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UNITED STATES DEPARTMENT OF AGRICULTURE
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H. T. & S. Office Report No. 167

REPORT ON A TRANSPORTATION TEST WITH DELICIOUS APPLES
UNDER HEATER SERVICE FROM WENATCHEE, WASH. TO JERSEY
CITY, NEW YORK CITY AND PHILADELPHIA: A COMPARISON
OF THE PERFORMANCE OF TWO TYPES OF REFRIGERATOR CARS
AND FIVE KINDS OF CAR HEATERS, JANUARY 1946

(A Summary of the Most Outstanding Results and
Observations)

By

Fisk Gerhardt, Physiologist, and
Harley English, Assistant Pathologist

Beltsville, Md.
February 6, 1946

823446

REPORT ON A TRANSPORTATION TEST WITH DELICIOUS APPLES UNDER HEATER SERVICE FROM WENATCHEE, WASH. TO JERSEY CITY, NEW YORK CITY AND PHILADELPHIA: A COMPARISON OF THE PERFORMANCE OF TWO TYPES OF REFRIGERATOR CARS AND FIVE KINDS OF CAR HEATERS, JANUARY 1946

(A summary of the most outstanding results and observations)

The purpose of this test was to study the performance of three types of thermostatically controlled alcohol heaters, a charcoal heater with thermostatic draft control, and a standard charcoal heater, in standard refrigerator cars and in similar refrigerator cars equipped with Preco fans. The influence of car performance during transit was also evaluated in terms of changes in the dessert quality of comparable test lots of fruit of known storage history that were carried at the same position in each of the test cars.

An outline of car and heater operation is shown in table 1. Eight commodity and four air temperatures at various positions in each car were taken by means of electric resistance thermometers read from the outside of the car. These thermometers were placed as follows:

Commodity

Bottom bunker, north side, A-end
" " " " B-end
Top bunker, centerline, A-end
" " " B-end
Top quarterlength, centerline, A-end
" " " B-end
" Door, centerline
Bottom door, north side

Air

Bottom bunker, north side, A-end
" " " " B-end
" door, north side
Top quarterlength, centerline

The cars used were selected for uniformity of design and size insofar as this was possible. All of them were 40 feet in length, and each had 3-1/2 inches of insulation in the floor and roof, and 3 inches in the sides and ends. The inside height of the fan cars was 7 ft. 6 in., and of the standard cars 6 ft. 10 in. In the latter the floor racks were 5 inches high and the bottom bulkhead openings 12-1/2 inches high. In the fan-equipped cars the floor racks were 7-1/2 inches high and the bottom bulkhead openings 6 inches high and therefore entirely beneath the floor racks. The other dimensions of all cars were similar.

The cars were loaded in the Wenatchee-Okanogan district on January 15, 1946, and moved to destination via the Great Northern, Chicago, Burlington and Quincy, and Pennsylvania Railroads. Each car contained a solid load of standard boxes of Delicious apples, the number of boxes per car varying from 798 to 854. The distance from the top of the load to the ceiling was 6-1/2 inches in the standard cars and 17 inches in the fan cars. All cars were loaded with side-wall air spaces of 4 to 6 inches.

Observations

Heater Difficulties. Before the temperature records are discussed, mention should be made of certain difficulties and irregularities that affected operations of some of the heaters. The thermostats of the alcohol heaters were set originally at 32° F. and those of the N. P. charcoal heaters with thermostatic draft control at 36°. Dangerously low commodity temperatures observed at New Rockford and Hannaford in the cars equipped with PFE alcohol heaters necessitated raising the thermostatic setting of these heaters from 1° to 3°. With the advent of warmer weather at Savanna the thermostats were reset at 32°. Through an oversight, the heaters in BRE 74616 were not lighted following refueling at Willmar, but were relighted at Dayton's Bluff. Float difficulty in one of the Solar alcoheaters located in WFE 66454 was found and corrected at Hillyard. Later it was necessary to replace a broken fuel line in the same heater. At Savanna the pilot light of this heater was found extinguished, presumably because of the dripping of condensation moisture from the bunker ceiling. It was relighted at Blue Island. One of the standard charcoal heaters in FGE 35284 was found to be dark at Willmar, undoubtedly because of fuel bridged across the throat of the magazine. It was relighted before departure.

