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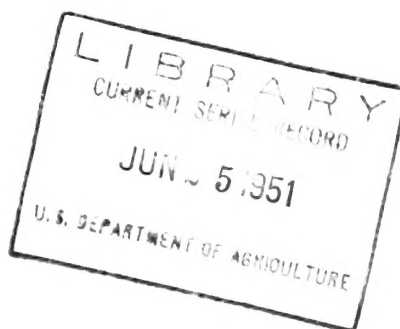
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H. T. & S. OFFICE REPORT NO. 249

X FRUIT TEMPERATURES IN COMMERCIAL NORTHWESTERN APPLE SHIPMENTS
PROTECTED WITH AUTOMATIC ALCOHOL HEATERS DURING
JANUARY AND FEBRUARY 1951. X

By

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Horticultural Crops

Wenatchee, Washington
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Fruit Temperatures in Commercial Northwestern Apple Shipments
Protected with Automatic Alcohol Heaters During
January and February 1951

OBJECT

Thermostatically controlled alcohol heaters have been put into use to an increasing extent for winter protection of apple and pear shipments in refrigerator cars from the Pacific Northwest following tests conducted by the Department and the Association of American Railroads from 1946 through 1948. The latter agency conducted further tests during 1948 and 1949, and these data have been published independently.

During the past two winters the Western Fruit Express Company has used a large number of Preco thermostatically controlled alcohol heaters for shipments billed Carrier's Protective Service. At the request of the Wenatchee Valley Traffic Association, shipping tests were undertaken during 1951 by the U. S. Department of Agriculture with the cooperation of the Western Fruit Express Company and Washington fruit shippers to obtain information on transit commodity temperatures in cars moved under commercial shipping conditions. It was the desire of shippers to have this information secured in a variety of refrigerator cars, both standard and fan-equipped, and in good and poor condition, such as are normally available throughout the variable weather conditions of the winter shipping season.

Ryan recording thermometers were placed in 17 commercial loads of apples, for shipment from North Central Washington shipping points to Chicago and New York from January 11 to February 24, by the U. S. Department of Agriculture. The Western Fruit Express Company, through its agents, provided information on train schedule, heater servicing and performance, and outside maximum and minimum air temperatures at each regular inspection point for all cars while in their territory. The data were consolidated by the local agent for release to the Department of Agriculture.^{1/}

PROCEDURE

Commodity Temperatures: Ryan recording thermometers were placed in the centers of apple packages, consisting of cartons, tray-pack boxes, and standard boxes in different shipments. In all cases, the packages in which the instruments were placed were a part of the consignment and received the same treatment as the remainder of the load. In each shipping test a package containing an instrument was placed in the bottom and top layers of the load at doorway, centerline positions. In one instance, test No. 5, it was necessary that the bottom test package be placed at the south side rather than at the centerline of the car.

Although the instruments recorded air temperatures within the packages, these would so closely approximate the temperature of the fruit that the temperatures recorded are referred to as "commodity temperatures" in this report. Fruit temperatures were secured with hand thermometers while the test packages were being prepared at time of loading and are shown in table 1. Temperatures recorded within the packages on the thermograph tapes were plotted at six-hour intervals and are presented in figures 1 to 17 as top and bottom layer temperature graphs for each car excepting for tests 5 and 6 from which instruments in bottom-layer boxes were not recovered and only top layer temperatures were secured.

^{1/} The authors are further indebted to the staff members of the Market Disease Laboratories, U.S.D.A. at Chicago and New York for their valuable assistance in returning instruments.

In test 9 no record of bottom temperatures were obtained due to instrument failure.

Heater Records: The Western Fruit Express was advised which cars contained the Ryan thermometers in order that the necessary data could be taken, and in most cases the cars received the normal Carrier's Protective Service. Preco alcohol heaters, with thermostats set at 32.5° F., were installed and pilots lighted at Appleyard, Washington, after the cars were brought from the various loading points. Exceptions to this occurred in test 11 in which charcoal heaters were used, and in tests 9, 10, and 17 in which pilots were lighted at Whitefish, Montana or Havre, Montana in accordance with operational procedures for charcoal heaters under Rule 515 par. C.

All drains were left open on the cars.

At each regular inspection point in Western Fruit Express territory it was noted whether the heaters were on pilot, full burner, or were dark at times of arrival and departure. The Preco heaters were removed at Minnesota Transfer as the cars went off-line and notations were made as to heaters supplied by the connecting lines and whether or not they were lighted. In the case of tests 14 and 15 the connecting line did not light heaters when they were installed, but the commodity temperature records indicate the heaters were lit sometime before the cars left Minneapolis. The above information, with maximum and minimum outside temperatures prevailing while the car was at the inspection point, and delays, is given on the charts, figures 1 to 17.

RESULTS

Temperature records for each car between Wenatchee and destination are shown in figures 1 to 17. No excessively high fruit temperatures were indicated in any of the cars during the period of protection by the alcohol heaters.

For a more ready comparison of transit temperatures, the data have been consolidated in table 1 with group segregations according to wheather encountered. The first group included cars which moved through weather of zero and above west of Minneapolis; the second, zero and below as far west as Breckenridge, Minnesota; the third, zero and below between Williston, N. Dakota and Minneapolis; the fourth, zero and below between Whitefish, Montana and Minneapolis; and the fifth, zero and below as far west as Hillyard, Washington. The gain in temperature was computed from temperatures recorded on the Ryan tapes at Appleyard and at the Minnesota Transfer. The initial fruit temperatures at Appleyard were not always identical with those taken by hand thermometer at loading because of temperature gains between times of loading and lighting of heaters.

Comparison of Charcoal and Alcohol Heaters: It will be observed in table 1 that the maximum temperature recorded in a top layer box between Wenatchee and Minneapolis was 50° F. in test 11. This was a non-fan car heated with charcoal heaters and experienced outside temperatures of zero and below from Whitefish east. The temperature gain in this car was 16°. The highest comparative temperature in a car heated with the alcohol heaters in similar weather, was 45° (test 9), with a temperature gain of 12°.

Figures 4, 5, and 6 are illustrative of instances where the temperature in the top layer of apples started a more rapid rate of gain as soon as the Preco heaters were replaced with charcoal heaters at Minneapolis.

Periods of Temperature Gains in Non-fan Cars: In tests 9, 10, and 17, pilots were lighted either at Whitefish or Havre, Montana following operating procedures for charcoal heaters under Rule 515 par. C. Although temperature gains in top-layer boxes shown for the cars in table 1 do not evidence benefits from the delayed lighting of pilots, such a conclusion would be invalid because of weather conditions. An examination of top layer temperatures in figures 1, 2, and 3 shows that when outside temperatures were moderate (from 25° to 45° F.) cars having pilots lighted at origin had top commodity temperature increases of approximately one degree per day in contrast to temperatures in tests 9, 10, and 17 in which pilots were dark. Tests 6, 8, and 10 indicate that when outside temperatures were in the range 12° to 25° F. the burning of pilot lights had little effect on top layer temperatures.

A study of temperature gains in the individual graphs, figs. 1 to 17 shows that there are two general conditions when temperature increases take place in the top layer, (1) when the weather is moderate (25° F. and above) with pilots burning and (2) during periods of sustained low temperatures when heaters are full burning for long periods. The studies suggest that there would be some benefit from leaving pilots dark when outside temperatures are 25° F. or higher.

The series of tests by the Association of American Railroads and the U. S. Department of Agriculture in 1947-48 ^{1/} showed that the use of automatic alcohol heaters in non-fan cars would not avoid excessive temperature increases in the top layers during protracted periods of full burner operation. Since the tests were conducted in 1947-48 some modifications have been made in the Preco heater. In none of the 1951 tests did top commodity temperatures increase at as fast rates as they did in some of the earlier tests.

