AD 736369

TECHNICAL REPORT
71-59-FL
71-59-ES

THE ANALYSIS OF HIGH TEMPERATURE OCCURRENCES AT SELECTED INTERNAL AND SURFACE LOCATIONS IN FOOD STORAGE DUMPS AND ISOLATED SMALL CARTONS AT YUMA, ARIZONA

by

William L. Porter

and

Aubrey Greenwald

January 1971

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

U.S. ARMY MATERIEL COMMAND

Food Laboratory
FL-132
ES-66

DISCLAIMER NOTICE

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
US ARMY NATICK LABORATORIES
Natick, Ma 01760

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b. GROUP

3. REPORT TITLE
The Analysis of High Temperature Occurrences at Selected Internal and Surface Locations in Food Storage Dumps and Isolated Small Cartons at Yuma, Arizona

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*
William L. Porter and Aubrey Greenwald

6. REPORT DATE
January 1971

7a. TOTAL NO. OF PAGES
Not numbered

7b. NO. OF REFS
5

8a. CONTRACT OR GRANT NO.

b. PROJECT NO. 1K0-14501-A71C

c. 7-83-05-004A

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
71- -FL FL-132
71- -ES ES-66

9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

10. DISTRIBUTION STATEMENT
This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY
US Army Natick Laboratories
Natick, Ma 01760

13. ABSTRACT

This is a detailed computer study of hourly temperature distributions at nine positions in cartons in four differently exposed storage dumps, in small isolated Abandon Ship Ration Cartons and at seven tarpaulin surface and carton surface positions. The observations were made during July 1955 at Yuma, Arizona, a desert area of extremely high solar radiation and ambient temperature.

A previous brief pilot report based on sampling and estimation techniques for the more extreme carton of each stack was published in 1959. Continued demand for more detailed temperature distribution data at the other 40 positions measured, including interior cartons, small isolated cartons, and tarpaulin and carton surface temperatures, coupled with the present availability of sophisticated data reduction and computer facilities at US Army Natick Laboratories has prompted the much more detailed analysis reported herein.

In general, the distributions and correlations resulting from the more detailed analysis confirmed previous results.

However, a mass of temperature distribution data in tabular and graphic forms is now available for all the positions studied, as well as the isolated small cartons and surface temperatures which were not heretofore studied.

As a consequence, regression equations relating storage temperature five-day means with outside air five-day means with high correlation coefficients are available for both large dumps and isolated cartons. The reliability of these relations suggests that in storage studies in other geographic areas, only a small carton need
(cont'd on attached)

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

Unclassified
Security Classification

Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Analysis	8					
Temperature	9		7			
Observation	9					
Mean	9					
Frequency distribution	9					
Divergence	9					
Cartons	9		9			
Yuma, Arizona	0					
Storage stability	4		4			
Food	4		4			
Thermal degradation	4		4			
Stacking			6			
Tarpaulins			6			

Unclassified

Security Classification

be studied, since adequate prediction can be made for the larger dumps, boxcars and warehouses for which relationships exist between period mean storage temperature and outside air temperature.

This document has been approved
for public release and sale; its
distribution is unlimited.

AD ________________

TECHNICAL REPORT

71-59-FL
71-59-ES

The Analysis of High Temperature Occurrences at Selected Internal and Surface Locations in Food Storage Dumps and Isolated Small Cartons at Yuma, Arizona

by

William L. Porter and Aubrey Greenwald

Project reference:
1KO-14501-A71C
7-83-05-004A

Series: FL-132
ES-66

January 1971

Food Laboratory
U.S. ARMY NATICK LABORATORIES
Natick, Massachusetts

Foreword

Temperature is the most important storage factor affecting the quality and acceptance of packaged stored food.

During July and August 1955, the temperature cycle within stored food, the carton air, and on carton and protective tarpaulin surfaces was measured at Yuma, Arizona in typical palletized field storage stacks and in small isolated Abandon Ship Ration cartons.

A preliminary report of extreme temperatures was made at the time of data collection (1). The present report was prepared because of the demand for more detailed storage temperature data and the availability of computer analysis. Detailed data reduction and analysis were carried out during 1963 and 1964.

The work was done under Project 1KO-14501-A71C, Food Research, and 7-83-005-004A, Environmental Requirements for Design of Military Items.

TABLE OF CONTENTS

	Page No.
Abstract	
Introduction	
Purpose of Study	1
Previous Studies and Preliminary Analysis	1
Scope of Present Study	1
Materials and Methods	
Climatic Considerations in Location of Study	2
Measurement Methods	2
Data Reduction, Computation and Analysis	3
Results and Discussion	
Confirmation of Results of Preliminary Analysis	
a. Absolute Maximum Temperatures	3
b. Frequency Distribution of all Hourly Temperatures in Surface Versus Interior Cartons for the Total Period, 22 June to 3 August	13
c. Prediction of Period Mean Storage Temperatures from Outside Air Temperatures	15
d. Prediction of Effective Temperatures for Storage Simulation	16
Frequencies, Means, and Standard Deviations of all Temperatures by Five-day Periods: Effect of Dry Versus Moist Air Mass on Surface and Interior Temperatures	22
Frequencies, Means, and Standard Deviations of all Temperatures in Isolated Abandon Ship Ration Cartons for Total Period and by Five-day Periods	27
Frequencies, Means, Standard Deviations, and Maxima of Paulin and Carton Surface Temperatures	27
Conclusions	33
Acknowledgements	35
Literature Cited	36

(cont'd)

TABLE OF CONTENTS (cont'd)

Page No.

Appendix:

A. Percentage Frequencies, Means, and Standard Deviations of Hourly Observations for Total Period, 22 June to 3 August, Tables III - XVI. 37

B. Percentage Frequencies, Means, and Standard Deviations of Hourly Observations by Five-day Periods, Tables XXI - LXV. 53

LIST OF TABLES

Table		Page No.
I	Absolute Maximum Temperatures in Air of Surface Cartons	13
II	Absolute Maxima, Means, and Standard Deviations of Hourly Temperatures at Representative Interior and Exterior Positions in Cartons of Stacks and Abandon Ship Ration Cases for Total Period	14
III - XIII	Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period -- 22 June to 3 August -- Various Positions (one table for each)	38 - 48
XIV	Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five-day Periods and for Total Period -- 22 June to 3 August -- Abandon Ship Ration - Black Cover	49
XV	Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five-day Periods and for Total Period -- 22 June to 3 August -- Abandon Ship Ration - No Cover	50
XVI	Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Three Five-day Periods only -- Abandon Ship Ration -- Raised Tarpaulin Fly Over Black Cover	51
XVII	Regression of Period Mean Storage Temperature on Period Mean Outside Air Temperature	17
XVIII	Effective Mean and Arithmetic Mean Temperatures in Top Center Carton Air	18
XIX	Storage Mean Temperature Contrast Between Dry and Moist Air Mass Periods	23
XX	Standard Deviations of Storage Temperatures in Dry Versus Moist Periods	24
XXI-LXV	Percentage Frequencies, Means and Standard Deviations of all Hourly Temperature Observations by Five-day Periods for all Positions - Raised Fly with Foil Stack, Raised Fly Stack, Tight Paulin Stack, Open Stack	54 - 98

LIST OF FIGURES

Figure		Page No.
1	Aerial View of Yuma Dump Storage Research Site	4
2	Location of Thermocouple Positions in Stack	5
3	Thermocouple Location in Cartons	6
4	Sectional View of the Test Carton	6
5	View Showing Open Stack and Covered and Uncovered Abandon Ship Ration Cartons	7
6	View of Tight Paulin Stack Showing Abandon Ship Ration Cartons Covered with Raised Fly	8
7	Frequencies, Means, and Standard Deviations of Hourly Observations for Total Period, June 22 - August 3, Open Stack	9
8	Frequencies, Means, and Standard Deviations of Hourly Observations for Total Period, June 22 - August 3, Raised Fly Stack	10
9	Frequencies, Means, and Standard Deviations of Hourly Observations for Total Period, June 22 - August 3, Tight Paulin Stack	11
10	Frequencies, Means, and Standard Deviations of Hourly Observations for Total Period, June 22 - August 3, Raised Fly with Foil Stack	12
11	Frequencies, Means, and Standard Deviations of Hourly Observations for Isolated Abandon Ship Ration Cartons for Total Period and by Five-day Periods -- Dry Period	19
12	Frequencies, Means, and Standard Deviations of Hourly Observations for Isolated Abandon Ship Ration Cartons for Five-day Periods -- Moist Period	20
13	Regression of Five-day Period Means of Top Center Carton Air Temperature and Abandon Ship Ration Carton Temperature on Outside Air Temperature	21
14	Frequencies, Means, and Standard Deviations of Hourly Temperatures for Top Center Carton Air by Five-day Periods -- Dry Period	25
15	Frequencies, Means, and Standard Deviations of Hourly Temperatures for Top Center Carton Air by Five-day Periods -- Moist Period	26

LIST OF FIGURES (cont'd)

Figure		Page No.
16	Frequencies, Means and Standard Deviations of Paulin Surface and Carton Surface Temperatures by Five-day Periods -- Raised Fly Stack	28
17	Frequencies, Means, and Standard Deviations of Paulin Surface and Carton Surface Temperatures by Five-day Periods -- Tight Paulin Stack	29
18	Frequencies, Means, and Standard Deviations of Paulin Surface and Carton Surface Temperatures by Five-day Periods -- Raised Fly with Foil Stack	30
19	Relation of Five-day Total Solar and Sky Radiation and Five-day Period Mean Outside Air Temperature	31
20	Relation of Five-day Period Mean Standard Deviation for Top Center Carton Air Temperature in Tight Paulin Stack and Five-day Period Mean Outside Air Temperature	32

Abstract

This is a detailed computer study of hourly temperature distributions at nine positions in cartons in four differently exposed storage dumps, in small isolated Abandon Ship Ration Cartons and at seven tarpaulin surface and carton surface positions. The observations were made during July 1955 at Yuma, Arizona, a desert area of extremely high solar radiation and ambient temperature.

A previous brief pilot report based on sampling and estimation techniques for the more extreme carton of each stack was published in 1959. Continued demand for more detailed temperature distribution data at the other 40 positions measured, including interior cartons, small isolated cartons, and tarpaulin and carton surface temperatures, coupled with the present availability of sophisticated data reduction and computer facilities at US Army Natick Laboratories has prompted the much more detailed analysis reported herein.

In general, the distributions and correlations resulting from the more detailed analysis confirmed previous results.

However, a mass of temperature distribution data in tabular and graphic form is now available for all the positions studied, as well as the isolated small cartons and surface temperatures which were not heretofore studied.

As a consequence, regression equations relating storage temperature five-day means with outside air temperature five-day means with high correlation coefficients are available for both large dumps and isolated cartons. The reliability of these relations suggests that in storage studies in other geographic areas, only a small carton need be studied, since adequate prediction can be made for the larger dumps, boxcars and warehouses for which relationships exist between period mean storage temperature and outside air temperature.

Introduction

A. Purpose of Study

This study is a detailed distributional analysis and correlation of all temperature observations made in a food storage dump study at Yuma, Arizona, in 1955. The previous preliminary analysis made at the time of the data collection (1) used daily maxima and a standardized average daily temperature distribution to estimate total temperature frequency in what was found to be the most critical carton, the Top Center Carton[1].

Since the time of the original publication, there have been frequent requests for more detailed data on interior and surface temperatures of the cartons and surface temperatures of the protective tarpaulins, hereinafter referred to as paulins, and on temperatures in isolated cartons. The availability of data reduction facilities and a GE 225 computer at the US Army Natick Laboratories has made such detailed analysis possible.

B. Previous Studies and Preliminary Analysis

During the original 43 day period in June, July, and August of 1955 (1) temperatures were observed at various points in four types of food storage dump stacks at Yuma, Arizona. The stacks were composed of cartons of Ration, Combat, Individual, (C Ration). Temperatures were also observed in three isolated small cartons containing Food Packet, Abandon Ship, provided by the U.S. Navy. The stacks were exposed with various types of protection, as were the isolated cartons.

The pilot report on the highest temperatures observed at critical points in these cartons was published in 1959 (1). Daily mean and maximum temperatures and the estimated frequency of all temperatures observed in the air of the most critical Top Center Carton were also reported.

A method of predicting interior temperatures, from outside air temperatures for weekly or monthly periods, had been developed in an earlier study of boxcar temperatures (2). Also, a method had been developed for computing an effective mean temperature to simulate the effect of all the fluctuating storage temperatures on food degradation. Finally, it was shown that for a given total daily solar radiation, air masses with greater moisture content produce higher storage and ambient mean temperatures than dry air masses.

C. Scope of Present Study

The present report is a compilation of frequency distributions, means and standard deviations of all temperatures at all the positions of observation (Figure 2), both for the total period and for the nine separate periods of five days each.

The 5 day period means were used in multiple linear regression computations as a check on the previous single correlation studies (1).

---

[1] The names of specific temperature measurement positions and of stacks are capitalized throughout the report, for purposes of clarity.

Although it uses much more detailed and sophisticated methods, the present study substantially confirms the limited results of the pilot study. In addition, it greatly extends the data for frequencies, means and standard deviations to all positions studied, particularly those in the interior of the stacks and on the critical outside surfaces. It also provides further confirmation of the greater warming effect which moist air masses, as contrasted with dry air masses, have on ambient air and storage temperatures in sunny climates.

Finally it completely validates (a) the method of predicting period mean interior temperatures from outside air temperatures, and (b) the prediction of effective storage temperatures.

Materials and Methods

A. Climatic Considerations in Location of Study

The details of the criteria used in selecting the study location and the internal observational sites have been described completely in the pilot study (1). The Yuma area has a summer climate combining extremely high daily maximum and mean air temperatures, and solar radiation. There is good accessibility to Army meteorological and support facilities. In addition, in July Yuma normally experiences a change from dry to a moderately moist air mass, although incoming solar and sky radiation remain high (2, 3). Thus, to a degree, one can contrast the effects of hot-dry and hot moderately humid conditions.

B. Measurement Methods

The procedures of temperature measurement by thermocouple and the experimental design have been reported in the pilot study (1). However, Figure 1 of the present study shows the dump layout and Figures 2, 3, and 4, the sites of temperature measurements in the stacks and individual cartons. In particular, Figure 2 gives the names of the various measurement positions which are referred to in the tables and discussion of this report.

Not described in the previous report were the measurements made on three isolated small Abandon Ship Ration Cartons, exposed in three different ways (Figures 5 and 6).