Heater Weather

Outside temperatures encountered during the test are shown in table 2. They should be considered average to mild, and probably quite representative of usual heater weather.

Commodity Temperatures and Car Performance

The temperature records of the various test cars are presented in the attached charts. In the fan-equipped cars, best temperature records were obtained when heaters and fans were operated in both ends of the car. A wide spread in commodity temperatures resulted from fan operation in the rear end and heat application only in the head end of the car. Using both fans and only one heater gave more satisfactory commodity temperatures than using one fan and two heaters. The thermo-charcoal heater produced higher maximum commodity temperatures than did the thermo-alcohol type when the heater was operated in one end of the car and the fan in the other end.

In most of the cars equipped with PFE alcohol heaters, dangerously low commodity temperatures were found in fruit next to the floor racks along the north side of the car. No freezing, however, was reported in any of the fruit at time of unloading.

In the standard cars, the WFE alcohol heater gave superior performance. Spread in commodity temperatures in this car compared favorably with that in some of the better operated fan cars. The charcoal heater with thermostatic draft control gave slightly better performance than the standard charcoal heater. In the standard car in which the PFE thermo-alcohol heater was used, dangerously high and dangerously low commodity temperatures were found.

For the purpose of rapid comparison, critical commodity temperatures in the various test cars are summarized in table 3. With the exception of four cars, all minimum average bottom commodity temperatures were dangerously low.

Heater Performance

No evidence was found of more rapid fuel consumption, pilot light failure, or other heater difficulty as a result of the operation of the fans. Commodity temperatures in cars equipped with Solar heaters indicate that the heat output of the pilot light should be reduced. Dangerously low fruit temperatures in certain cars also indicated that special attention should be given to making the thermostats more accurate and dependable in operation. This was made evident in the performance of some of the heaters using liquid fuels.

Fuel Consumption

Data on fuel consumption of the various types of heaters under test are summarized in table 4. Consumption of liquid fuel varied from about 9 to 14.5 gallons per car. There was no appreciable difference in the amount of fuel consumed in the two types of charcoal heaters under test.

Observations at Time of Unloading

When the cars were unloaded the test boxes of apples were removed to the Department of Agriculture laboratory in New York, where data were taken on firmness, composition and dessert quality of the fruit. This part of the investigation has not yet been completed.

Considerable shifting of the load was noted in all of the test cars. This was due in part to inadequate stripping. In some cases serious breakage occurred at the doorway where the load was lower. In two cars the bunker bulkhead at one end was damaged by rough switching. The exposed lids of many boxes adjacent to the side wall air spaces had sprung open sufficiently to release considerable fruit along the side walls of some cars.

Acknowledgments

Besides the writers the test party consisted of the following, all of whom accompanied the cars from Wenatchee and to whom thanks are expressed for their helpful cooperation:

A. A. Hamer, General Mechanical Inspector, Western Fruit Express Co.,
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Ray Doering, Test Engineer, Pacific Fruit Express Co., San Francisco,
California
Charles Boyd, Chief Refrigerating Engineer, Northern Pacific Railroad,
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C. S. Markee, Service Engineer, Solar Aircraft Co., San Diego, California
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Wenatchee-Okanogan Cooperative Federation
J. M. Wade
Justman-Frankenthal Co.
Fruit Growers' Service Co.

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Chicago, Burlington & Quincy Railroad
Pennsylvania Railroad
Western Fruit Express Co.
Northern Pacific Railroad
Pacific Fruit Express Co.