Alcohol Heaters in Fan Cars: Tests 4, 5, 7 and 13 were made with fan cars. The temperature graphs for these cars are excellent for the period of heating with Preco heaters. [However delays caused by the switchmen's strike, at or near terminals, after charcoal heaters had been installed at Minneapolis resulted in excessive heat accumulations in the top of the loads and raised temperatures to undesirable levels in tests 4, 5, and 13.] These tests confirmed the conclusions of previous studies (cited above) that the use of automatic alcohol heaters in fan cars avoided freezing without causing excessive temperatures in the tops of the loads.

CONCLUSIONS

1. Thermostatically controlled alcohol heaters gave satisfactory protection to apple loads in non-fan refrigerator cars while in transit between Wenatchee and Minneapolis during a variety of winter weather conditions.

2. These heaters, under the same weather conditions, did not raise commodity temperatures in top layers of the load as rapidly as the charcoal heaters used in one test. This was further demonstrated where charcoal heaters were

^{1/} Redit, W. H., and Smith, Edwin. 1948. Car heaters and winter protection of fruit shipments. Summary of transportation tests with apples from Washington State December 1947, January and February 1948. AAR-USDA tests 22, 23, 24, 25, 26 and 27.

installed and lit by connecting lines at Minneapolis.

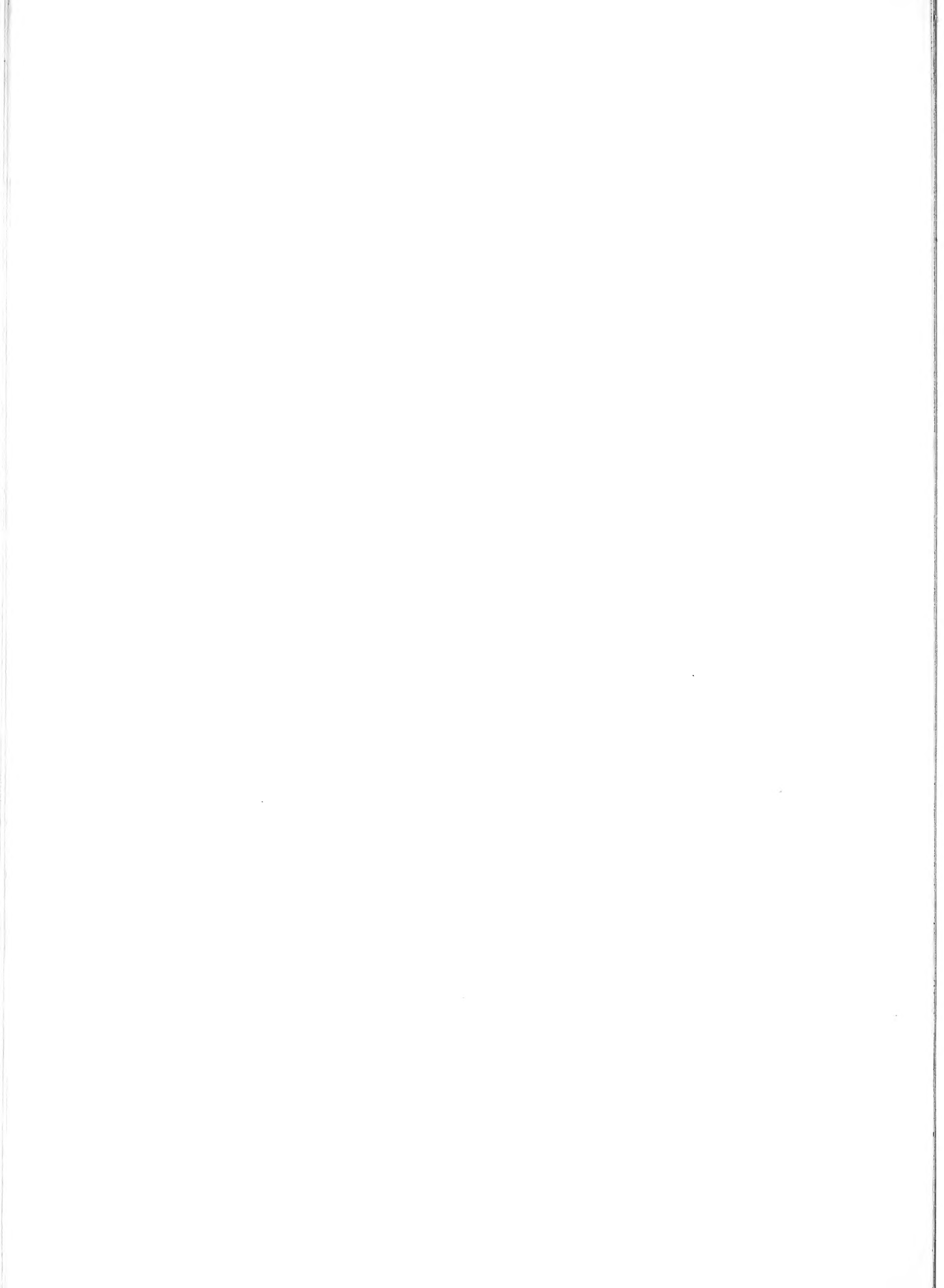
3. The results indicate that lower top layer fruit temperatures result when the alcohol heater pilots are not lit at origin when outside temperatures are 25° or above and there is no immediate prospect of lower temperatures.

4. Automatic alcohol heaters in fan-equipped cars maintained the most satisfactory commodity temperatures in both mild and severe weather. Forced air circulation minimized temperature differentials between the top and bottom layers, raising the temperatures of the bottom layers to prevent freezing and preventing warm temperatures in the top layers. It was noticeable, however, that in those fan cars subjected to long delays commodity temperatures in top layers increased at rates comparable to those of non-fan cars.

Table 1. Commodity temperature data from seventeen apple shipping tests, 1951.

Types of weather	Test No.	Type of Car	Hand thermometer readings at loading	Commodity temperatures		Average	Gain		Heaters lit at	Remarks	
				Maximum Top	Minimum Bottom		Top	Bottom			
			Deg. F.	Deg. F.	Deg. F.	Deg. F.	Deg. F.	Deg. F.			
Temperatures zero and above, Wen. to M'pls.	1	Non-fan	---	41	36	36.3	33.7	7	2	Wenatchee	Charcoal heaters substituted at Willmar.
	2	do.	---	37	33	34.6	32.5	6	1	do.	
	3	do.	---	35	32	33.0	32.0	5	0	do.	
	8	do.	32	40	34	35.6	31.5	6	3	do.	
	14	do.	33-34	37	33	35.9	32.2	4	1	do.	
	15	do.	31	36	---	34.5	---	6	0	do.	
	17	do.	31-32	41	36	38.3	36.0	4	0	Havre	
Temperatures zero and below Brck'rdge to M'pls.	7	Fan	32-34	35	34	34.8	33.4	1	1	Wenatchee	Below zero, Minot
	13	Fan	31	35	35	33.5	32.6	4	4	Wenatchee	
	6	Non-fan	32	40	---	36.5	---	6	---	Wenatchee	
	16	do.	36	44	36	40.8	34.9	8	1	do.	
	4	Fan	34-35	37	35	35.7	33.7	0	3	do.	
	5	do.	35	37	---	36.3	---	1	---	do.	
	9	Non-fan	32	45	---	38.4	---	12	---	Whitefish	
Temperatures zero and below Whitefish to M'pls.	10	do.	32	43	34	38.3	31.5	8	4	do.	
	11	do.	33	50	36	41.4	34.1	16	1	do.	Charcoal heaters used throughout
	12	Non-fan	32-33	42	33	38.2	31.4	8	-1	Wenatchee	

1/ Temperature maximums, averages and gains were indicated on thermograph tapes from Appleyard to Lyndale Junction, Minn.