These ration cartons had the following characteristics (4):
(1) A fibreboard carton measuring about 2 3/4 x 7 3/8 x 14 3/4 inches contained 15 individual food packets and a cigarette packet each packaged in a waterproof bag.
(2) The bag at time of the study was composed (reading from outside in) of a scrim cloth, aluminum foil, polyethylene-laminated material.
(3) The individual food packets each contained two starch jelly bars, four mint tablets, chewing gum, and matches. The sixteenth packet contained two packages of cigarettes.
(4) Weight per carton was 5.95 pounds and the cube per carton was 0.16 cu. ft.
(5) Each food packet weighed 5.12 oz. and had a cube of 18.8 cu. in.

The current counterpart (5) to this ration has been changed only by the substitution of a polyester, aluminum foil, polyethylene-laminated bag.

The water content of most of the items is about 10% and the ration is designed for and stored in lifesaving craft aboard ships, usually under a suitable paulin cover. This low water content, the type of packaging and the size of this ration would seem to make it quite comparable to other presently used small, isolated carton rations.

One carton was exposed with its normal protective black neoprene-coated nylon cover, and a second without this cover (Figure 5). Finally one carton was exposed with both its black cover and a small raised paulin fly cover (Figure 6). Thermocouples were inserted one-half inch into the air between the packages of those cartons and temperature measurements were made on the same schedule as for the larger stacks (i.e. every half hour).

C. Data Reduction, Computation, and Analysis

Hourly data from the electronic recorder charts were reduced to a digital form on punch cards using a Contact Telereader, Teleducer, Program Unit, Teletypewriter and an IBM Card Punch (procured from the then Telecomputer Corporation, Burbank, California).

The resulting punched data were tabulated and analyzed by computer (GE 225) to provide frequencies, means and standard deviations of all hourly observations at all positions, both by five-day periods and for the total 43 day period of the study. The subdivision into five-day periods permitted the computation of the linear regression of period mean storage temperatures on outside air temperatures and also a multiple regression including radiation and wind speed as additional independent variables. Regression analysis had been very successful in the boxcar (2) and warehouse temperature studies (3) as a predictive method for storage temperature stress. Similar high correlations were found in this study.

Results and Discussion

A. Confirmation of Results of Preliminary Analysis

(a) Absolute Maximum Temperatures

The detailed analysis undertaken in the present study confirmed the validity of the hypothesis that the highest mean temperatures were found in the Top Center Carton Air. However, the Top Southwest Corner Carton Air reached greater absolute maximum temperatures as shown in Table I, and Figures 7, 8, 9, and 10.

Carton Air temperatures were normally measured within one of the 6 ration packages. However, thermocouples located outside and between the ration packages showed even higher absolute maximum air temperatures (Table I - Top Center Carton Air Temperature Outside Ration Package).

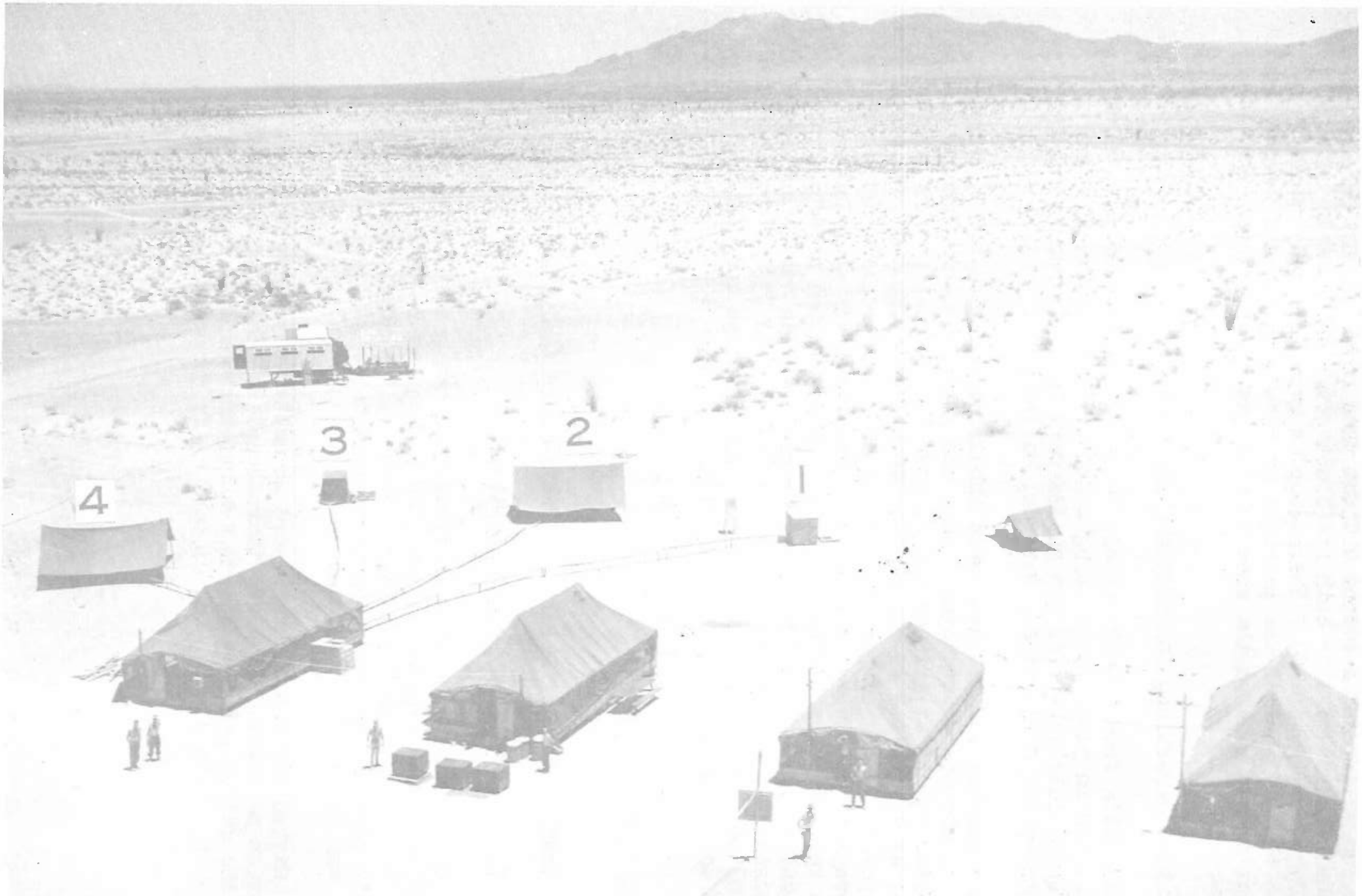
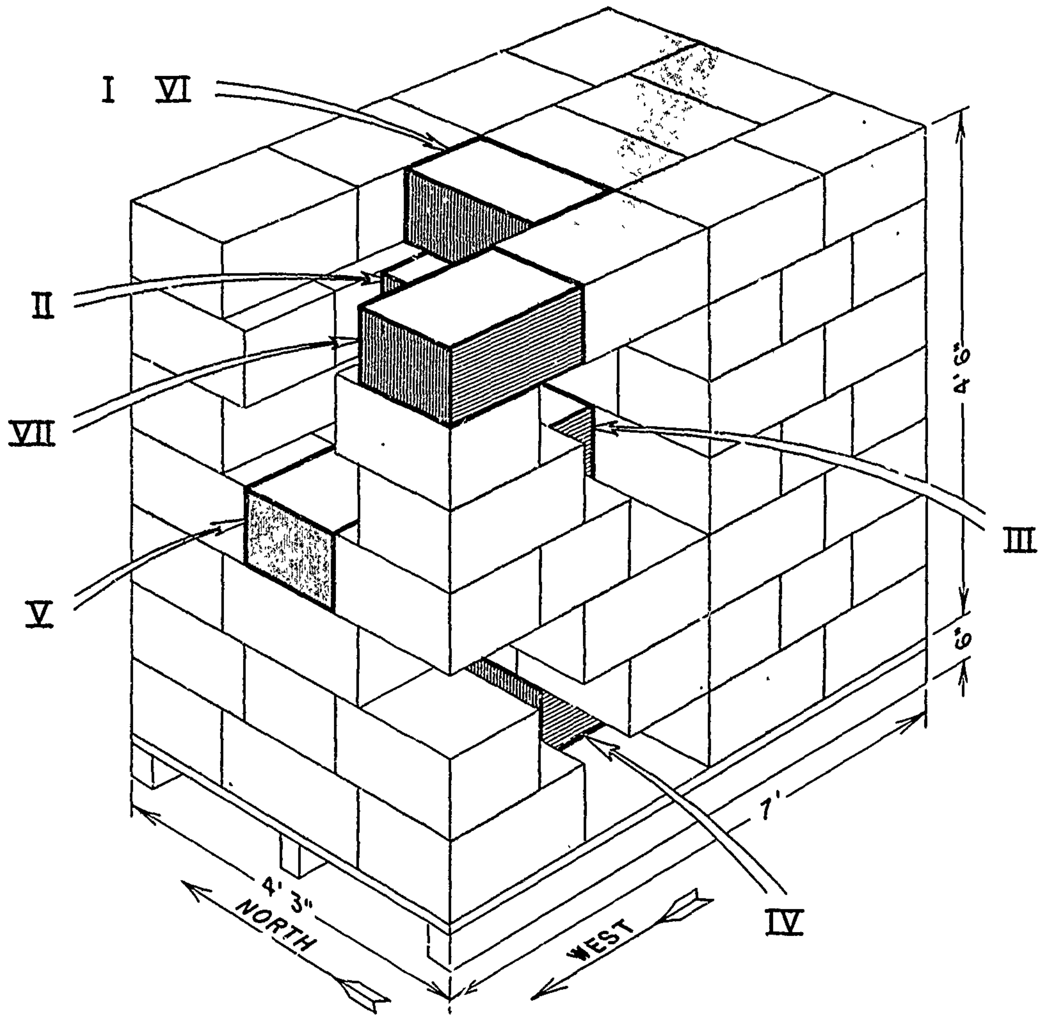


Figure 1. Aerial view of Yuma Dump Storage Research site, facing due east. Recording cables radiate from instrument tent in left center to the four research stacks. The stacks are (left to right): No. 4, Raised fly with foil; No. 3, Tight paulin stack; No. 2, Raised fly stack; No. 1, Open stack. Three dwelling tents are in foreground.



I A	Top Center Carton - Air
I C	Top Center Carton - Food
II A	Carton Below I - Air
III A	Carton In Diametric Center Of Stack -Air
IV A	Center Bottom Carton - Air
V A	Center West Face Carton - Air
V C	Center West Face Carton - Food
VI A	Top Center Carton - Air Outside Ration Package
VII A	Upper Southwest Corner Carton - Air

A = Thermocouple In Ration Package - Air
C - Thermocouple In Can In Ration Package - Food

Figure 2. Location of thermocouple positions in stack.

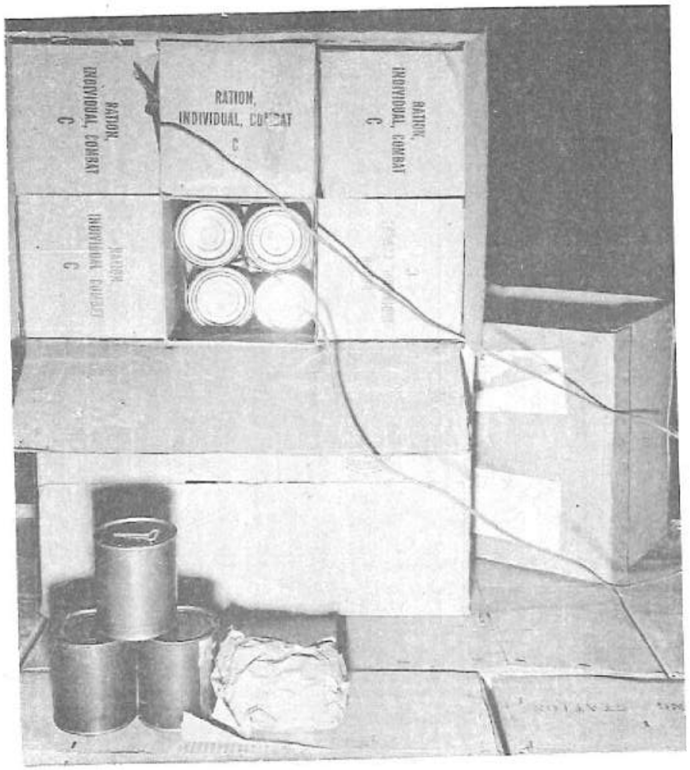


Figure 3. Thermocouple location in cartons (outside retaining sleeve is visible at the right).

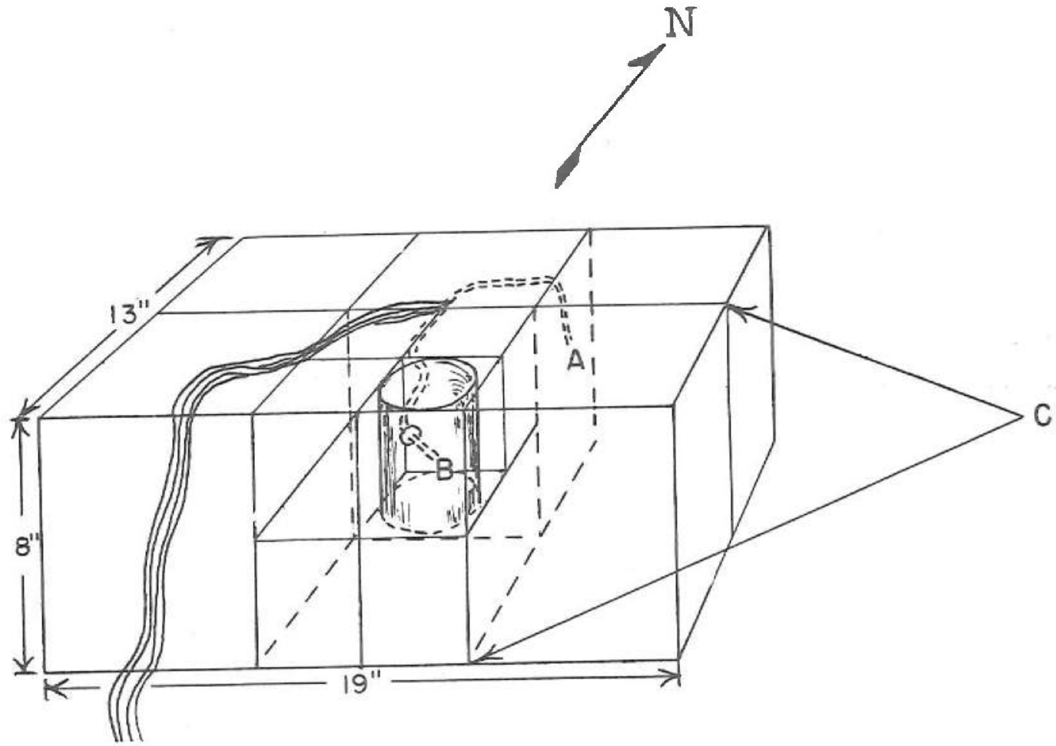


Figure 4. Sectional view of the test carton, showing combat ration package (A: Carton air thermocouple; B: Food thermocouple; C: Ration package).