Acknowledgment is also made of the helpful assistance of Mr. H. H. Foreman, Service Agent, Interstate Commerce Commission who accompanied the test as an official observer for that agency and assisted in the collection of the data.

Table 1. Car line-up for Heater Transportation Test Trip
(Wenatchee, Wash. to Jersey City, N. J. January 16-26, 1946)

Number	Car		Fan Operation	Kind of Heater	Position of Heater		Drains
	Type						
WFE 66454	Fan		Rear only	Solar alcoheater	1 front 1 rear		2 plugged on north side 2 open on south side
WFE 66501	Fan		Both ends	PFE Thermo-alcohol	Front regular front standby		2 plugged on north side 2 plugged on south side
WFE 66471	Fan		Both ends	PFE Thermo-alcohol	1 front 1 rear		2 plugged on north side 2 open on south side
BRE 74616	Fan		Rear only	PFE Thermo-alcohol	Front regular front standby		2 plugged on north side 2 open on south side
BRE 74579	Fan		Rear only	N.P. Thermo- charcoal	Front regular front standby		All drains plugged
BRE 74602	Fan		Both ends	Solar alcoheater	1 front 1 rear		2 plugged on north side 2 open on south side
FGE 35284	Standard		None	Standard WFE charcoal	1 front 1 rear		All drains plugged
WFE 65184	Standard		None	PFE Thermo- alcohol	1 front 1 rear		2 plugged on north side 2 open on south side
WFE 65570	Standard		None	WFE Thermo- alcohol	1 front 1 rear		2 plugged at diagonal ends of car
WFE 65877	Standard		None	N.P. Thermo charcoal	1 front 1 rear		All drains plugged

Table 2.-Temperature Record - Test Train From Wenatchee, Wash.
January 16, 1946

Place	Time of reading	Date	Outside Temperature
Ephrata	9:50 p.m. PT	1-16	30
En route	11:30 a.m.	17	37
Troy	5:15 p.m.	17	34
En route	6:15 p.m. MT	17	30
En route	9:00 p.m.	17	30
En route	10:45 p.m.	17	24
Cutbank	10:00 a.m.	18	36
En route	10:45 a.m.	18	42
En route	1:30 p.m.	18	29
En route	11:15 p.m.	18	20
En route	7:30 a.m.	19	10
Oswego	8:00 a.m.	19	16
En route	10:30 a.m.	19	29
En route	11:00 a.m.	19	30
En route	9:15 p.m. CT	19	12
En route	11:00 p.m.	19	4
Berthold	1:00 a.m.	20	0
En route	1:45 a.m.	20	2
En route	3:00 a.m.	20	0
En route	4:30 a.m.	20	0
Brantford	3:15 p.m.	20	-2
Hannaford	6:35 p.m.	20	-7
Breckenridge)	3:50 a.m.	21	-8
Breckenridge)	4:45 a.m.	21	-10
Benson	10:40 a.m.	21	-4
En route	4:20 p.m.	21	-2
En route	5:10 p.m.	21	-4
Daytons Bluff	1:40 a.m.	22	-5
En route	9:00 a.m.	22	-2
En route	10:30 a.m.	22	6
En route	6:00 p.m.	22	16
En route	8:50 p.m.	22	19
En route	7:25 a.m.	23	21
En route	9:15 a.m.	23	23
En route	1:00 p.m.	23	31
En route	8:30 a.m.	24	30
En route	8:45 p.m.	24	34
Pitcairn	2:45 a.m.	25	30
Enola	10:00 a.m.	25	36