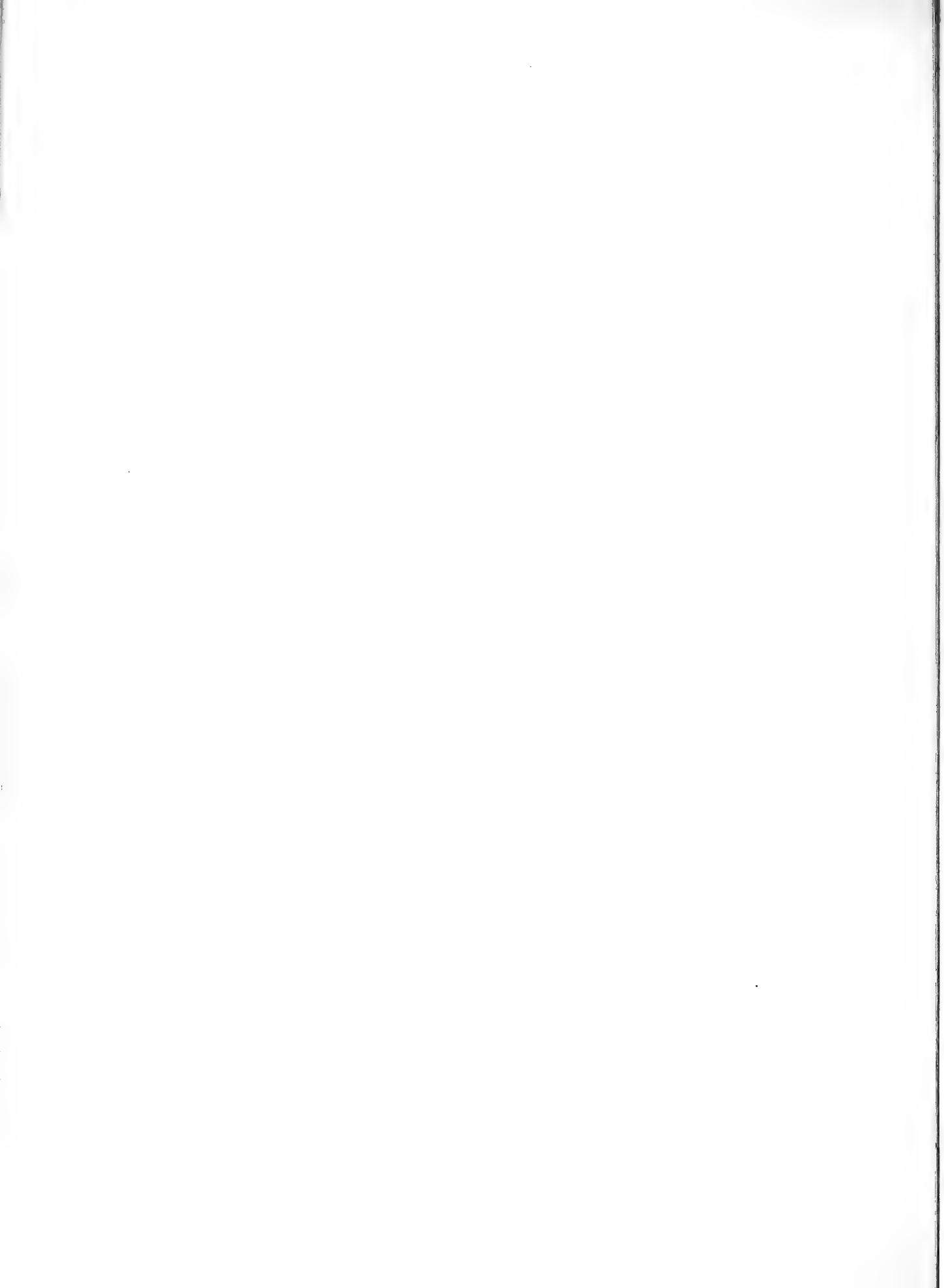
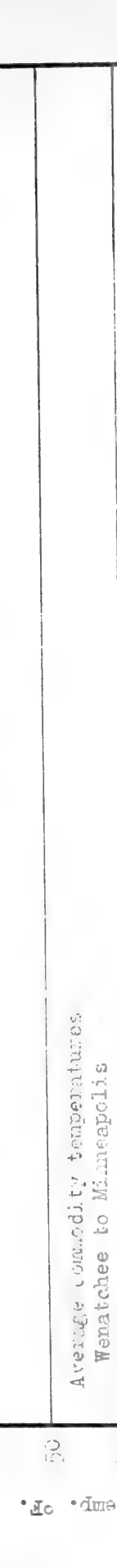


FIGURE 2.
 Type of Packages - Standard Boxes
 Clearance Around Lading:
 Top - 14 inches
 Sides - 4 1/2 to 8 1/2 inches
 Height of Floor Racks - 6 inches
 Heater Placement - 1 each bunker

Test No. Wen.-2.
 Car No. SFRD 34181
 Type of Car - Non-fan
 Car Condition - Good
 Commodity - Winesap Apples
 Heaters - Freco (Wenatchee to Minn.)