Figure 5. View Showing Open Stack and Covered and Uncovered Abandon Ship Ration Cartons.

Figure 6. View of Tight Paulin Stack Showing Abandon Ship Ration Cartons Covered with Raised Fly.

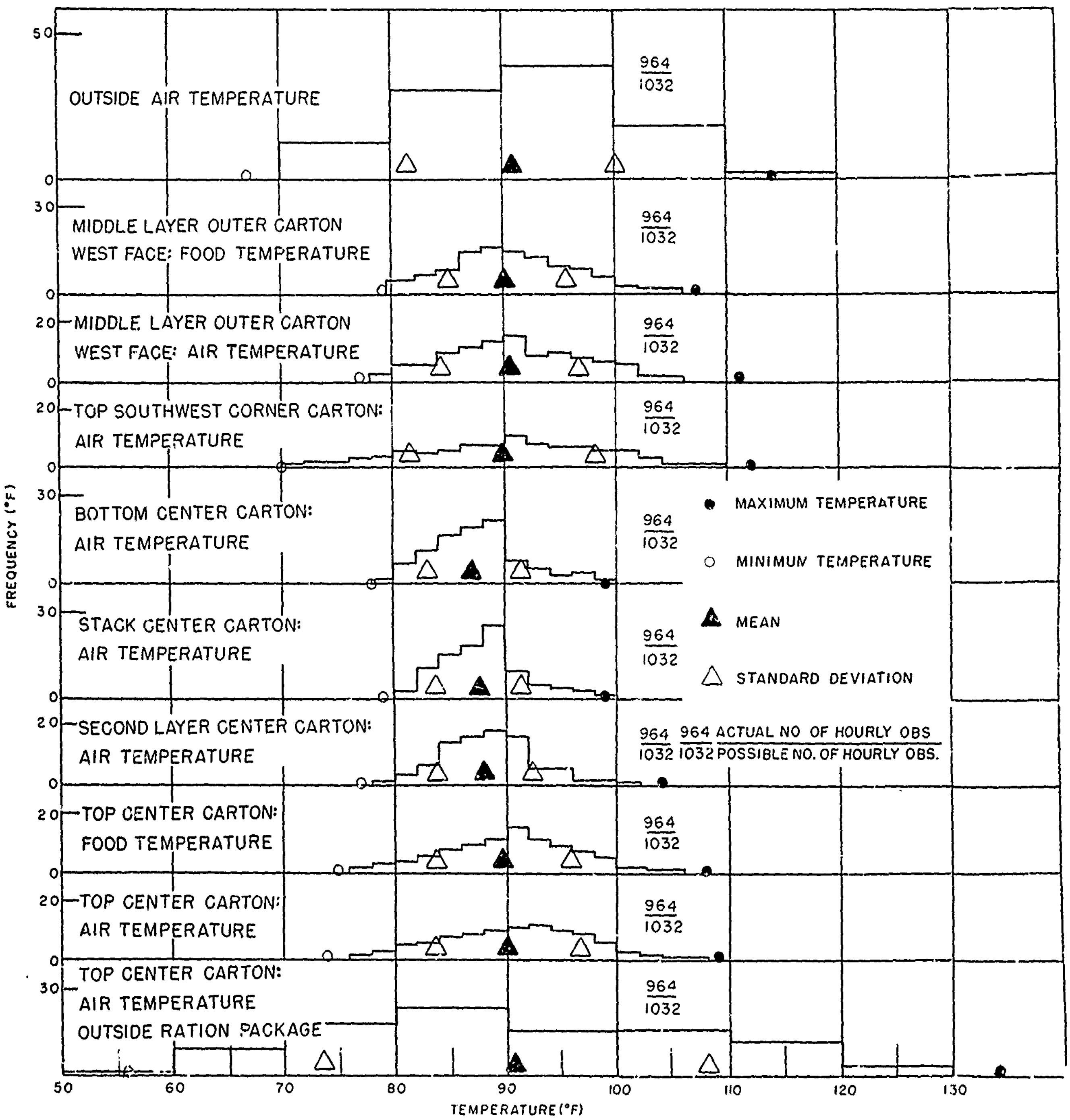


Figure 7. Frequencies, Means, and Standard Deviations of Hourly Observations for Total Period, June 22 - August 3, Open Stack.

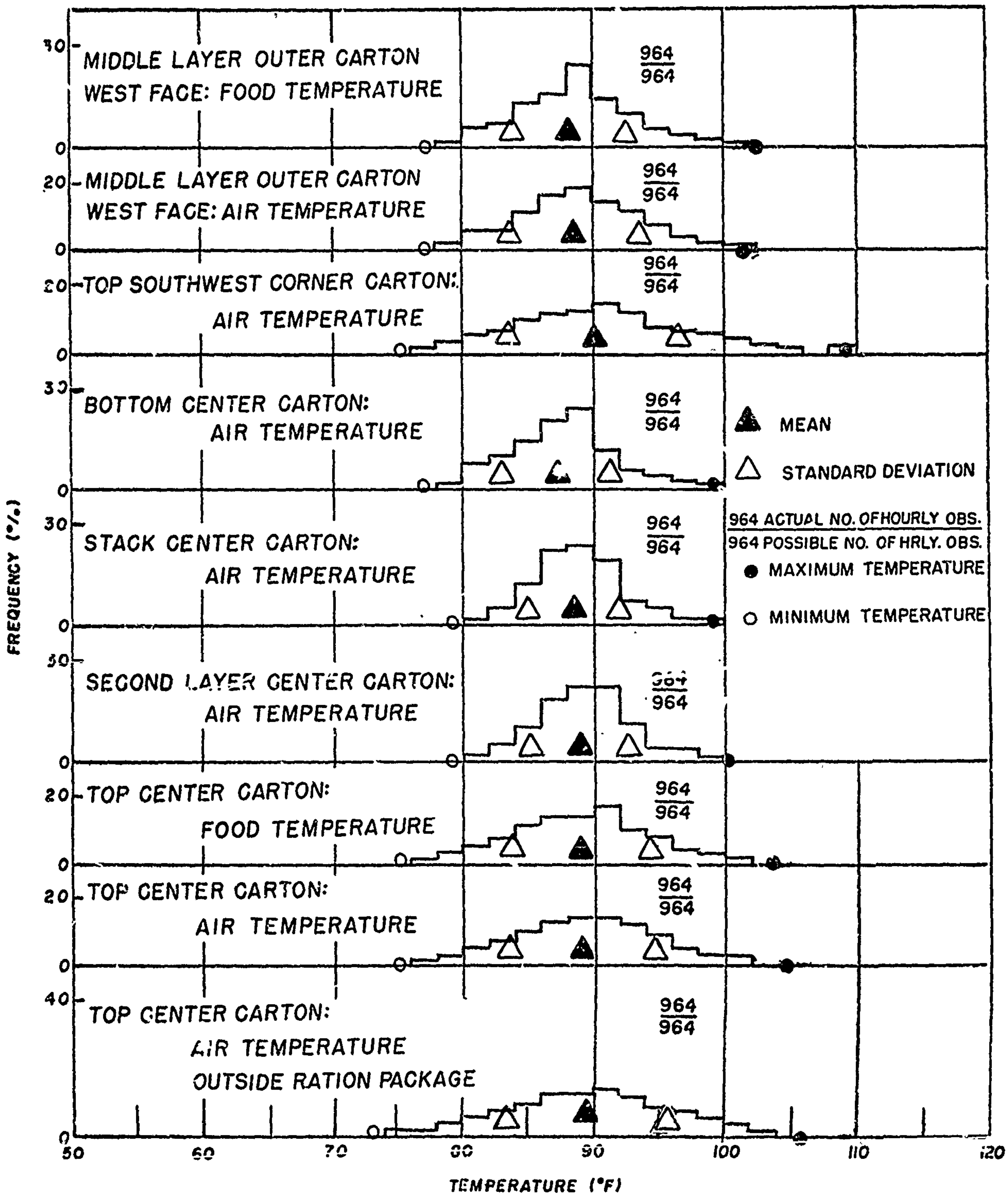


Figure 8. Frequencies, Means, and Standard Deviations of Hourly Observations for Total Period, June 22 - August 3, Raised Fly Stack.

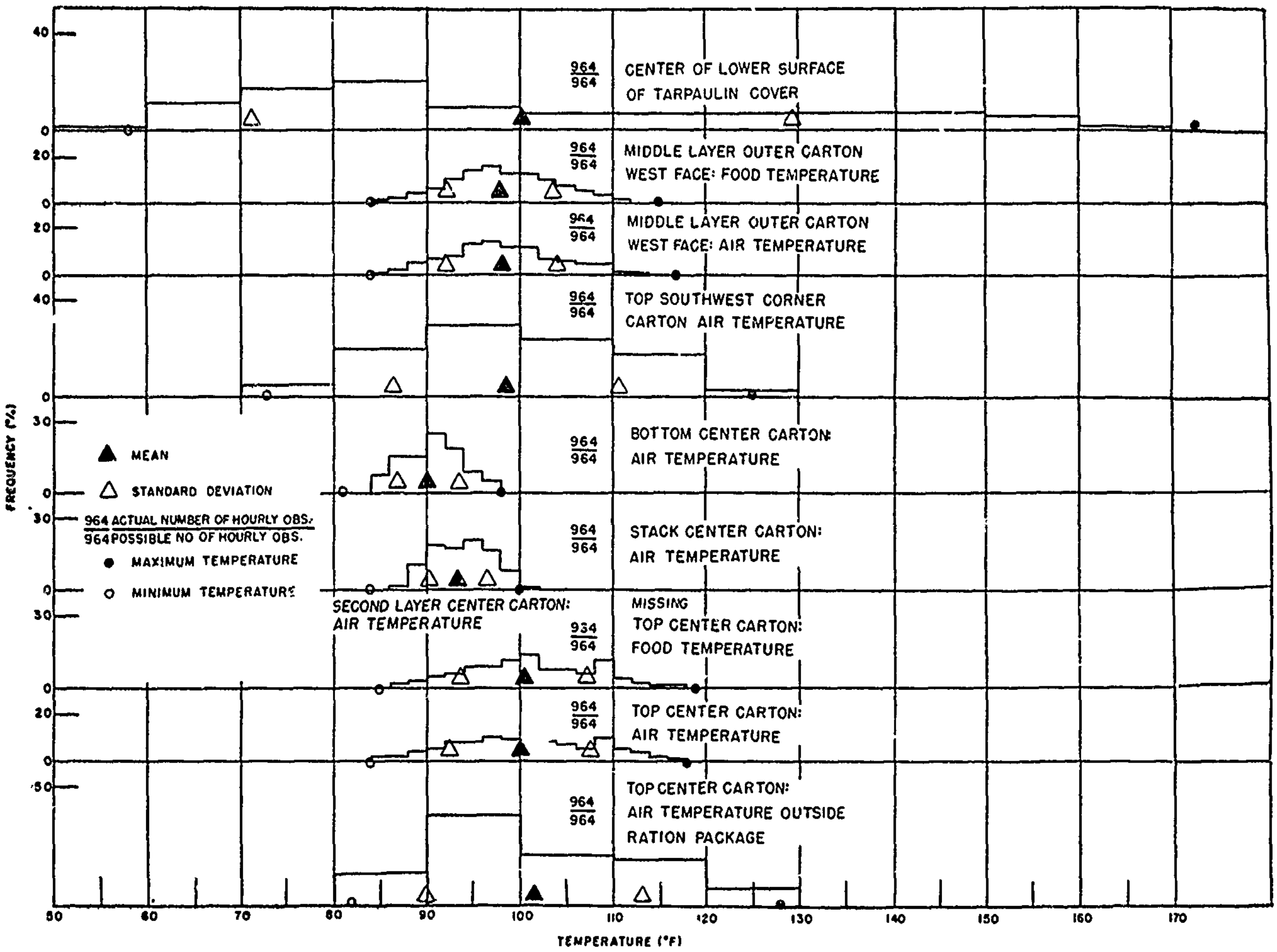


Figure 9. Frequencies, Means, and Standard Deviations of Hourly Observations for Total Period, June 22 - August 3, Tight Paulin Stack.