Table 3.- Critical Commodity Temperatures

Car		Fan Operation	Kind of Heater	Position of Heater	° F.		Spread ° F.	Maximum Average Top	Minimum average Bottom
Number	Type				Maximum	Minimum			
WFE 66454	Fan	Rear end	Solar alcohol	Front rear	51.0	30.5	20.5	43.8	30.7
WFE 66501	Fan	Both ends	PFE alcohol	Front-regular Front-Standby	42.5	27.0	15.5	39.3	27.5
WFE 66471	Fan	Both ends	PFE alcohol	Front Rear	40.0	27.0	13.0	37.2	27.6
BRE 74616	Fan	Rear end	PFE alcohol	Front-regular Front-standby	48.0	27.0	21.0	39.7	27.1
BRE 74579	Fan	Rear end	N. P. Thermo-charcoal	Front-regular Front-standby	53.0	28.0	25.0	42.3	28.6
BRE 74602	Fan	Both ends	Solar alcohol	Front Rear	43.5	29.5	14.0	42.1	29.8
FGE 35284	Standard	None	WFE Standard charcoal	Front Rear	51.0	26.0	25.0	47.9	26.3
WFE 65184	Standard	None	PFE alcohol	Front Rear	63.5	26.0	37.5	52.8	26.3
WFE 65570	Standard	None	WFE alcohol	Front Rear	45.5	29.0	16.5	41.2	29.5
WFE 65877	Standard	None	N. P. Thermo-charcoal	Front Rear	48.0	26.5	21.5	43.2	26.8

Table 4.--Fuel Consumption Record

Car		Kind of Heater	Position of Heater	Heater Number	Fuel Consumed	Total Fuel Consumed Per Car
Number	Type					
WFE 66454	Fan	Solar alcohol	Front Rear	9 7	8.63 gal. 5.88 "	14.51 gal.
WFE 66501	Fan	PFE alcohol	Front-Regular Front-Standby	B-320 B-398	8.38 gal. 1.13 "	9.51 "
WFE 66471	Fan	PFE alcohol	Front Rear	B-322 B-339	4.88 " 4.88 "	9.76 "
BRE 74616	Fan	PFE alcohol	Front-Regular Front-Standby	B-342 B-310	6.62 " 2.63 "	9.25 "
BRE 74579	Fan	N.P. thermo-charcoal	Front-Regular Front-Standby	348 333	26.0 lbs. 22.0 "	48.0 lbs.
BRE 74602	Fan	Solar alcohol	Front Rear	3 16	6.38 gal. 5.63 "	12.01 gal.
WFE 35284	Standard	WFE standard charcoal	Front Rear	S-1767 S-4357	22.5 lbs. 24.0 lbs.	46.5 lbs.
WFE 65184	Standard	PFE alcohol	Front Rear	B-369 B-326	8.75 gal. 3.25 "	12.0 gal.
WFE 65570	Standard	WFE alcohol	Front Rear	37 35	6.13 gal. 2.75 "	8.88 gal.
WFE 65377	Standard	N.P. thermo-charcoal	Front Rear	267 290	22.0 lbs. 25.5 lbs.	47.5 lbs.

Temperature of.

HEATER
RECORD

x Maximum
 — Minimum
 - - - Average Tops
 o Average Bottoms

MAIN BURNER ON

FRONT

REAR

Pilot

Pilot

Intermittent Burning

Total Fuel Used

8.63 gal.

5.88 gal.

JANUARY

16 17 18 19 20 21 22 23 24 25 26 27 28

Loading Point Wash.
 Apple Yard
 Hill Yard
 Whitefish
 HAVE
 Williston
 MINOT
 New Rockford
 Breckenridge
 Willmar
 Dayton Bluff
 E Winona
 Savanna
 Blue Island
 Dayton
 Columbus
 Pica
 Altoona
 Enola
 Jersey City

N.Y. Mar 29

DATE AND PLACE

Temperature °F.

x x x Maximum
 — Minimum
 - - - Average Tops
 o o o Average Bottoms

Total Fuel Used
 8.38 gal.
 1.13 gal.

