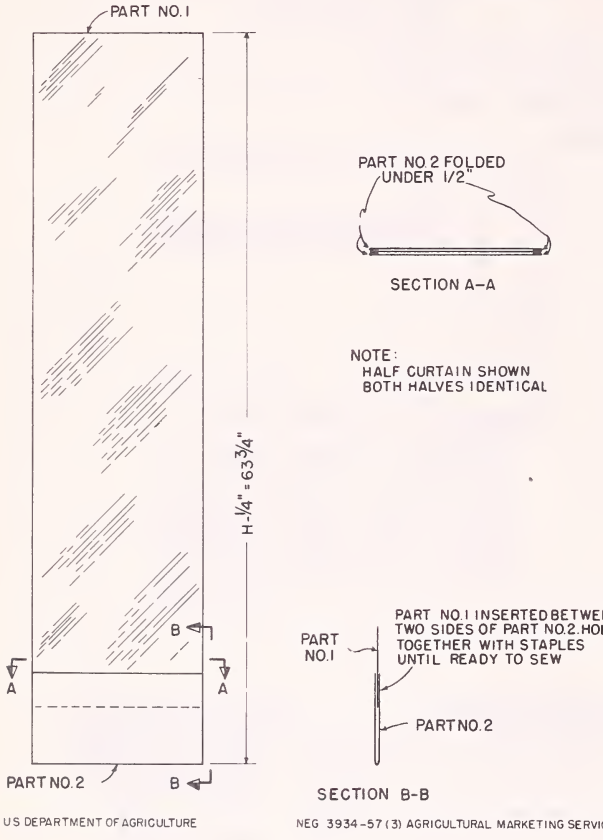
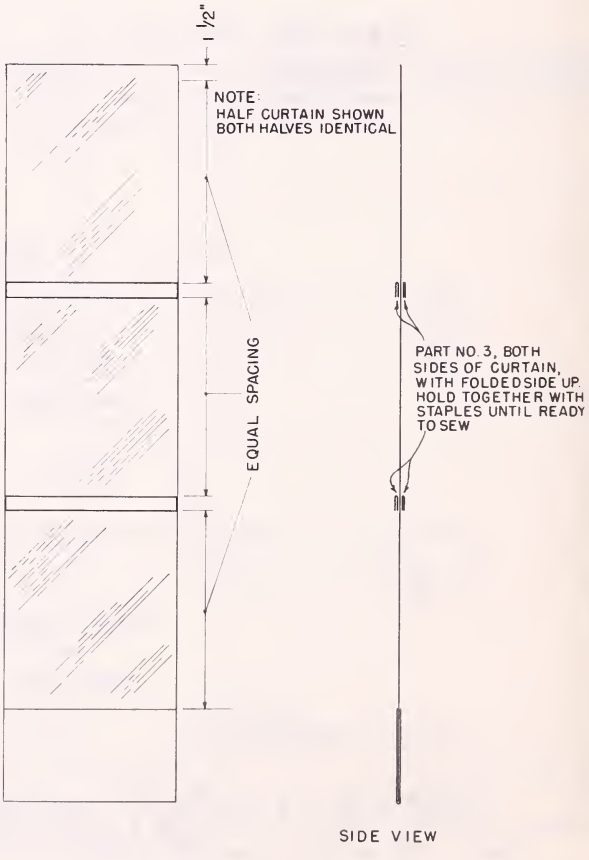


Figure 25.--Assembly of parts No. 1 and No. 2 of curtain for a 30" x 64" door opening.

Figure 26.--Assembly of part No. 3 to curtain for a 30" x 64" door opening.



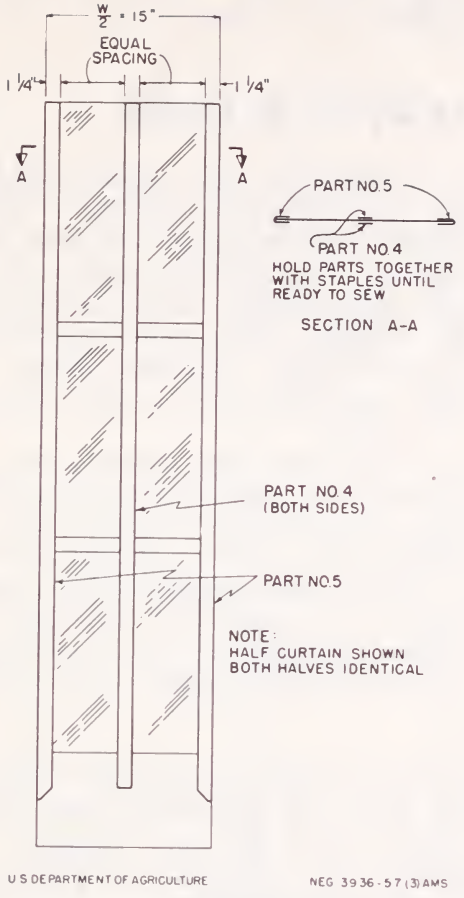


Figure 27.--Assembly of parts No. 4 and 5 to curtain for a 30" x 64" door opening.