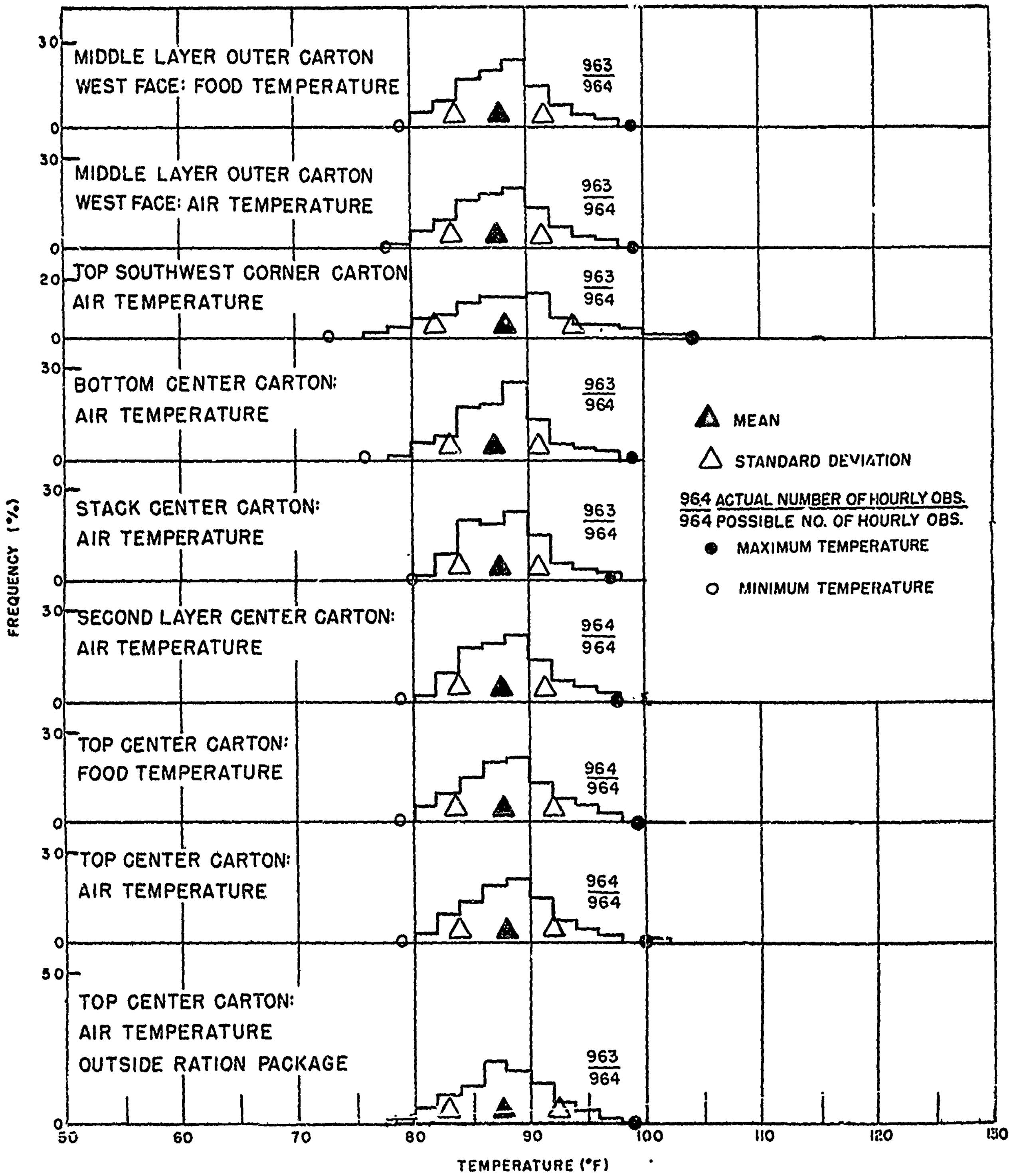


Figure 10. Frequencies, Means, and Standard Deviations of Hourly Observations for Total Period, June 22 - August 3, Raised Fly with Foil Stack.

Table I

Absolute Maximum Temperatures in Surface Carton Air

	Outside Air	Abandon Ship Ration	Open Stack	Raised Fly Stack	Tight Paulin Stack	Raised Fly with Foil Stack
Top Center Carton			109	104	118	100
Middle Layer Outer Carton on West Face of Stack			111	101	117	99
Top Southwest Corner Carton			112	109	125	104
Abandon Ship Ration with Black Cover		131				
Abandon Ship Ration with No Cover		127				
Outside Air	114					
Top Center Carton Air Temperature Outside Ration Package			134[a]	106	128	99

[a]This value seems atypically high and is suspect since the thermocouple may have been touching the upper surface of the C-Ration carton, which was in direct contact with solar radiation.

This position is regarded as unrealistic for typical packaged food exposure. It might apply, however, to a carton containing unpackaged items like nuts, oranges, or dried potatoes.

(b) Frequency Distributions and Means of all Hourly Temperatures in Surface Cartons Versus Interior Cartons for the Total Period, 22 June to 3 August

Tables II-XV and Figures 8-12 display the frequencies, means and standard deviations of all hourly temperatures at all positions observed, including the isolated Abandon Ship Ration Cartons for the total period.

Table II shows only the means, standard deviations and absolute maxima for surface as contrasted with interior cartons.[a] This table shows clearly that the stack covered with a tight paulin had the highest mean temperatures even in the Bottom Center Carton. The other three stacks have surprisingly little mean temperature gradient between the surface and interior cartons. There is also little difference from stack to stack at comparable positions in each of the three types of stacks other than that of the Tight Paulin stack.

[a]These composed only 16% of the volume of the stacks, but this proportion would, of course, be much greater in larger stacks.

Table II

Absolute Maxima, Means and Standard Deviations of Hourly Temperatures at Representative Interior and Exterior Positions in Cartons of Stacks and Abandon Ship Ration Cases for Total Period

Position	Mean	Standard Deviation	Absolute Maximum
Outside Air	90.8	9.4	114
Abandon Ship Ration Black Cover	95.9	17.7	131
Abandon Ship Ration No Cover	92.4	15.9	127
Top Center Carton Air			
Open Stack	90.2	6.5	109
Raised Fly Stack	89.1	5.5	104
Tight Paulin Stack	100.2	7.6	118
Raised Fly with Foil Stack	88.0	4.0	100
Second Layer Center Carton Air			
Open Stack	88.1	4.4	104
Raised Fly Stack	88.9	3.7	100
Tight Paulin Stack	M	M	M
Raised Fly with Foil Stack	87.7	3.6	97
Stack Center Carton Air			
Open Stack	87.6	3.8	99
Raised Fly Stack	88.4	3.5	99
Tight Paulin Stack	93.3	3.3	100
Raised Fly with Foil Stack	87.6	3.4	96
Bottom Center Carton Air			
Open Stack	87.1	4.2	99
Raised Fly Stack	87.2	4.1	99
Tight Paulin Stack	90.1	3.3	98
Raised Fly with Foil Stack	87.2	3.8	99

The latter has a 10 F^{o} gradient of mean temperature between Top Center and Bottom Center Cartons, compared to the nearly isothermal conditions of the other stacks. Indeed, mean temperatures at all positions listed in Table II except those in the Tight Paulin Stack and the Abandon Ship Ration were equal to or lower than mean Outside Air temperature. These findings from detailed data confirm similar ones of the pilot study (1) which was based on estimates made from 9 selected days.

The variance of the data is revealed both by the standard deviations and the absolute maxima of Table II and the more detailed figures and graphs (Tables III-XVI and Figures 7-12). Here again, however, it is the Top Center Carton Air of the tight paulin stack and the isolated small cartons of the Abandon Ship Ration Cartons which show large standard deviations and high absolute maxima. In the isolated cartons of the latter, the heat mass is so small that one would expect the large variance and the high maxima, since there is little of the ballasting effect found in the larger stacks.

As a rough rule for estimation of absolute maxima, during the total period of the test for the two most extreme positions, the Black-covered Abandon Ship Ration Carton and the Top Center Carton of the Tight Paulin Stack, the addition of 35 F^{o} to the monthly mean of the former and 20 F^{o} to the monthly mean of the latter, will give the monthly maximum within 1-2 F^{o}.

In all the remaining positions shown in Table II, the standard deviation is between 3 and 6 F^{o}, the higher figures being associated with the surface positions. Indeed, the Outside Air temperature shows a greater standard deviation than temperature at any position except the air of the Abandon Ship Ration Cartons.

(c) Prediction of Period Mean Storage Temperatures from Outside Air Temperature

The more accurate analysis made possible by the complete reduction of all hourly observations and computer analysis of the reduced data refined the regression equations previously reported in the pilot study (1). Using eight five-day periods, linear regression analysis of (Table XVII) the following values for the equation:

$$y = b + cs \pm SE$$

where y = 5-day mean Top Carton Air temperature

b = ordinate intercept

c = slope of least squares regression line

x = 5-day mean Outside Air temperature

SE = standard error

CC = Pearson product-moment coefficient of correlation.

The correlation coefficients are significant at less than the 0.01% level and were significantly higher than those found in the pilot study. A plot of the regression lines is shown in Figure 13. In multiple correlation, the addition of radiation and wind speed did not increase the correlation coefficient. It is thus confirmed that period mean storage temperatures in storage dumps can be predicted from period mean outside air temperatures.

(d) Prediction of Effective Temperatures for Storage Simulation

A method of computation of an effective mean temperature to simulate the degradative effect of fluctuating food storage temperatures was developed in the pilot study (1, p. 33-34 and Appendix B, p. 59). The method requires knowledge of two functions: (1) the dependence of degradation rate on temperature, either in empirical tabular, graphical, or mathematical form, and (2) the frequency distribution of all temperatures in stored food during the period of storage, such as those found in the present study for Top Center Carton Air (Table III).

Thus, for a given month, an effective mean temperature can be derived which will, in all cases, somewhat exceed the arithmetic mean of storage temperatures because of the known increase in degradation of most foods with temperature increase (1, p. 33). Table XVIII shows a comparison of such effective mean temperatures with arithematic mean temperatures for Top Center Carton Air in all four stacks for the entire period 22 June to 3 August.

Table XVII

Regression of Period Mean Storage Temperature on Period Mean Outside Air Temperature

Stack Type	b	C	SE	CC
Open Stack	0.15	0.99	± 0.76	0.97
Raised Fly Stack	4.03	0.94	± 0.67	0.98
Tight Paulin Stack	36.9	0.70	± 0.76	0.95
Raised Fly with Foil Stack	20.5	0.74	± 0.44	0.98
Abandon Ship Ration				
Black Cover	15.5	0.88	± 1.18	0.93
No Cover	-6.0	1.08	± 0.64	0.98

Table XVIII

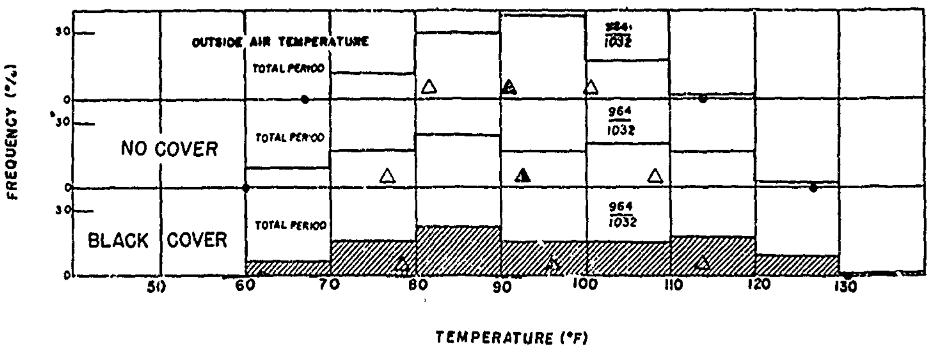
Effective Mean and Arithmetic Mean Temperatures in Top Center Carton Air[a]

Type of Stack	Arithmetic[b] Mean (°F)	Effective[b] Mean (°F)	Difference (°F)
Open Stack	89.8	90.8	1.0
Raised Fly Stack	88.8	89.4	0.6
Tight Paulin Stack	100.4	101.8	1.4
Raised Fly with Foil Stack	87.8	88.5	0.7
Outside Air	90.8		

[a] Both means were derived by computer; the effective mean was computed from the known temperature distribution in Table III and an assumed exponential function of food degradation based on doubling for every 18°F increase in temperature, which holds roughly for many foods.

[b] Computed for total period 22 June to 3 August.

TOTAL PERIOD
1955



DRY PERIOD
1955

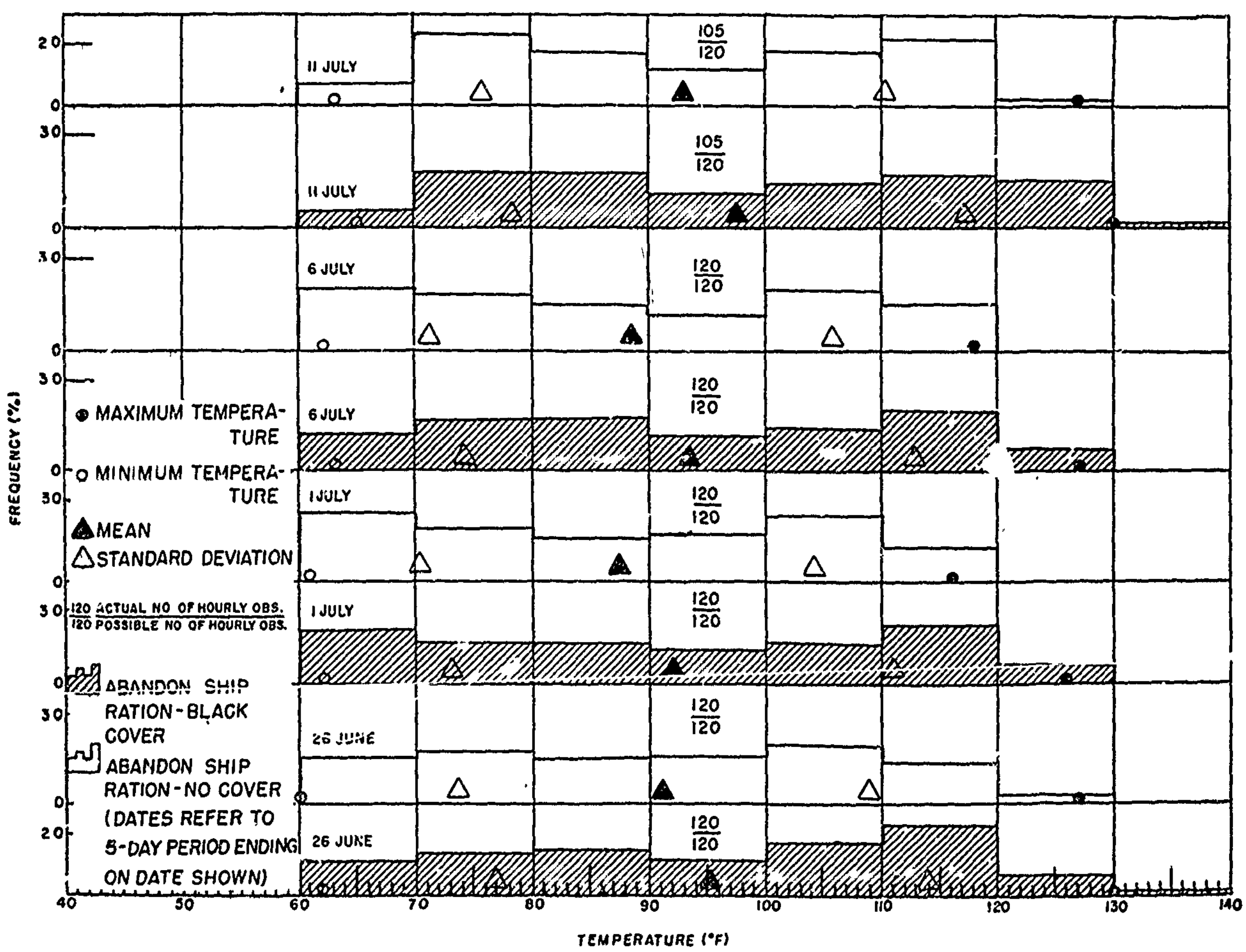


Figure 11. Frequencies, Means, and Standard Deviations of Hourly Observations for Isolated Abandon Ship Ration Cartons for Total Period and by Five-day Periods -- Dry Period.