60
 55
 50
 45
 40
 35
 30

Average commodity temperatures
 Wenatchee to Minneapolis
 Top 34.6
 Bot. 32.5

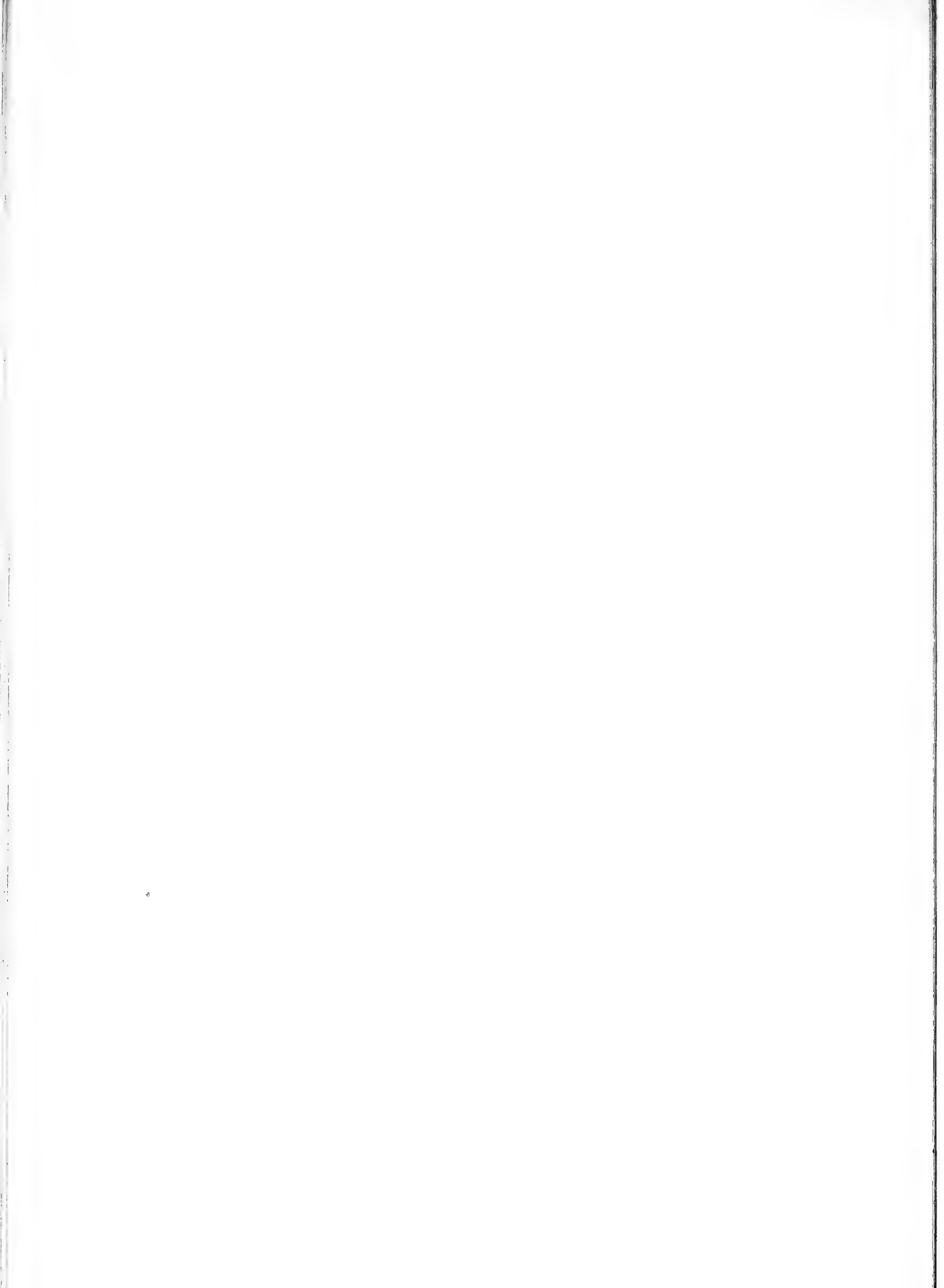


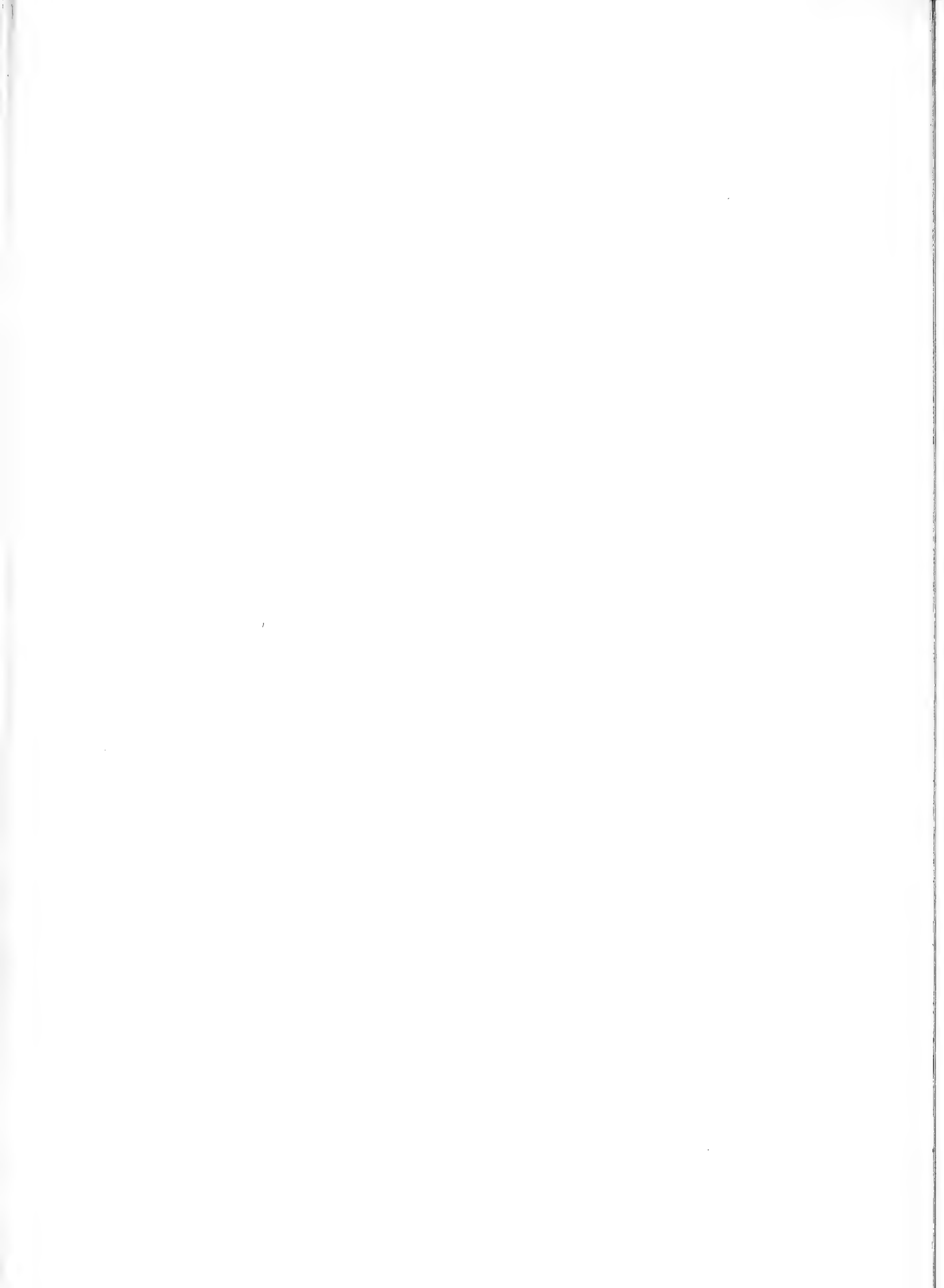
Front FDP DP FP FP FP FP FP FP FP FP FP FP P Milw. #S 153, alcohol heater installed, lit.
 Rear FP FP FP FP FP FP FP FP FP FP P

Outside Temp.
 Max. 32 35 31 36 25 30 23 23 31
 Min. 27 34 25 32 24 23 28 20 31

Inspection Points	Terminal Delay	12	13	14	15	16	17	18	19	20	21	22	23
Appleyard Wash.	■												
Hillyard	■												
Whitefish Mont.	■												
Hayre	■												
Williston	■												
N.D.	■												
Minot	■												
Brck' rdge	■												
Minn.	■												
Willmar	■												
Mpls.	■												

Unloaded Chicago Jan. 27



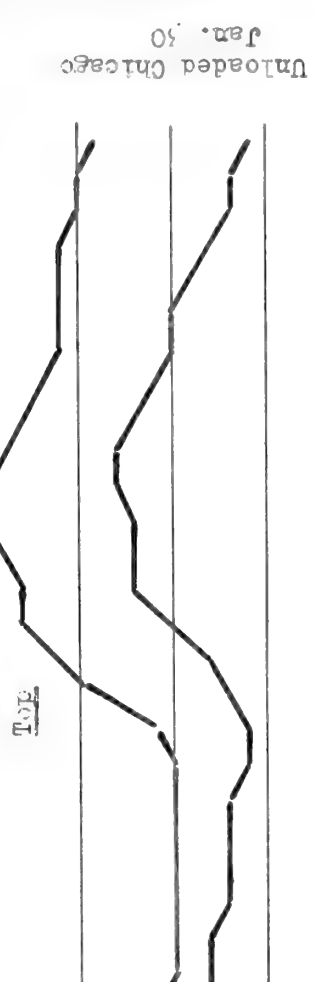


Test No. Wep.-4
 Car No. SFRD 15269
 Type of Car - Fan
 Car Condition - Good
 Commodity - Winesap Apples
 Heaters - Preco (Wenatchee to M'pls.)

FIGURE 4.