REGULAR
 STANDBY
 MAIN BURNER ON
 INTERMITTENT BURNING
 PILOT
 DARK

16 17 18 19 20 21 22 23 24 25 26 27 28
 JANUARY

Loading
 WASH.
 Apple yard
 Hill yard
 White fish
 HAVRE
 Williston
 Minnot
 New Rockford
 Breckenridge
 Willmar
 Dayton Bluff
 E. Winona
 SAVANNAH
 Blue Island
 Dutton
 Columbus
 PITCAIRN
 Afton
 ENOIA
 Diver-ted to
 Philadelphia

Date and Place

TEMPERATURE °F.

x x MAXIMUM
 — MINIMUM
 - - - AVERAGE TOPS
 o AVERAGE BOTTOMS

HEATER
RECORD

Total Fuel Used
 26 Lbs.
 22 Lbs.

REGULAR
 STANDBY
 DARK
 BURNING

16 17 18 19 20 21 22 23 24 25 26 27 28
 JANUARY

LOADING POINTS WASH	Abbeysard	Hillyard	Whitefish	HAVRE	Williston	THINOT New Rockford	Breckenridge	WILLMAR Dayton Bluff	E. WINONA SARANNA	Blue Island DALTON	Columbus	PICAIAN Aitona ENOIA	Jersey City	Jersey City unloading
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DATE AND PLACE

CAR - BSE 74616 TAN OPERATION - DEAR

TEMPERATURE °F.

x x MAXIMUM
 — MINIMUM
 - - - Average Tops
 o Average Bottoms

REGULAR
 Standby
 Pilot
 DARK
 MAIN BURNER ON
 Total Fuel Used
 6.62 gal.
 2.63 gal.

16	17	18	19	20	21	22	23	24	25	26	27	28
LOADING POINTS WASH.	Appleyard	Hillyard	Whitefish	HAYRE	Williston	THINOT New Rockford	Breckenridge WILLMAR Dayton Bluff	E. WINONA SAVANNA	Blue Island DALTON Columbus	PITCAIRN ALTONA ENOIA	Jersey city	Jersey city Unloading

Date and Place

CAR - N.E. 88711

DATE AND PLACE

TEMPERATURE °F.

x x x Maximum
 ——— Minimum
 - - - Average Tops
 o o o Average Bottoms

55
50
45
40
35
30
25

TOTAL FUEL USED

HEATER RECORD

FRONT

REAR

DARK

BURNING

22.5 Lbs.

24.0 Lbs.

16

17

18

19

20

21

22

23

24

25

26

27

28

JANUARY

Landing
Points
WASH

RAIL YARD

HILL YARD

Whitefish

HAVRE

Williston

THINOT

New Bedford

Beckenridge

Willmar

Dayton Bluff

E. WINONA

SARANNA

Bille Island

Dalton

Columbus

Pitcairn

Altona

ENOIA

Jersey City

N.Y. Pier 29

DATE AND PLACE

TEMPERATURE OF.

CAR - WFE 65784 STANDARD PFE Thermo-Alcohol - Both Ends

HEATER RECORD

FRONT REAR

MAIN BURNER ON

INTERMITTENT BURNING

TOTAL FUEL USED

8.75 gal

3.25 gal

16 17 18 19 20 21 22 23 24 25 26 27 28

JANUARY

Appleyard	Williston	MINOT	New Rockford	BREC Kent Idge	Willmar	Daystar Bluff	E. WINONA	SAVANNAH	Blue Island	DALTON	COLUMBUS	PITCAIRN	ALTONA	JASEY CITY	N.Y. DIA-29
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DATE AND PLACE

	16	17	18	19	20	21	22	23	24	25	26	27	28	Total Fuel Used
FRONT							XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	6.13 gal
REAR							XXXXXX	XXXXXX						2.75 gal

MAIN BURNER ON

Intermittent Burning

Pilot

JANUARY

loading points
WASH

Appleyard

Hillyard

Whitefish

HAVRE

Williston

MINOT

New Rockford

Breckenridge

Willmar

Dayton Bluff

E. WINONA

SAVANNA

Blue Island

Dalton

Columbus

PITCAIRN

Altoona

ENOIA

Jersey City

N.Y. Pier 29