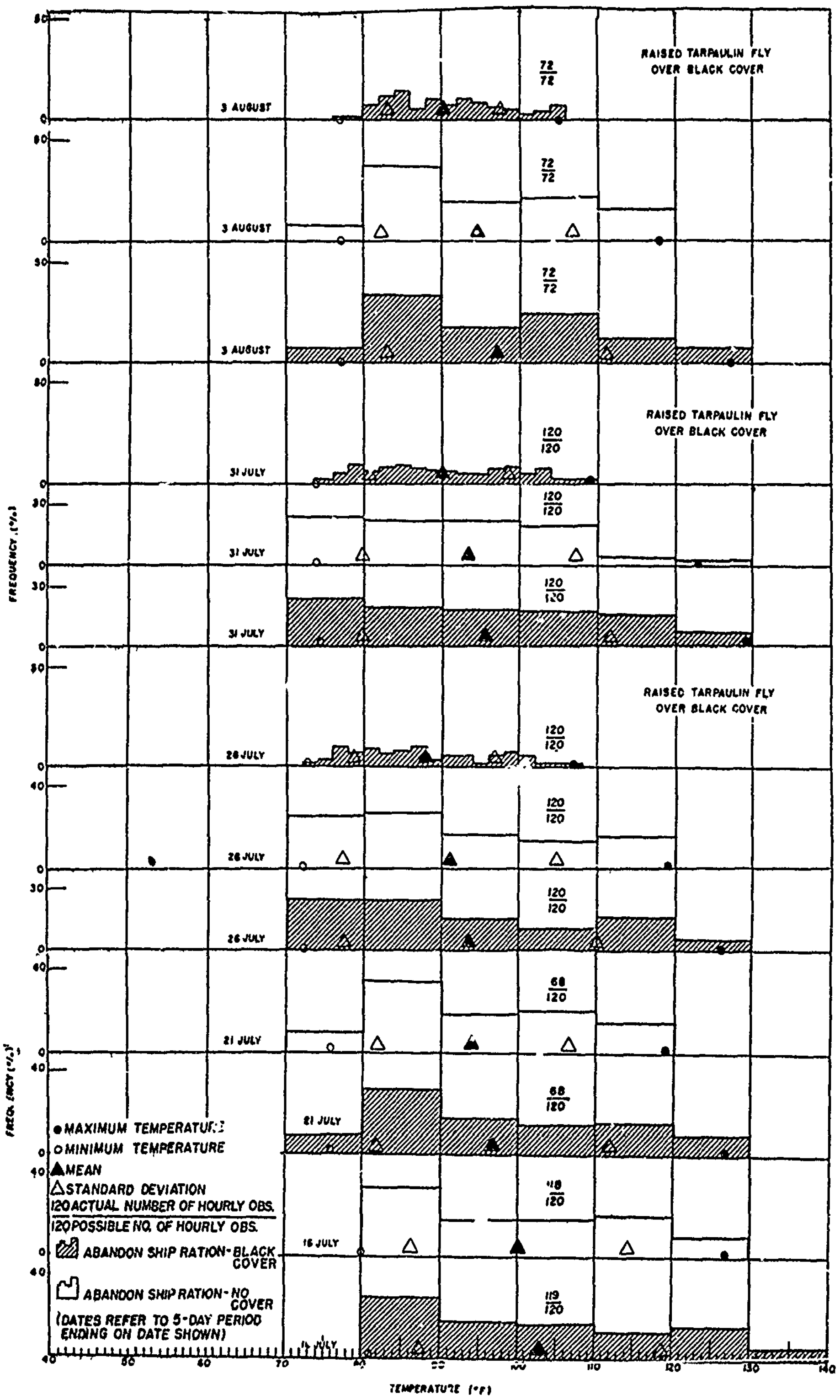


Figure 12. Frequencies, Means, and Standard Deviations of Hourly Observations for Isolated Abandon Ship Ration Cartons for Five-day Periods -- Moist Period.

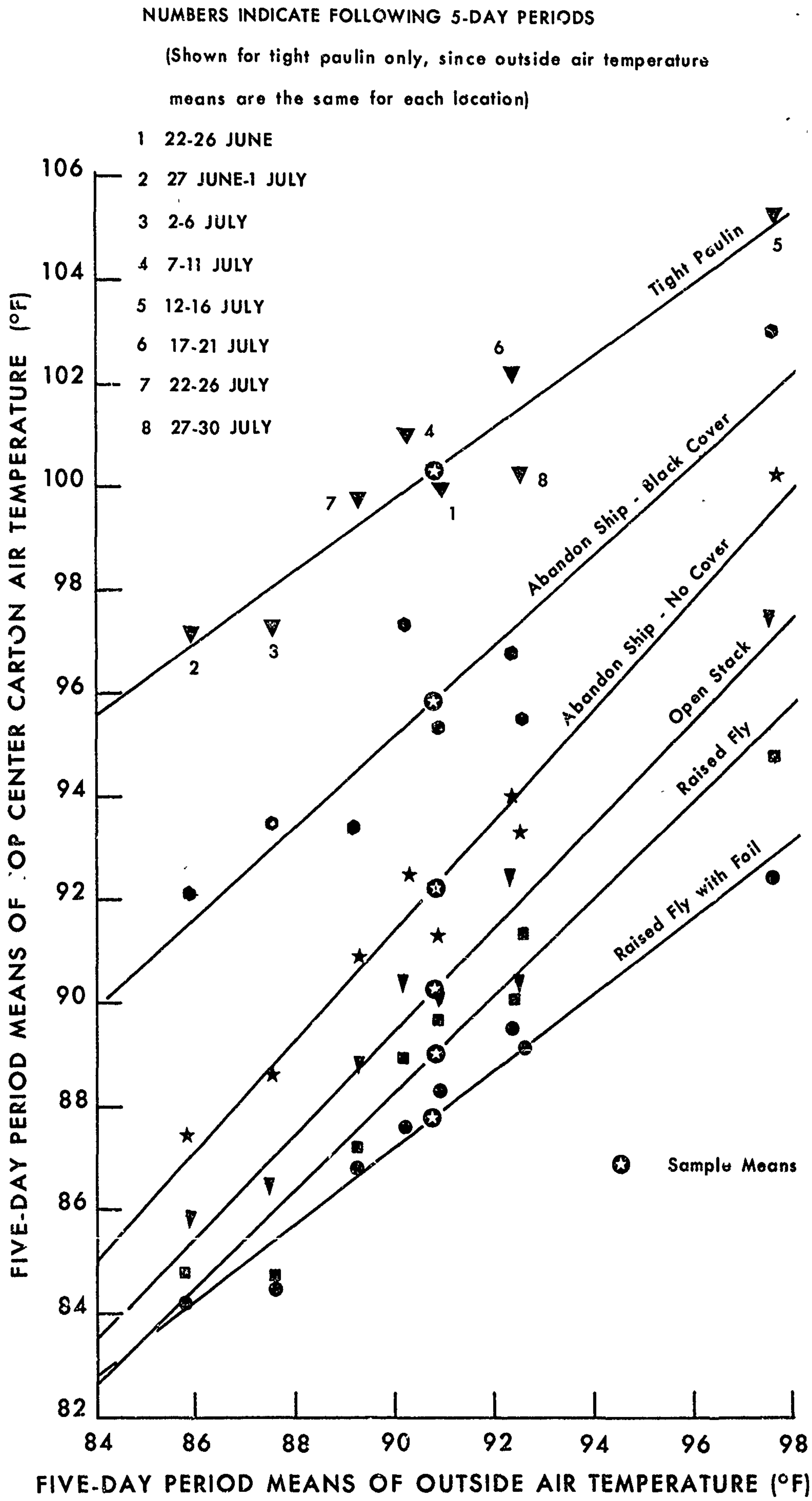


Figure 13. Regression of Five-day Period Means of Top Center Carton Air Temperature and Abandon Ship Ration Carton Temperature on Outside Air Temperature.

It was satisfying to find that the values derived herein by computer analysis of the detailed data are within 1 F° of those found by the methods of estimation used in the pilot study (1). The addition of about 1.5 F° to the predicted monthly arithmetic mean will adequately predict the effective mean monthly temperature in dump storage air.

Using the food degradation function, whether it be empirical (graphical or tabular), or mathematical, a series of predicted effective storage temperatures can be averaged by similar methods to give, for example, an effective mean annual temperature for storage simulation.

B. Frequencies, Means and Standard Deviations of all Temperatures by Five-day Periods: Effect of Dry Versus Moist Air Mass or Surface and Interior Temperatures

Tables XIV-LXV and Figures 11, 12, 14, and 15 were prepared to illustrate the distribution of temperatures when the total period was broken down into five-day intervals.

Table XIX, a summary table of means, shows most clearly the increase in mean storage temperature between the first four periods of dry air mass weather and the last five periods when a more moist air mass moved in. At all positions, both interior and surface, a 3 to 5 F° increase in mean storage temperature occurred, in spite of the fact that, as was discussed thoroughly in the pilot study (1, p. 39-41), total incoming solar and sky radiation decreased and air mass moisture and cloud cover increased in the latter period.

The increase in storage temperature was as great in the interior as at the surface and sometimes greater (Tight Paulin Stack, Table XIX).

Figure 18 shows graphically the decrease in five-day total radiation and increase in five-day mean Outside Air temperature during the moist period.

The reasons for the increase in storage temperature in sunny, but humid weather have been discussed in the pilot study (1, p. 39-43). It is largely due to reduction of outgoing long wave radiation at night by the increased water vapor in the total air mass column which results in much higher minimum temperatures.

The much more detailed temperature distribution data of this report show that the effect of hot humid air is found throughout the interior and surface cartons. It reinforces the conclusion made in the pilot study (1, p. 47) that summer storage heat stress will be greatest in areas like the shores of the Red Sea, or even on large tropical islands where high solar radiation is combined with high atmospheric humidity.

Table XX shows that although mean storage temperatures increase in the moist period, the mean standard deviations of the contrasting grouped dry and moist five-day periods show very little change in the large stacks. Thus, although the daily range is reduced by great increase in the minimum temperature (1, p. 39) with minor increase in the daily maximum, the variance of the whole five-day period temperature distribution changes little.

Table XIX

Storage Mean Temperature Contrast Between Dry and Moist Periods

Stack and Position	Dry Period Ending 11 July (°F)	Moist Period Ending 3 September (°F)	Difference (F°)
Stack Center Carton Air			
Open Stack	86.0	89.1	3.1
Raised Fly	86.9	89.7	2.8
Tight Paulin	90.9	95.7	4.8
Raised Fly with Foil	85.8	89.4	3.6
Bottom Center Carton Air			
Open Stack	85.2	88.8	3.6
Raised Fly	85.2	89.1	3.9
Tight Paulin	87.7	92.4	4.7
Raised Fly with Foil	85.2	89.2	4.0
Top Center Carton Air			
Open Stack	88.2	92.0	3.8
Raised Fly	87.0	91.1	4.1
Tight Paulin	98.8	101.5	2.7
Raised Fly with Foil	86.2	89.7	3.5
Second Layer Center Carton Air			
Open Stack	86.5	89.7	3.2
Raised Fly	87.3	90.4	3.1
Tight Paulin	M	M	M
Raised Fly with Foil	85.9	89.6	3.7
Outside Air	88.7	92.7	4.0
Abandon Ship Ration			
Black Cover	94.7	97.1	2.4
No Cover	90.1	94.6	4.5
Tight Paulin Stack			
Center of Lower Surfaces of Tarpaulin Cover	98.5	101.4	2.9

Table XX

Standard Deviations of Storage Temperatures in Dry Versus Moist Periods

Stack	Position	Dry Period Ending 11 July	Moist Period Ending 3 September
Tight Paulin	Top Center Carton Air	7.8	6.5
	Stack Center Carton Air	1.6	1.9
Open Stack	Top Center Carton Air	5.9	5.0
	Stack Center Carton Air	2.1	2.7
Abandon Ship Ration	Black Cover	19.1	15.4
	No Cover	17.3	13.3
Tight Paulin	Center of Lower Surface of Tarpaulin Cover	32.2	24.9

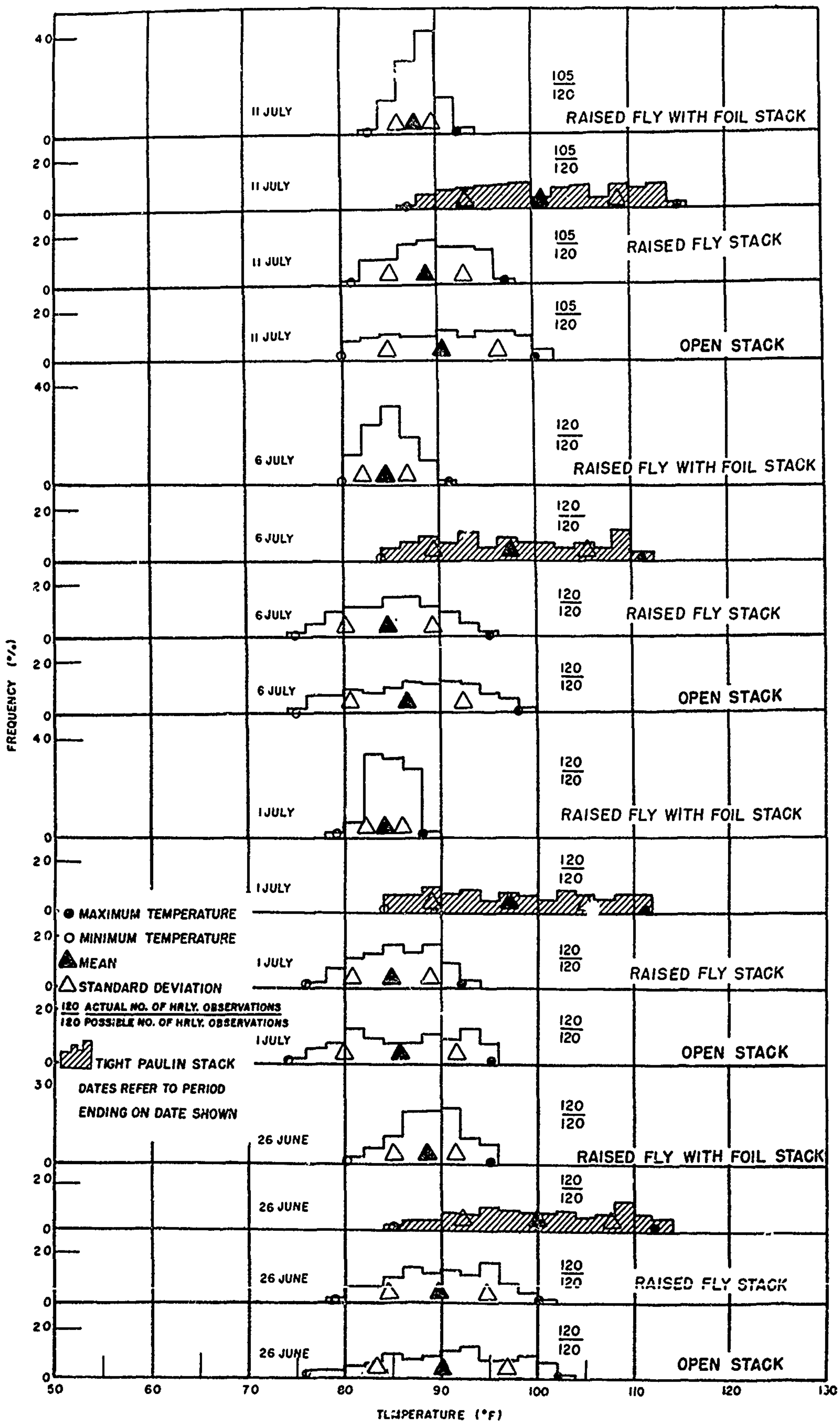


Figure 14. Frequencies, Means, and Standard Deviations of Hourly Temperatures for Top Center Carton Air by Five-day Periods -- Dry Period.