Type of Packages - Standard Boxes
 Clearance Around Lading:
 Top - 12 inches
 Sides - 6 to 8 inches
 Height of Floor Racks - 7 inches
 Heater Placement - 1 each bunker

Average commodity temperatures
 Wenatchee to Minneapolis



Loaded Wenatchee 8:30 to 12 noon

Unloaded Chicago Jan. 30

Front * * F PP PP PP PP PP PP PP PP PP PP PP PP PP PP PP
 Rear * * F PP PP PP PP PP PP PP PP PP PP PP PP PP PP PP
 *Charcoal heaters in place, not lit.

Max. 45 34 30 12 0 2 -10 5 -2
 Min. 28 34 23 12 -5 -3 -12 4 -11

Appleyard Wash.
 Hillyard
 Whitelish Mont.
 Havre
 Williston
 N.D.
 Minot
 Brck'rdge Minn.
 Willmar
 M'pls.

Jan. 15 16 17 18 19 20 21 22 23 24 25 26

Inspection Points
 Terminal delay

Outside Temp.

Commodity Temp. °F

P-Pilot
 F-Full
 D-Dark
 H

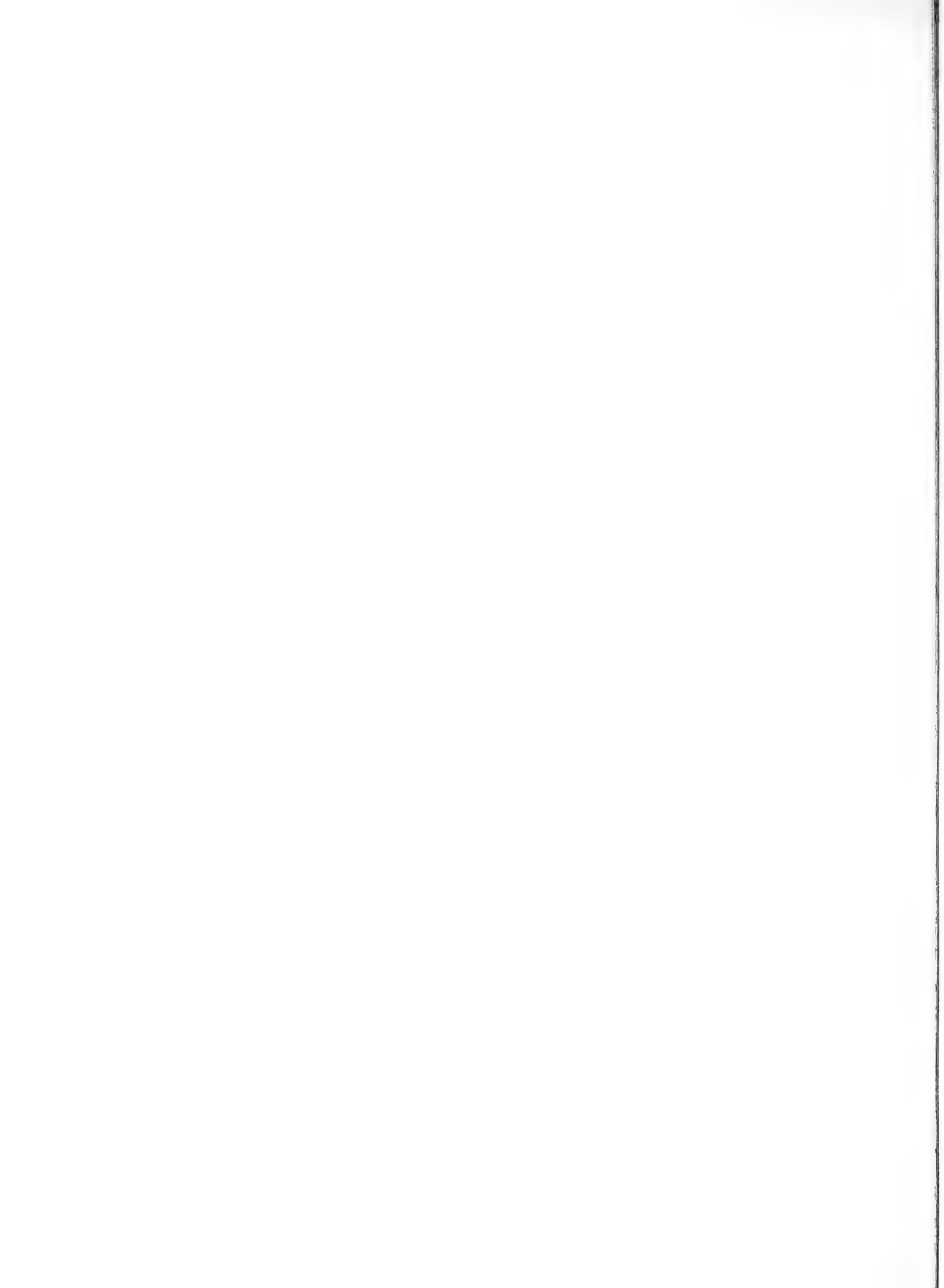
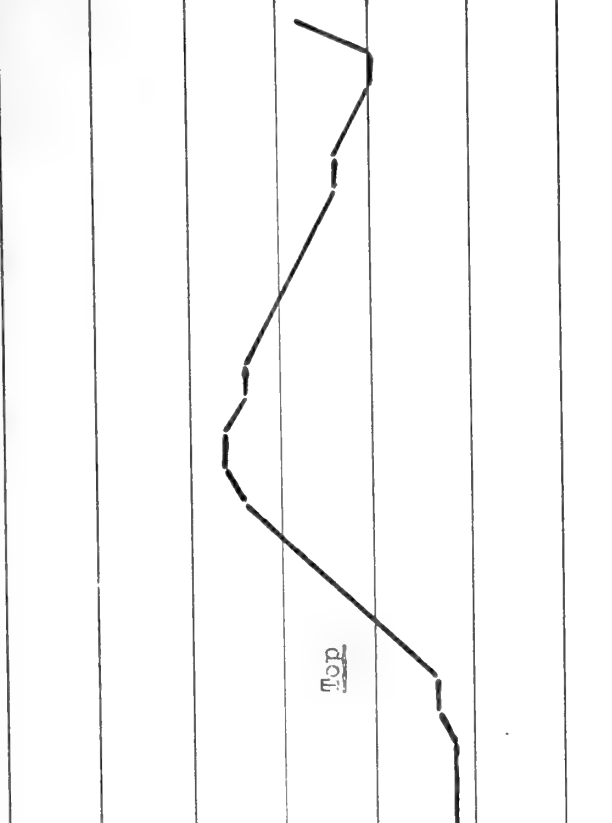


FIGURE 5.

Test No. 2511-2
 Car No. ART 27028
 Type of Car - Fan
 Car Condition - Good
 Commodity - Delicious Apples
 Heaters - Preco (Wenatchee to M'pls.)

Clearance Around Lading:
 Top - 15 inches
 Sides - 3½ inches
 Height of Floor Packs - 7½ inches
 Heater Placement - 1 each bunker



Loaded Cashmere 8:30 to 10 a.m.
 Place and time of unload unknown

P-Pilot
 F-Full
 D-Dark

Front * * F PP PP PP FF FF PP FF FF C1010, charcoal heater installed, lit
 Rear * * F PP PP PP FF FF PP FF FF B9879, charcoal heater installed, lit

*Charcoal heaters in place, not lit.

Outside Temp.
 Max. 32 34 30 12 0 2 -10 5 -2
 Min. 28 34 23 12 -5 -3 -12 4 -8

Inspection Points Terminal Delay

Appleyard Wash.
 Hilliard
 Whitetish Mont.
 Havre
 Williston N.D.
 Minot
 Brck'rdge Minn.
 Willmar
 M'pls.