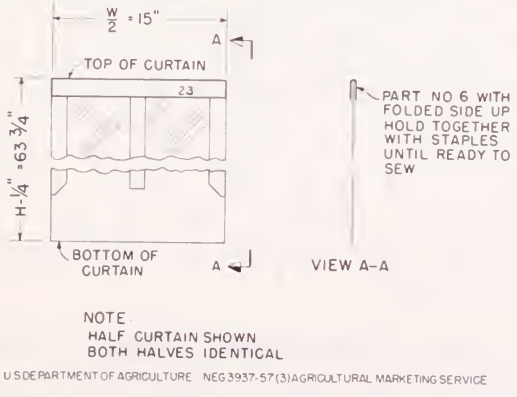


Figure 28.--Assembly of part No. 6 to curtain for a 30" x 64" door opening.

Sewing and addition of lead shot to the curtain is shown in figure 29. The pockets at the bottom are sewn shut after addition of the lead shot.

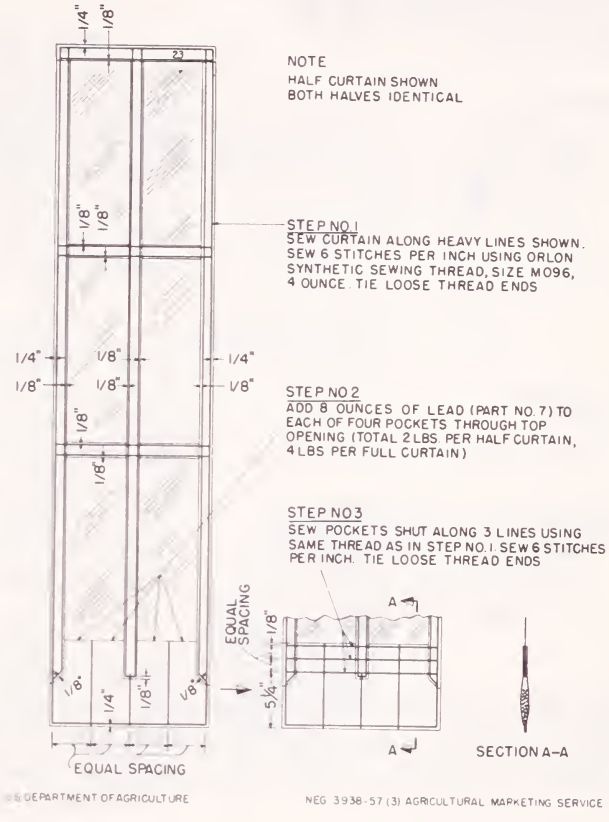


Figure 29.--Sewing and addition of part No. 7 (lead weight) to curtain for a 30" x 64" door opening.

The assembly of the spur grommets (part No. 8) to the curtain top is shown in figure 30.

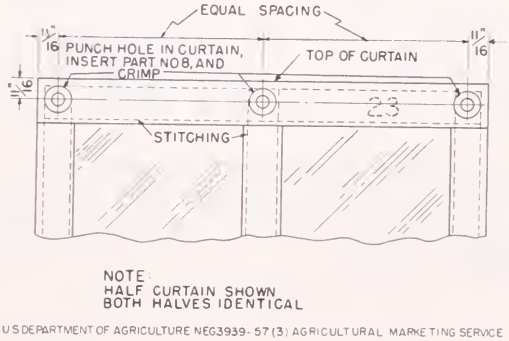


Figure 30.--Assembly of part No. 8 to curtain for a 30" x 64" door opening.

The assembly of the double eye harness snaps (part No. 9) to the curtain and to the angle iron hanger (part No. 10) is shown in figure 31.

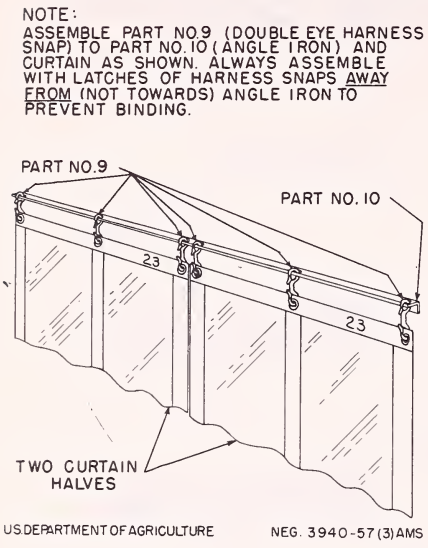


Figure 31.--Assembly of parts No. 9 and 10 to curtain for a 30" x 64" door opening.