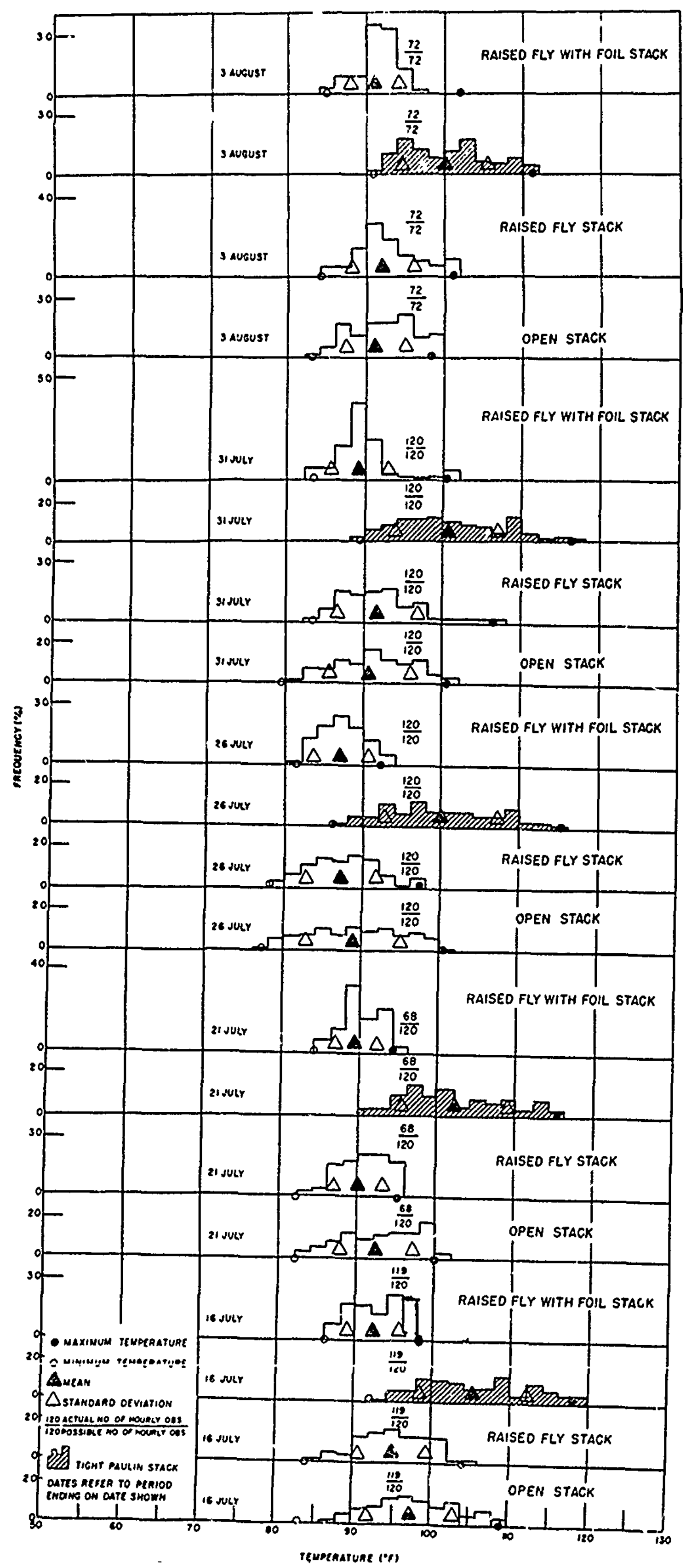


Figure 15. Frequencies, Means, and Standard Deviations of Hourly Temperatures for Top Center Carton Air by Five-day Periods -- Moist Period.

C. Frequencies, Means and Standard Deviations of All Temperatures in Isolated Abandon Ship Ration Cartons for Total Period and by Five-day Periods

Figures 11 and 12 and Tables II, XIX, XX, XIV, XV, and XVI show the storage temperature distribution data for the isolated cartons.

Although the total period mean temperatures in both the isolated Covered and Uncovered Abandon Ship Ration Cartons are lower than those in the Tight Paulin Stack Top Carton, the absolute maxima, standard deviations, and calculated effective means of the distributions provide evidence that they have both a more severe short and long term temperature stress than the Top Carton of the Tight Paulin Stack and the Open Stack, respectively. Effective mean storage temperature for the Black Covered Abandon Ship Ration is 102°F, and for the uncovered ration 97.5°F. Although the margin is small, they are obviously the most extreme type of exposure of food in cartons.

These high effective mean temperatures have obvious implications for rations which, under combat conditions, may be expected to be consumed after long periods of isolated exposure away from the relative protection of a storage dump.

D. Frequencies, Means, Standard Deviations and Maxima of Paulin and Carton Surface Temperatures

Figures 9, 15, 16 and 17 and Tables XII, XXX, XXXI, XXXII, XLII, XLIII, XLIV, LIV, LV show the distribution of protective paulin and carton surface temperatures. As might be expected, the absolute maxima and range of these temperatures are much greater than at other observed positions, although the mean temperatures are not notably different from the more extreme carton air temperatures of the corresponding stack. Note, for example, that in Figure 9, the mean temperature of the lower surface of the paulin cover on the Tight Paulin Stack is virtually identical with that of the Top Carton Air of that stack, whereas its maximum is 172°F compared to 118°F in Top Carton Air. The minimum temperature reached by this surface, 58°F, is 10°F below the Outside Air temperature minimum (Figure 7).

The resultant daily range of the paulin surface is greater than even that of the loose sandy soil surface of the surrounding desert. The comparable figures on 27 June are 114°F for the paulin versus a 78°F range for the soil surface (1). This has obvious implications as to the temperature stress on fabrics, threads, and dyes, in addition to the solar radiation stress, which at Yuma approaches the maximum for the United States (2).

Neither of the surfaces on the other paulin-covered stacks reached the extremes found in the Tight Paulin Stack. During the period ending 26 June, for example, the Raised Fly and Foil Stack paulin surface reached 156°F while that on the Raised Fly Stack peaked at 149°F.

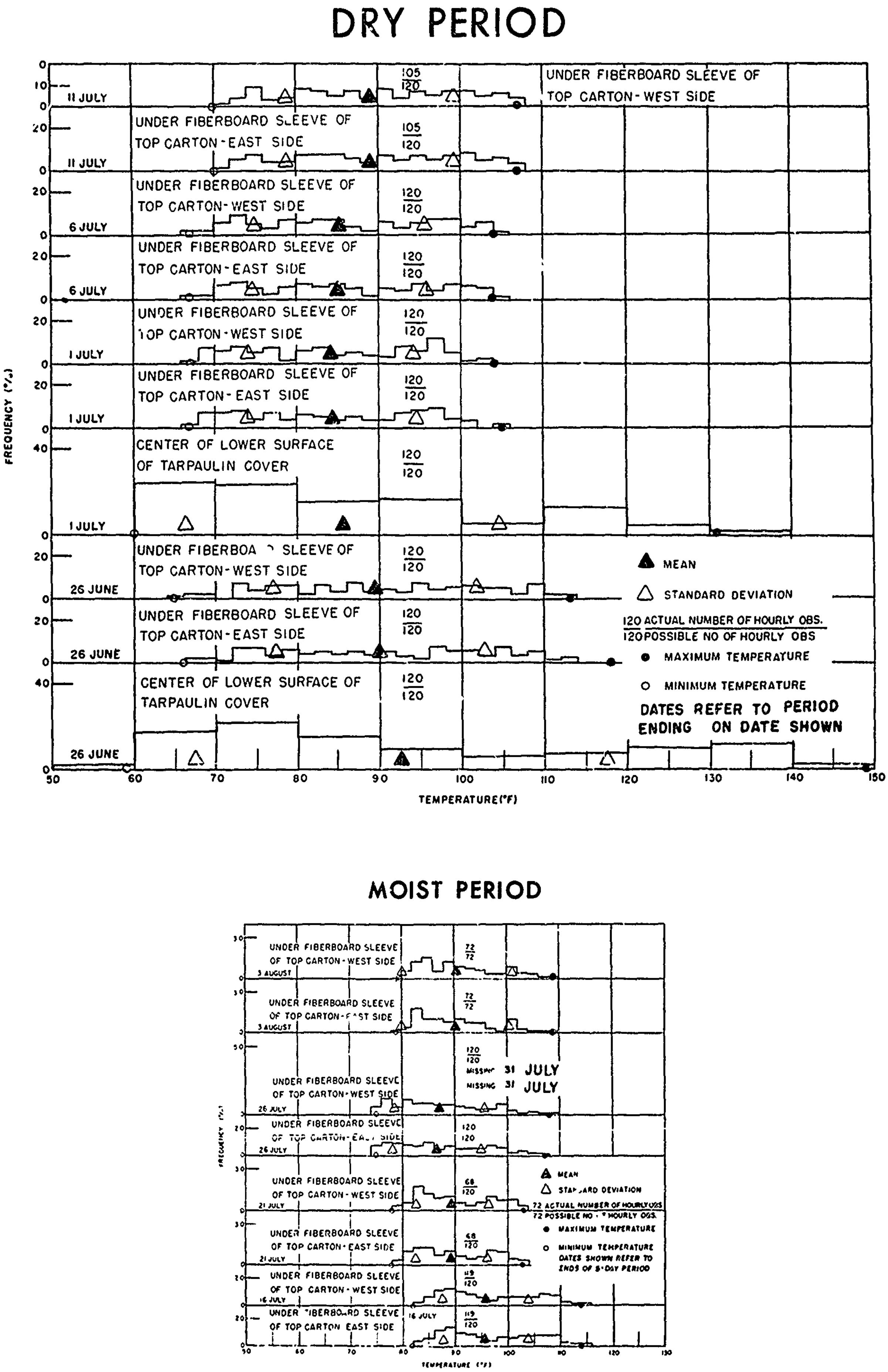


Figure 16. Frequencies, Means, and Standard Deviations of Pavlin Surface and Carton Surface Temperatures by Five-day Periods -- Raised Fly Stack.