Jan. 15 16 17 18 19 20 21 22 23 24 25 26

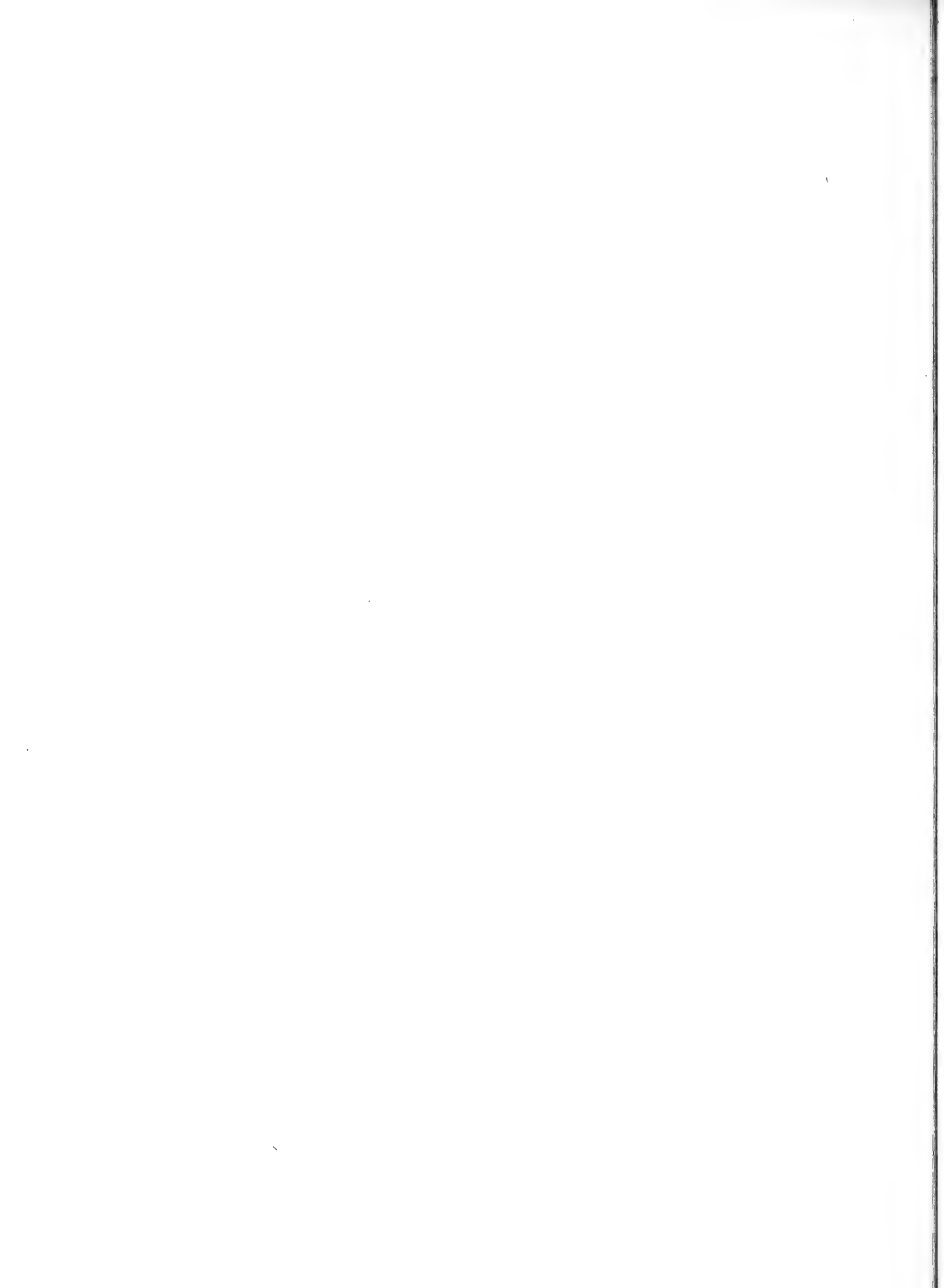
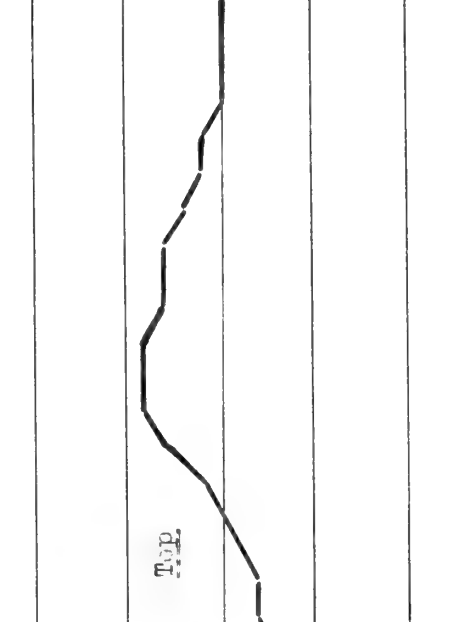


FIGURE 6.
 Type of Packages - Tray Pack Boxes
 Clearance Around Lading:
 Top - 5 inches
 Sides - 2½ to 4 inches
 Height of Floor Racks - 5 inches
 Heater Placement - 1 each bunker

Test No. Wen.-6
 Car No. FGE 33523
 Type of Car - Non-fan
 Car Condition - Fair
 Commodity - Delicious Apples
 Heaters - Preco (Wenatchee to M'pls.)



Average commodity temperatures
 Wenatchee to Minneapolis

Top 36.5
 Top
 9 am to 1:30 pm
 Unloaded Milwaukee
 Jan. 26

Front FP FP PP PP DF DF PP DF FF FF B12974, charcoal heater installed, lit.
 Rear FP FP PP PP PP FF FF FF FF B1293, charcoal heater installed, lit.

Max. 42 28 24 12 -2 -4 -14 -6 5
 Min. 31 28 22 12 -2 -7 -14 -10 -3

Inspection Points Terminal Delay	17	18	19	20	21	22	23	24	25	26	27
Appleyard Wash.	█										
Hillyard	█										
Whiterish Mont.		█									
Have			█								
Williston				█							
Minot					█						
Brck'ridge						█					
Min.							█				
Willmar								█			
M'pls.									█		