HOW TO INSTALL THE CURTAIN

The manner of installing the curtain inside the truck is shown in figure 32. Remove or repair any ragged or pointed metal on the door or around the door opening which might damage the curtain. The angle iron hanger should be positioned so that the curtain hangs with one-half inch clearance at the bottom. Curtain sides should be even with the sides of the door opening.

If the curtain does not hang exactly straight, it is sometimes of help to switch the two half curtains--or reverse one or both of the halves in order that the inside face of the curtain becomes the outside face. After the curtain halves are positioned they should be marked "L" for left and "R" for right. These markings can be scratched or stamped on the outside metal grommet at the top of each curtain.

At the end of the summer season the snaps should be unhooked from the suspension bar and the curtain halves, with snaps still attached, stored until the next summer. If the curtains are properly identified it should not be difficult to install them in the same truck and position when they are again needed.

CONCLUSIONS

The curtain described in this report is of definite help in maintaining lower product and air temperatures in refrigerated local delivery trucks during the summer months. It allows better lighting inside the truck with the door open than the use of an artificial light with the rear door partially closed.

Passing through the curtain while moving in and out of the truck, is of course, somewhat of an inconvenience to the driver. However, most of the drivers became accustomed to the curtain and felt that elimination of dripping inside the truck more than offset that inconvenience.

While the curtains thus far were used on only frozen food and meat trucks, there is reason to believe that they would also be of benefit for other refrigerated trucks used in local delivery of milk, ice cream, produce, or other perishable items.

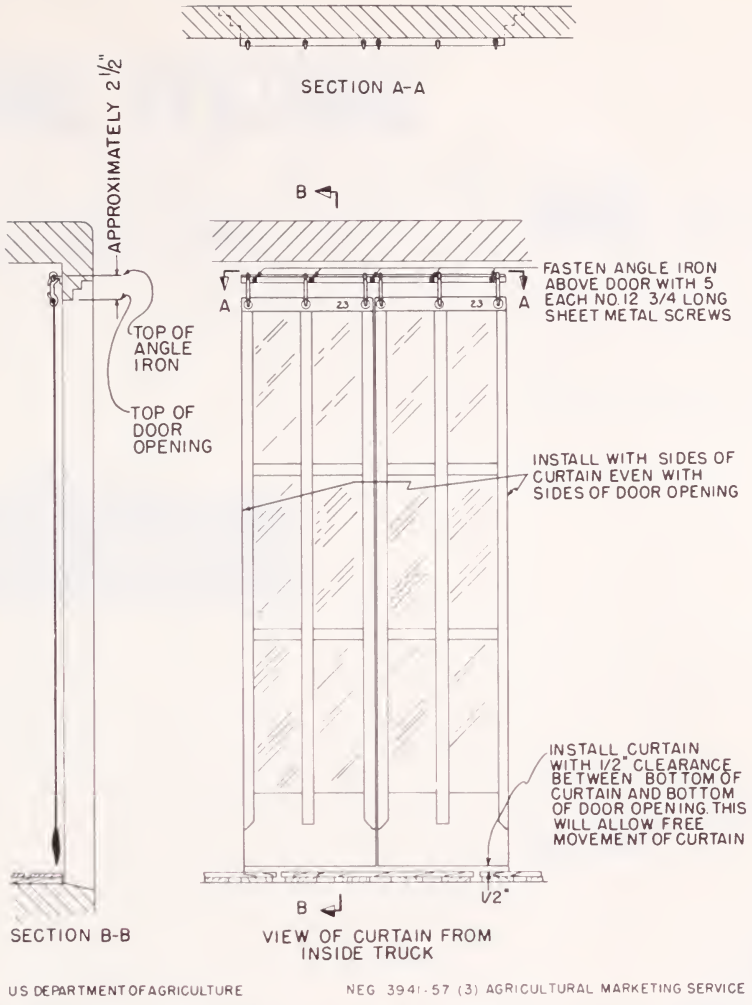


Figure 32.--Installation of curtain inside truck at rear door opening.

The curtain was tested on trucks which had the "cold-plate" type of refrigerating system. However, the curtain should also be of benefit when used in local delivery trucks which have other types of refrigeration systems.

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