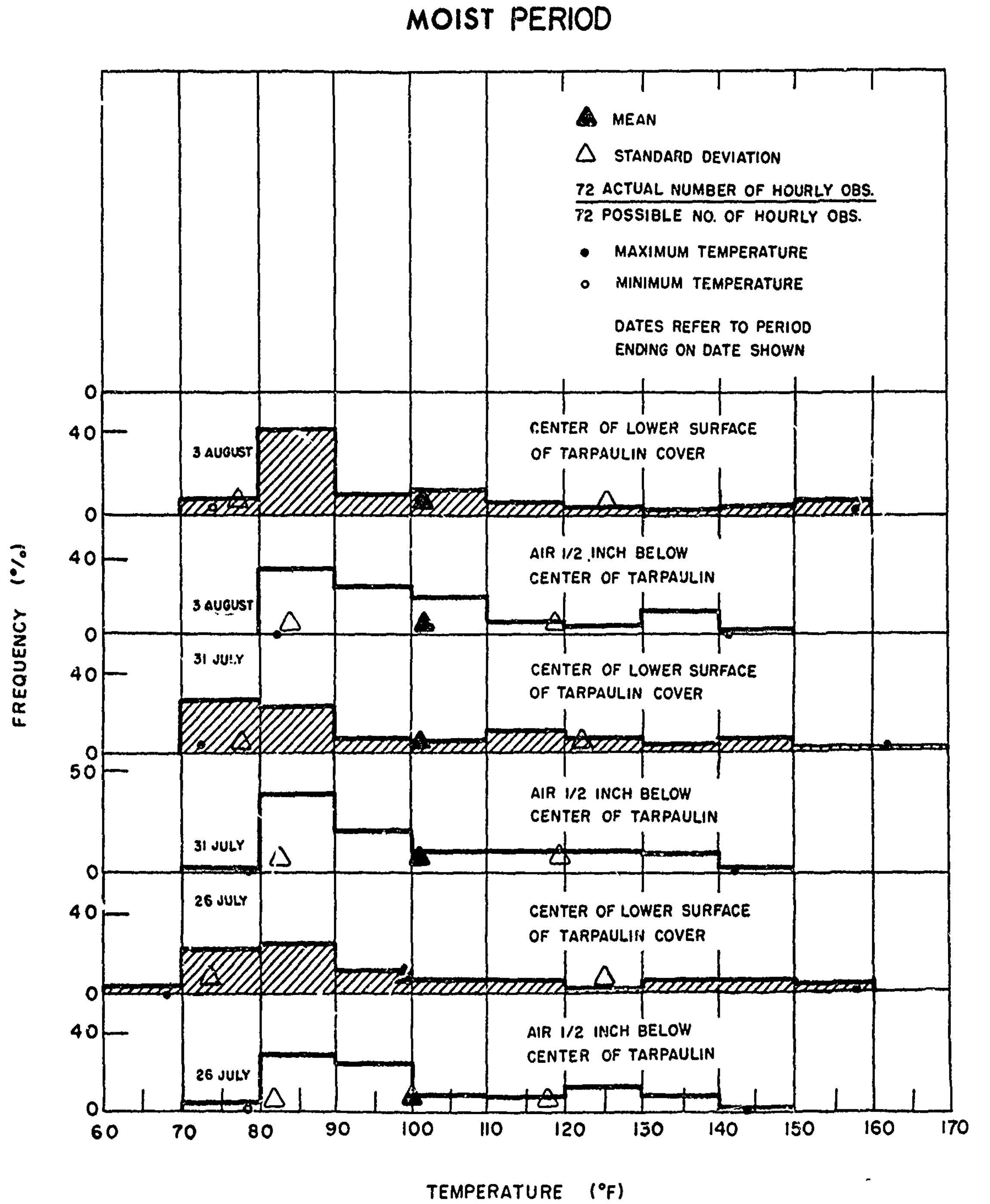
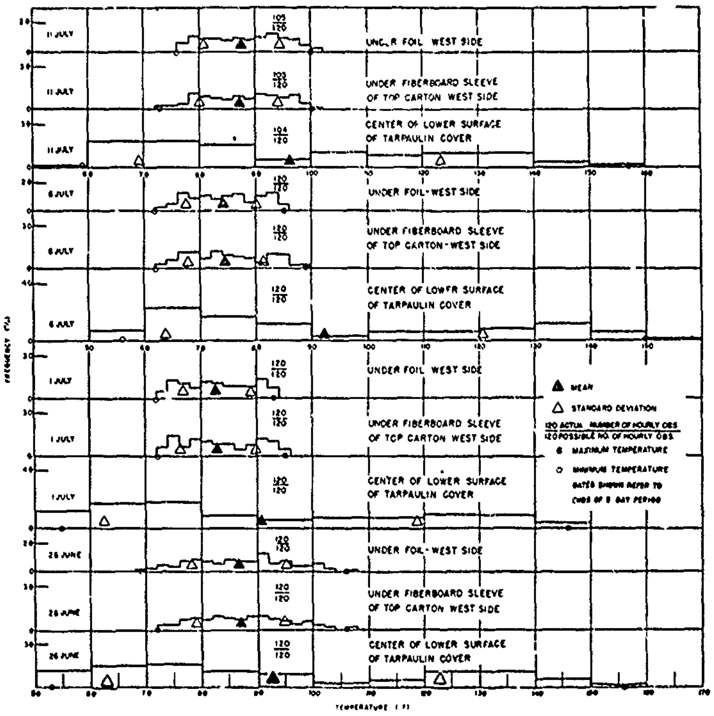


Figure 17. Frequencies, Means, and Standard Deviations of Paulin Surface and Carton Surface Temperatures by Five-day Periods -- Tight Paulin Stack.

DRY PERIOD



MOIST PERIOD

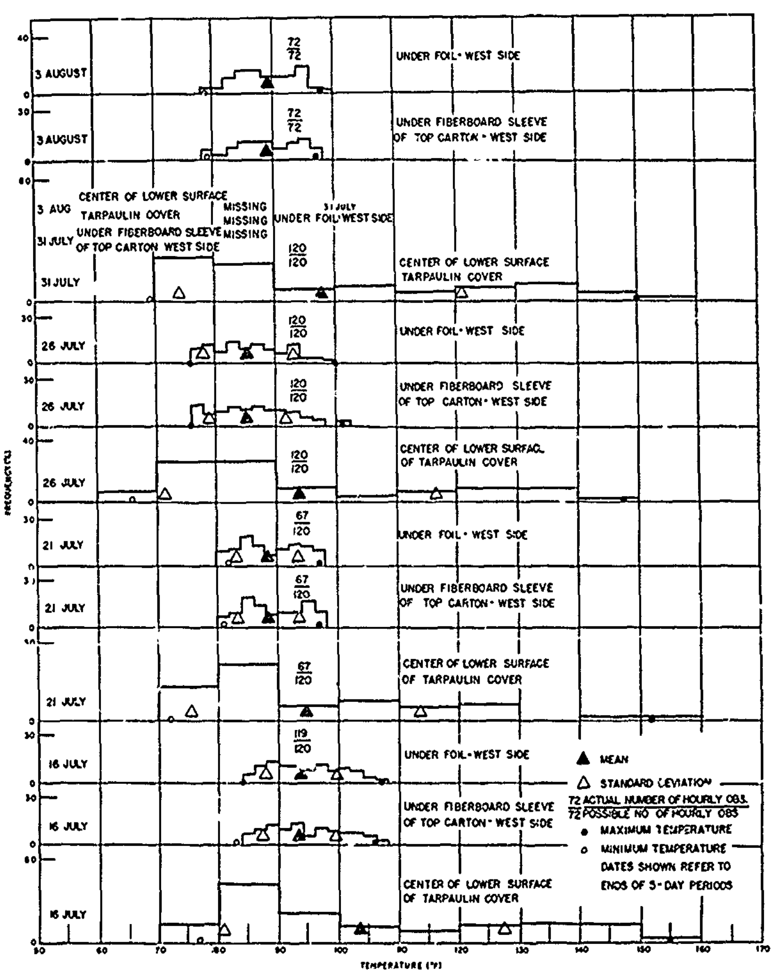


Figure 18. Frequencies, Means, and Standard Deviations of Paulin Surface and Carton Surface Temperatures by Five-day Periods -- Raised Fly with Foil Stack.

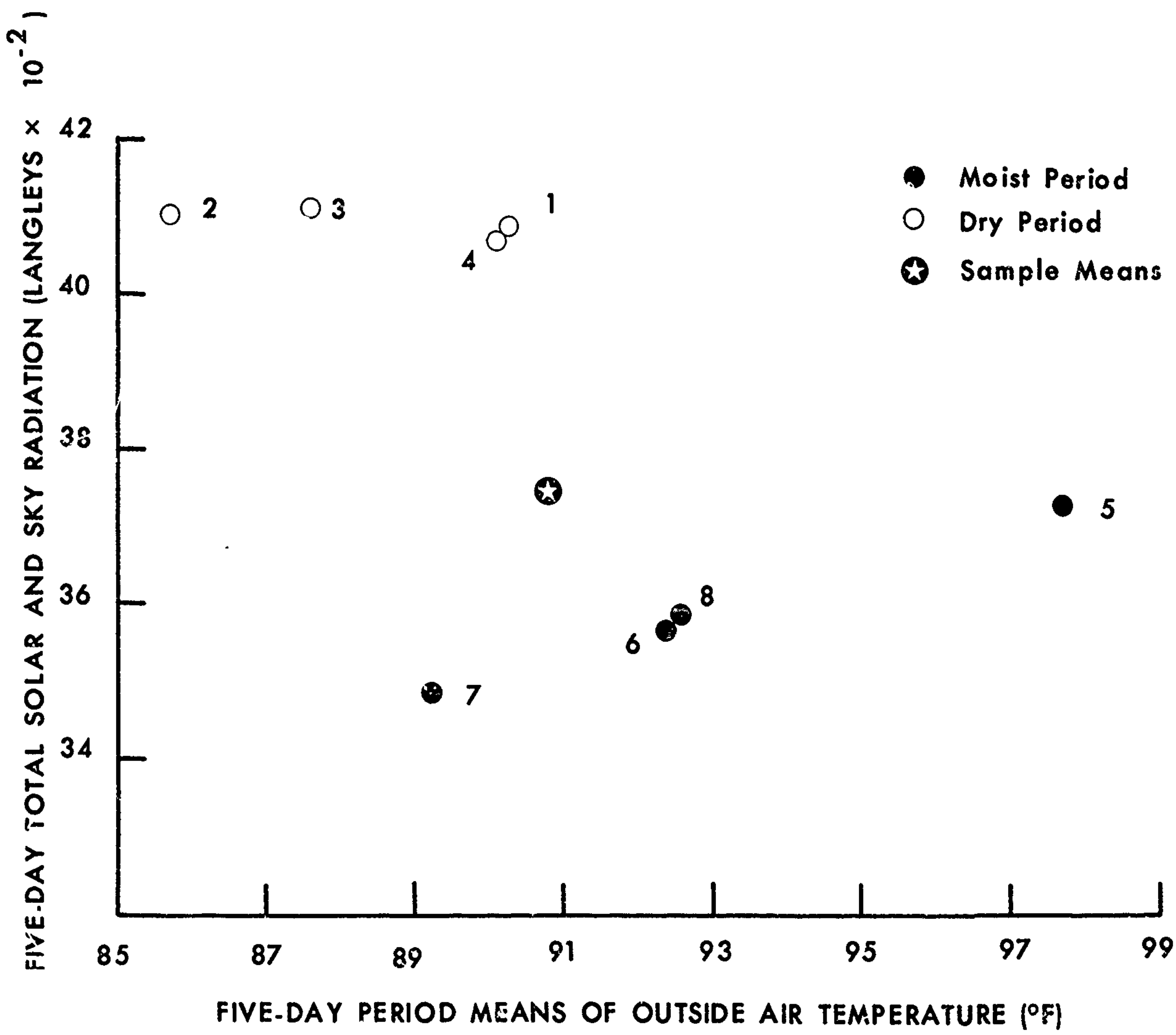


Figure 19. Relation of Five-day Total Solar and Sky Radiation and Five-day Period Mean Outside Air Temperature.

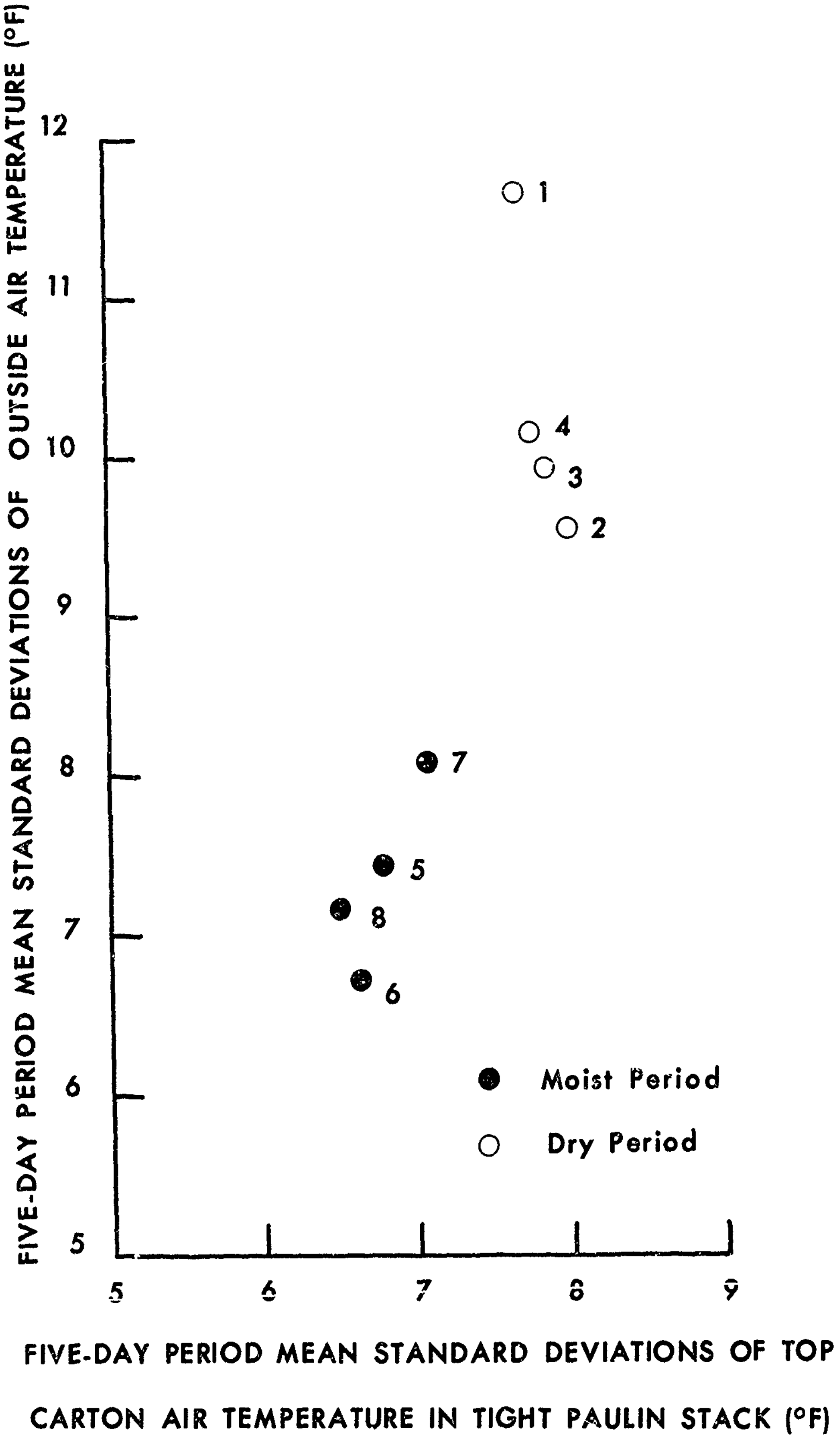


Figure 20. Relation of Five-day Period Mean Standard Deviation for Top Center Carton Air Temperature in Tight Paulin Stack and Five-day Period Mean Outside Air Temperature.

Conclusions

The present report is a detailed computer study of hourly temperature distribution at nine similar positions in cartons in each of four differently exposed storage dumps, in three isolated Abandon Ship Ration Cartons and at seven tarpaulin surface and carton surface positions. The observations were made during the hottest 43 days of the year at Yuma, Arizona, an area of extreme ambient and storage heat stress.

Most of the findings of the previous pilot report, some of which were based upon a sampling and estimation method, were confirmed by this computer study of all the collected data:

a. In the large dumps, absolute maximum temperature observed in carton air was, as reported before, 128°F in the Top Center Carton of the Tight Paulin Stack. However, absolute food temperature maximum was 118°F.

b. The Tight Paulin Stack showed at all comparable positions the highest temperatures. For the Top Center Carton it was approximately 12 F° higher in effective mean temperature (102°F) for the 43 day period than the other stacks.

c. The Tight Paulin Stack also showed a pronounced gradient of temperature from surface to interior (about 6 F° lower in the Stack Center Carton Air in effective mean temperature than at Top Center Carton).