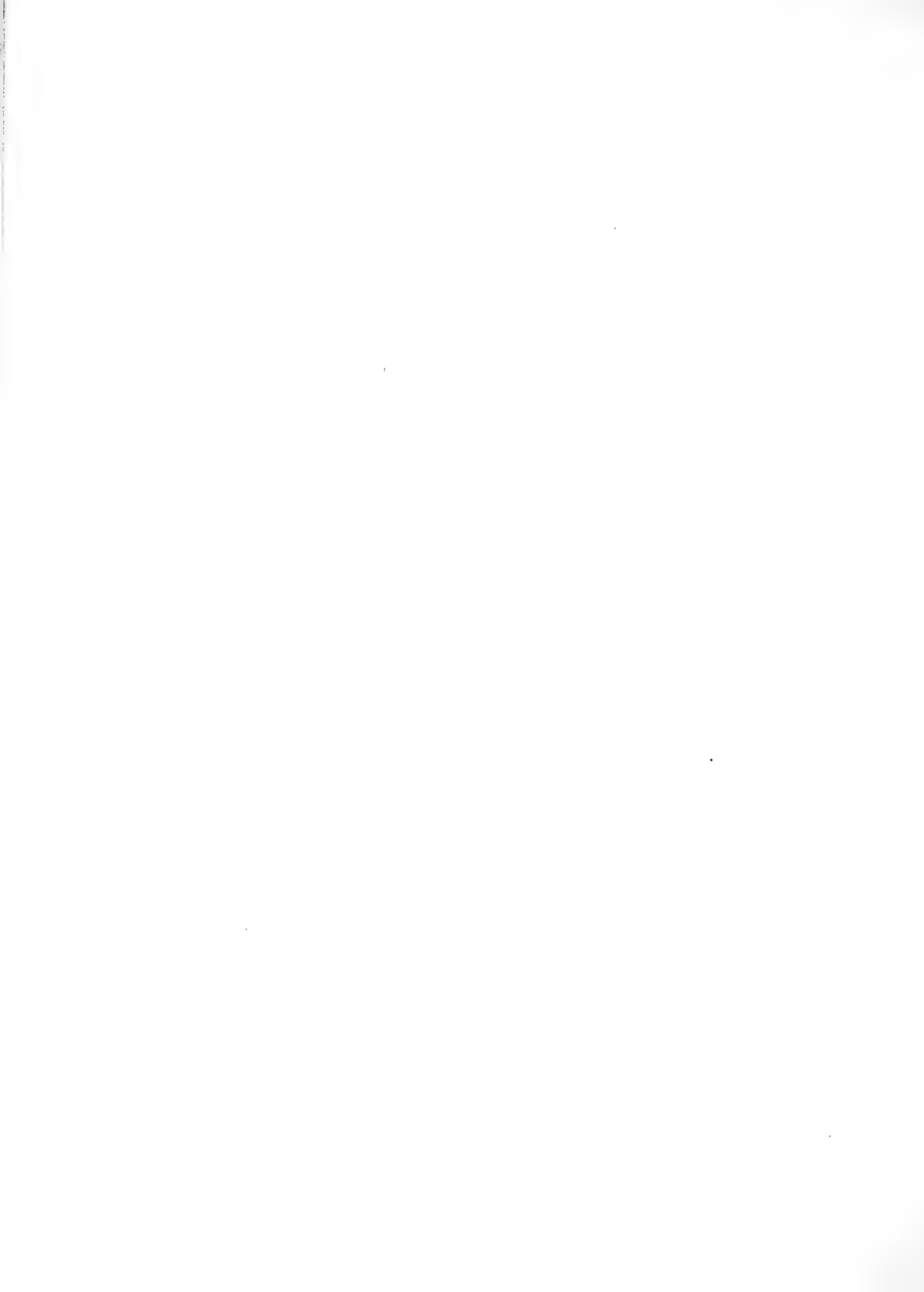


FIGURE 9.

Type of Packages - Standard boxes
 Clearance Around Lading:
 Top - 10 inches
 Sides - 4 to 6 1/2 inches
 Height of Floor Racks - 4 1/2 inches
 Heater Placement - 1 each bunker

Test No. Wen.-9.
 Car No. FWDX 20047
 Type of Car - Non-fan
 Car Condition - Fair
 Commodity - Winesap Apples
 Heaters - Preco (Wenatchee to M'pls.)

60

55

50

45

40

35

30

Commodity Temp. °F.

Average commodity temperatures
 Wenatchee to Minneapolis

Top 38.4

9:00 AM to Noon

Top

Unloaded Chicago
 Feb. 9

°P-Pilot
 °F-Full
 °D-Dark

Front D D D D P* FF FF FF FF P CNW 8716, charcoal heater installed, lit.
 Rear D D D D P* FF FF FF FF P

* Changed to CPS at Whitefish, heaters lit.

Outside Temp.

Max. 38 40 -2 -16 -25 -22 4
 Min. 30 38 -8 -16 -32 -32 -2

Inspection Points

Appleyard Wash.	Hillyard	Whitefish Mont.	Have	Williston N.D.	Minot	Brck'rds Minn.	Willmar Minn.	M'pls.
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Terminal Delay

Jan. 24	25	26	27	28	29	30	31	Feb. 1	2	3
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FIGURE 10.

Type of Packages - Standard boxes
 Clearance Around Lading:
 Top - 10 inches
 Sides - 4 to 6 inches
 Height of Floor Racks - 5 inches
 Heater Placement - 1 each bunker

Test No. Wen.-10
 Car No. BRE 75428
 Type of Car - Non-fan
 Car Condition - Fair
 Commodity - Delicious Apples
 Heaters - Preco (Wenatchee to M'pls.)

60

55

50

45

40

35

30

Average commodity temperatures
 Wenatchee to Minneapolis

Top 38.3
 Bot. 31.5

Top

Bottom

Loaded Chelien
 9:00 am to Neor

Unloaded New York
 Feb. 8

P-Pilot
 F-Full
 D-Dark

Front D D D P* FF FF FF FF F Soo #2976, charcoal heater installed, lit
 Rear D D D P* FF FF FF FF F Soo #5806, charcoal heater installed, lit
 * Changed to CPS at Whitefish, heaters lit.

Outside Temp.

Max. 40 20 -18 -2 -15 -7 -14
 Min. 36 12 -19 -2 -18 -15 -18

Inspection Points
 Terminal Delay

Appleyard Wash.

Hillyard

Whitefish Mont.

Have

Williston N.D.

Minot

Brck' rge Minn.

M'pls.

Jan. 25

26

27

28

29

30

31

Feb. 1.

2

3

4

Test No. Wen.-12
 Car No. WFE 49364
 Type of Car - Non-fan
 Car Condition - Fair
 Commodity - Delicious Apples
 Heaters - Preco (Wenatchee to M'pls.)

FIGURE 12.
 Type of Packages - Standard boxes
 Clearance Around Lading:
 Top - 11 inches
 Sides - 5 inches
 Height of Floor Racks - 6 inches
 Heater Placement - 1 each bunker

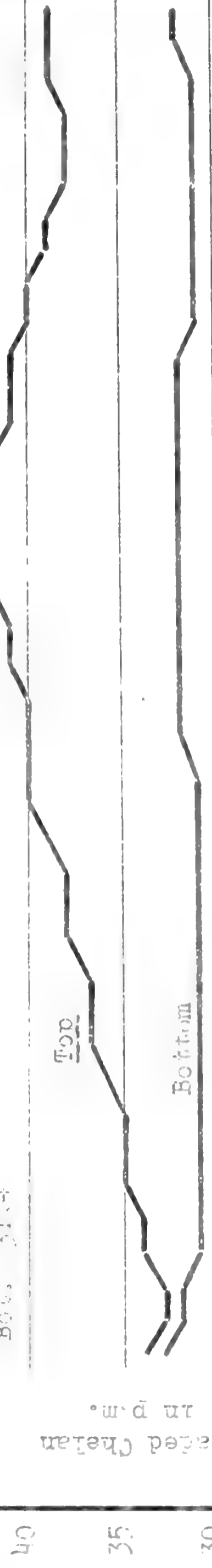
60
55
50
45
40
35
30

Average commodity temperatures
 Wenatchee to Minneapolis

Top 38.2
 Bot. 31.4

Loaded Chelan
 in p.m.

Unloaded New York
 Feb. 13



Front F F FF FP FF FP F Soo #5719, charcoal heater
 Rear F F FF FP FP FF F installed, lit

Max.	10	-5	-17	-8	-6	-13	-15	9	18
Min.	6	-6	-26	-10	-15	-15	-12	6	6

Outside Temp.

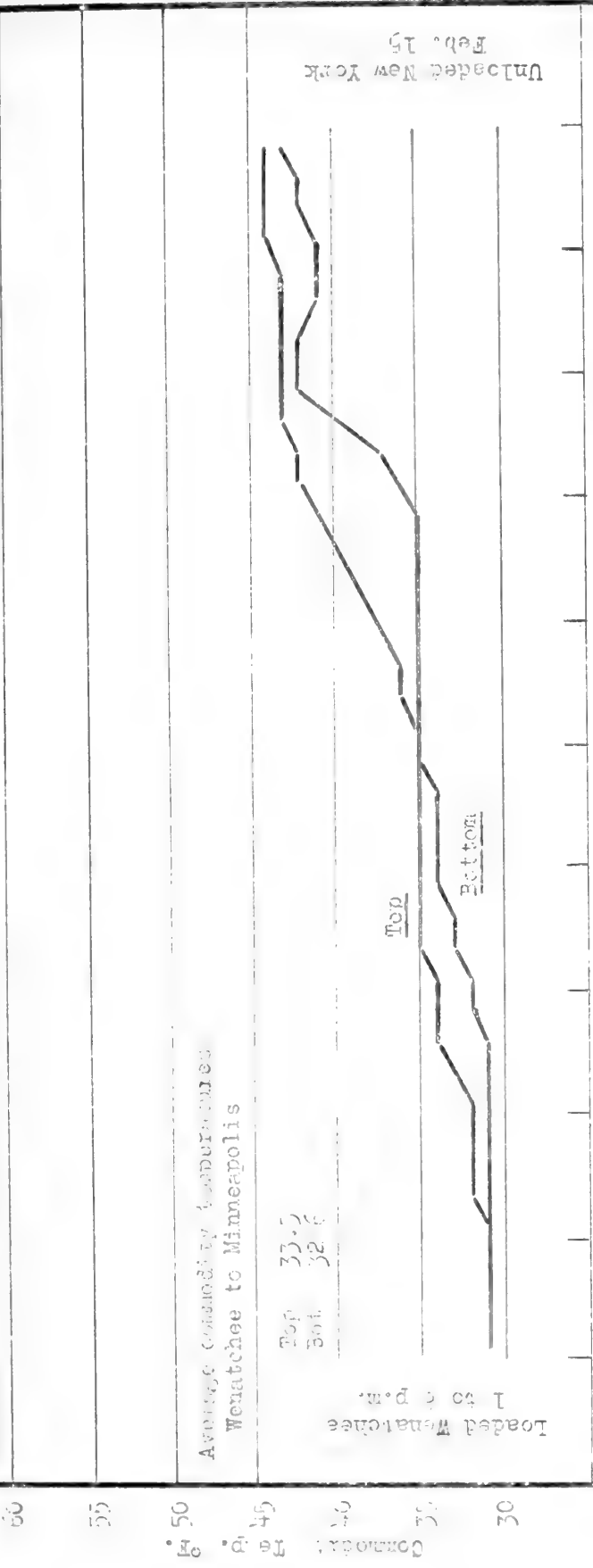
Jan. 27	28	29	30	31	Feb. 1.	2	3	4	5	6
Appleyard Wash.	Hillyard	Whitefish Mont.	Havre	Williston N.D.	Minot	Brck'rdge Minn.	Willmar	M'pls.		

Injection Points
 Delay

FIGURE 13.

Type of Packages - Standard Boxes
 Clearance Around Lading:
 Top - 14 inches
 Sides - 4 to 7 inches
 Height of Floor Racks - 7½ inches
 Heater Placement - 1 each bunker

Test No. Wen.-13.
 Car No. PFE 64090
 Type of Car - Fan
 Car Condition - Fair
 Commodity - Delicious Apples
 Heaters - Proco (Wenatchee to Mpls.)



Front F F FP FP FP FP FP FP FP FP FP FP FP FP FP
 Rear F F FP FP FP FP FP FP FP FP FP FP FP FP FP

CHW7151, charcoal heater installed, lit.

Max.	25	30	32	14	12	2	8	-8	8
Min.	16	30	32	14	4	2	-5	-12	-12

Appleyard Wash.	Hallyard	Whitfish Mont.	Havre	Williston N.D.	Manot	Brck'rdge Minn.	Willmar	M'pls.	M'pls.	M'pls.	M'pls.
2	3	4	5	6	7	8	9	10	11		
Feb. 1											

Outside Temp.
 Inspection Points Terminal Delay

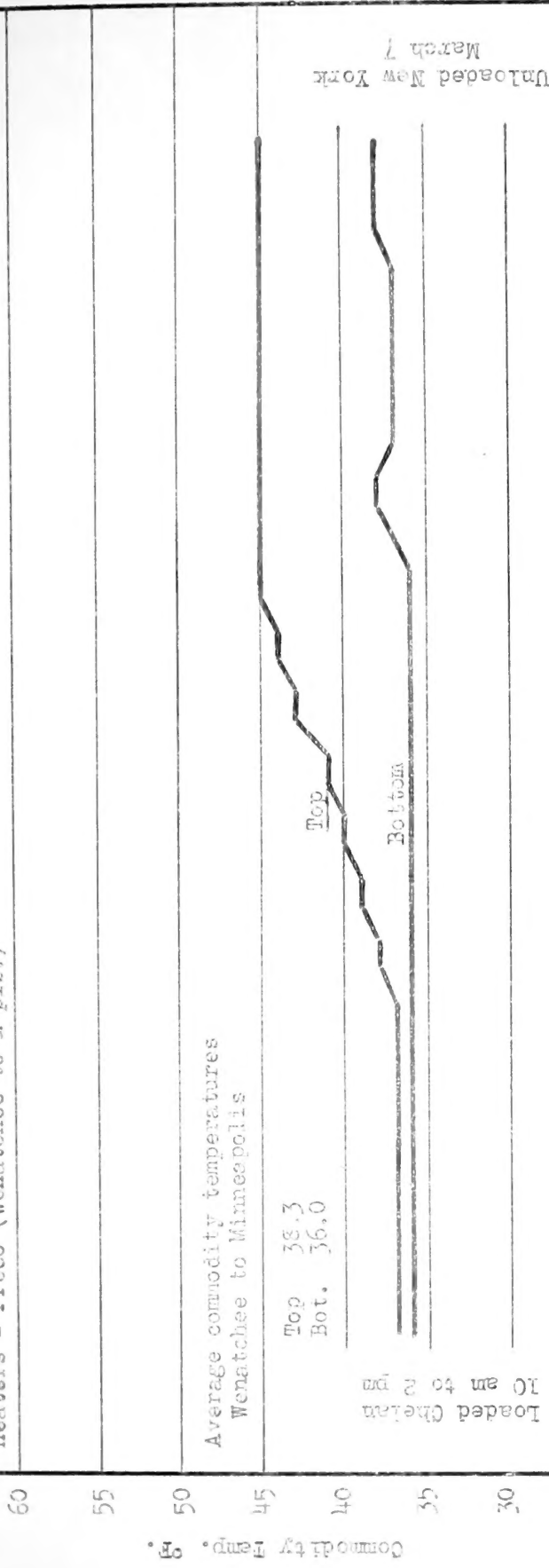
Unloaded New York Feb. 15



FIGURE 17.

Type of Packages - Standard boxes
 Clearance Around Lading:
 Top - 13 inches
 Sides - 6 inches
 Height of Floor Racks - 5½ inches
 Heater Placement - 1 each bunker

Test No. Wen.-17.
 Car No. BRE 74947
 Type of Car - Non-fan
 Car Condition - Fair to Good
 Commodity - Delicious Apples
 Heaters - Preco (Wenatchee to M'pls.)



Unloaded New York
 March 7

S-F-Pilot
 F-Full
 D-Dark
 H

Front D D D DF* FF PP FF PP F B0069, alcohol heater installed, lit.
 Rear D D D DF* FF PP FF PP F B0065, alcohol heater installed, lit.

* Changed to CPS at Havre, heaters lit.

Outside Temp.

Max. 38 32 36 6 10 12 12 15 5
 Min. 38 28 28 6 10 12 12 6 2

Inspection Points
 Terminal Delay

Appleward Wash.	Hillyard	Waltersish Mont.	Havre	Williston N.D.	Minot	Brck' rds Minn.	Willmar M'pls.	March 1	2	3	4	5	6
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