This conclusion, previously suggested by a sample of one of the hottest days, 15 July, was validated by the total data analysis.

d. Based on the total data analysis, the remaining three stacks showed little mean temperature gradient from surface to interior and little mean temperature difference from stack to stack, although the more protected stacks showed a smaller temperature range due to both lower maximum and higher minimum temperatures. Again, the earlier estimate, based on random sampling, was confirmed.

e. Both mean and effective mean temperatures at the position of extreme stress -- Top Center Carton Air, as derived by computer differed by 1 F° or less from the values derived previously by the use of an averaged normalized daily cycle and the known daily maxima to compile an estimated distribution.

The computer based values for effective mean storage temperature for the 43 day period are as follows:

Tight Paulin Stack	101.8
Open Stack	90.8
Raised Fly Stack	89.4
Raised Fly with Foil Stack	88.5

These values are derived, as before, based on an assumed doubling of food degradation rate for every 18 F°. The necessary increment added to the arithmetic mean for the period is in all cases less than 1.5 F°.

f. Correlation coefficients in the regression of storage air temperature for 5-day period means on 5-day mean outside air temperature were raised to highly significant levels by computer analysis (0.95-0.98, where N = 8). Similar high correlation coefficients were found for the regression of Abandon Ship Ration Carton on Outside Air, permitting the prediction of dump storage air temperature from isolated small carton air temperatures by cross correlation, where the latter are the only available data.

g. The isolated Black Covered Abandon Ship Ration Carton Air reached an absolute maximum temperature of 131 °F, and its effective mean was 103 F , making it by a slight margin, the most extreme storage environment as compared to the Tight Paulin Dump and the Standing Boxcar.

h. No significant changes from the pilot study in the absolute maximum surface temperatures of paulin and cartons were observed, 171°F for the paulin of the Tight Paulin Stack being the highest observed.

However, the total distribution tables and graphs are provided for 7 surface temperature positions, permitting cumulative degradation computations if a temperature degradation relation is known.

i. The effect of a moist air mass in producing higher mean storage temperatures was shown to prevail in the interior as well as the surface cartons and in the isolated Abandon Ship Ration Cartons and the paulin surfaces.

Recommendations for Food Testing Temperatures

a. The present detailed data analysis affords little reason to alter the previously stated daily extreme temperature cycle and the long-term 6 months at 100 F° as prudent food testing limits.

b. It is recommended that the effect of the combination of moist air mass and high solar radiation be tested at such areas as the Red Sea and Persian Gulf littorals. The present data and correlations would justify the use of a small isolated carton for measurement, since data thus gained would permit prediction for the larger dumps by methods suggested herein.

Acknowledgements

In addition to the many persons whose contributions to the study were acknowledged in Technical Report EP-121, special mention should be made herein of the following persons who made great contributions to this study.

In particular, the tedious, painstaking and accurate data reduction on which the whole study depends is largely the work of Mr. Willard Morse, then of the Earth Sciences Laboratory.

Special thanks are also due to Mr. David M. Gracia and Mr. Ronald J. Geromini, then of the Data Analysis Branch, who are largely responsible for the programming and execution of the computer analysis.

Miss Gertrude Barry, Cartographer, prepared most of the temperature distribution charts. SP5 Vernon Couch gave other valuable cartographic assistance.

Special thanks are due to Commander R. O. Merrill, Supply Corps, US Navy, the then Navy Liaison Officer at US Army Natick Laboratories, for supplying valuable information and the Abandon Ship Ration Cartons tested. The painstaking and creative editorial assistance of Mr. T. E. Niedringhaus and Miss Patricia Prell are gratefully acknowledged.

Finally, the laborious and precise preparation of the final manuscript is largely the result of the efforts of Miss Evelyn M. Zicko, Food Chemistry Division, Food Laboratory.

References

1. Porter, W. L. and SP3 Nico H. Roos, Occurrence of High Temperatures in Yuma Storage Dumps, Technical Report EP-121, QMR&D Command, Environmental Protection Research Division, November 1959.

2. Porter, W. L. Occurrence of High Temperatures in Standing Boxcars, Technical Report EP-27, QMR&D Command, Environmental Protection Division, Natick, Mass., February 1956.

3. Porter, W. L. and A. Greenwald, Temperature Distribution and Effects of Insulation and Night-time Ventilation in an Army Warehouse (in press).

4. Armed Forces Food and Container Institute, Operational Rations Current and Future, March 1963, published by R. and D. Associates, Armed Forces Food and Container Institute, 1819 W. Pershing Road, Chicago, Illinois, p. 25.

5. Food Laboratory, Operational Rations Current and Future of the Department of Defense, US Army Natick Laboratories, Natick, Mass 01760, p. 29.

Table III

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Top Center Carton Air

Temperature (^oF)

	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	112-3	114-5	116-7	$\bar{x}$	S_x	N
n Stack	2	3	5	6	8	9	10	11	12	10	9	6	3	2	1	1						90.2	6.5	964
sed Fly ack	1	3	5	7	10	13	14	14	12	9	5	3	3									89.1	5.5	964
ht Paulin ack					2	2	4	5	8	8	10	9	8	8	7	5	10	5	4	2	1	100.2	7.6	964
sed Fly with il Stack			3	10	14	19	21	15	8	5	3		1									88.0	4.0	964

APPENDIX A

Percentage Frequencies, Means and Standard Deviations of Hourly
Observations for Total Period
22 June to 3 August

Table III - XVI

Table III

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Top Center Carton Air

Temperature (°F)

	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	112-3	114-5	116-7	$\bar{x}$	S_x	N
Open Stack	2	3	5	6	8	9	10	11	12	10	9	6	3	2	1	1						90.2	6.5	964
Raised Fly Stack	1	3	5	7	10	13	14	14	12	9	5	3	3									89.1	5.5	964
Tight Paulin Stack					2	2	4	5	8	8	10	9	8	8	7	5	10	5	4	2	1	100.2	7.6	964
Raised Fly with Foil Stack			3	10	14	19	21	15	8	5	3		1									88.0	4.0	964

Table IV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Top Center Carton - Air Outside Ration Package

Temperature (°F)

	50-9	60-9	70-9	80-9	90-9	100-9	110-9	120-9	$\bar{x}$	S_x	N
Open Stack	1	9	18	23	15	16	12	4	90.7	17.3	964
Tight Paulin Stack				41	38	21	19	8	101.5	11.5	964

Temperature (°F)

	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	$\bar{x}$	S_x	N
Raised Fly Stack	1	1	3	5	7	9	12	12	13	11	8	7	5	3	1			1	89.4	6.2	964
Raised Fly with Foil Stack			2	6	10	13	21	18	14	8	5	2	1						87.7	4.6	963

Table V

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Top Center Carton Food

Temperature (°F)

	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100 -1	102 -3	104 -5	106 -7	108 -9	110 -1	112 -3	114 -5	116 -7	$\bar{x}$	S_x	N
Open Stack	2	3	4	6	8	10	12	16	12	9	7	5	2	1	1							89.8	6.0	964
Raised Fly Stack	1	3	5	7	11	14	14	17	10	8	4	3	2									88.8	5.3	964
Tight Paulin Stack						2	3	5	6	9	9	12	14	7	7	6	12	4	2	1	1	100.4	6.8	964
Raised Fly With Foil Stack			5	9	15	20	21	13	8	6	3											87.8	4.1	964

Table VI

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Top Southwest Corner Carton Air

Temperature (°F)

	70-1	72-3	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	$\bar{x}$	S_x	N
Open Stack	1	2	2	3	4	6	5	6	8	8	11	8	7	7	6	6	3	1	1	1		89.7	8.3	964
Raised Fly Stack				1	3	5	6	9	11	12	14	11	7	6	5	4	2	1		1		89.9	6.5	964
Raised Fly with Foil Stack				2	4	7	8	12	14	14	15	7	5	5	3	1	1					88.1	6.0	963

Temperature (°F)

	70-9	80-9	90-9	100-9	110-9	120-9	$\bar{x}$	S_x	N
Tight Paulin Stack	5	20	30	24	18	3	98.5	12.1	964

Table VII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Second Layer Center Carton Air

Temperature (°F)

	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	$\bar{x}$	S_x	N
Open Stack	2	4	7	15	17	19	17	6	6	2	2	1	88.1	4.4	964
Raised Fly Stack		2	5	10	18	22	22	11	4	4	1		88.9	3.7	964
Tight Paulin Stack	- - - - - -	- - - -	- - - -	- - - -	- - - -	- - Missing	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -
Raised Fly With Foil Stack		2	10	18	19	22	14	7	5	3			87.7	3.6	964

Table VIII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Middle Layer Outer Carton West Face - Air

Temperature (^{o}F)

	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	112-3	$\bar{x}$	S_x	N
Open Stack	2	5	5	9	11	13	15	8	9	7	6	5	1	1					90.5	6.3	964
Raised Fly Stack	2	6	6	11	16	18	14	11	7	4	2	1							88.4	4.8	964
Tight Paulin Stack				1	2	5	7	8	13	14	12	12	7	6	5	5	1	1	98.0	6.0	964
Raised Fly With Foil Stack	1	6	9	16	18	20	14	7	4	3									87.5	3.9	963

Table IX

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Middle Layer Outer Carton West Face - Food

Temperature (^{o}F)

	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	$\bar{x}$	S_x	N
Open Stack		4	6	8	14	15	14	12	9	8	5	2	1	1				90.3	5.3	964
Raised Fly Stack	1	6	7	13	15	24	14	10	5	3	2	1						88.2	4.3	964
Tight Paulin Stack				1	2	4	6	10	13	15	12	12	9	7	5	3	1	97.7	5.6	964
Raised Fly With Foil Stack		5	9	16	19	22	14	7	4	3								87.6	3.8	963

Table X

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Stack Center Carton Air

Temperature (^{o}F)

	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	$\bar{x}$	S_x	N
Open Stack	3	11	16	19	26	10	5	4	3	1		87.6	3.8	964
Raised Fly Stack	2	5	12	22	23	19	7	5	2	2		88.4	3.5	964
Tight Paulin Stack				2	11	19	18	21	17	9	2	93.3	3.3	964
Raised Fly with Foil Stack	2	9	20	19	23	15	6	4	3			87.6	3.4	964

Table XI

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Bottom Center Carton Air

Temperature (^{o}F)

	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	$\bar{x}$	S_x	N
Open Stack	1	7	12	17	20	22	8	5	3	4	1	87.1	4.2	964
Raised Fly Stack	1	7	9	14	20	23	11	5	4	2	1	87.2	4.1	964
Tight Paulin Stack				8	16	16	25	19	9	6		90.1	3.3	964
Raised Fly with Foil Stack	1	6	8	17	18	25	13	5	4	3		87.2	3.8	963

Table XII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Center of Lower Surface of Tarpaulin Cover

Temperature (°F)

	50-9	60-9	70-9	80-9	90-9	100-9	110-9	120-9	130-9	140-9	150-9	160-9	$\bar{x}$	s_x	N
Raised Fly with Foil Stack[a]	1	11	17	20	9	7	7	7	7	7	6	1	100.1	29.0	964

----

[a] Temperature at this position was not measured for the total period in the other three stacks.

Table XIII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations for Total Period - 22 June to 3 August

Outside Air

Temperature (°F)

	70-9	80-9	90-9	100-9	110-9	$\bar{x}$	s_x	N
Open Stack[a]	12	30	38	17	1	90.8	9.4	964

----

[a] Temperature at this position was not measured in the other three stacks.

Table XIV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods and for Total Period - 22 June to 3 August

Abandon Ship Ration - Black Cover

Period Ending	Temperature (°F) 60-9	70-9	80-9	90-9	100-9	110-9	120-9	130-9	$\bar{x}$	s_x	N
June 26	11	14	15	12	17	23	7	1	95.4	18.6	120
July 1	18	14	14	12	14	20	7		92.1	19.0	120
July 6	12	17	17	12	13	17	11		93.5	19.4	120
July 11	5	18	18	11	14	17	15	1	97.8	19.5	105
July 16			30	18	17	13	16	5	103.0	15.6	119
July 21		9	32	18	15	16	10		96.8	15.0	68
July 26		25	25	16	11	17	6		93.4	16.2	120
July 31		7	23	19	18	17	15	7	95.5	15.8	120
Aug 3		7	37	19	21	15			97.0	14.3	72
Total Period	6	15	22	15	15	17	9	1	95.9	17.7	964

Table XV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods and for Total Period - 22 June to 3 August

Abandon Ship Ration - No Cover

Temperature (°F)

Period Ending	60-9	70-9	80-9	90-9	100-9	110-9	120-9	$\overline{x}$	S_x	N
June 26	15	17	15	16	20	14	3	91.3	17.6	120
July 1	22	17	14	15	22	11		87.4	17.0	120
July 6	20	18	15	12	19	15		88.6	17.3	120
July 11	7	23	17	12	17	22	2	93.0	17.2	105
July 16			34	18	18	20	10	100.3	13.9	119
July 21		10	35	19	21	15		94.1	12.6	68
July 26		26	27	17	14	16		90.9	13.8	120
July 31		23	21	21	19	4	2	93.4	13.7	120
August 3		7	37	19	21	15		94.4	12.3	72
Total Period	8	16	23	16	19	16	2	92.4	15.9	964

Table XVI

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Abandon Ship Ration - Raised Tarpaulin Fly Over Black Cover

Temperature (°F)

Period Ending	72-3	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	$\bar{x}$	S_x	N
July 26	2	3	10	7	9	7	8	10	3	6	6	2	6	7	6	2	2	2		87.6	9.0	120
July 31		2	5	9	6	8	9	7	6	6	5	5	7	8	5	7	2	2	2	89.9	9.0	120
August 3			1	1	7	11	14	5	10	7	10	8	6	5	3	4	7			90.4	7.3	72

APPENDIX B

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Table XXI - LXV

Preceding page blank

Table XXI

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Top Center Carton Air

Temperature (°F)

Period Ending	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	$\bar{x}$	S_x	N
June 26		2	6	11	21	21	22	10	8				88.4	3.3	120
July 1	1	6	33	31	27	2							84.2	1.9	120
July 6		12	24	32	19	10	2						84.5	2.4	120
July 11			1	13	29	41	14	2					87.7	1.9	105
July 16					8	18	17	13	23	20	1		92.3	3.4	119
July 21				7	13	34	18	23	4				89.5	2.6	68
July 26		2	14	20	25	19	13	6					86.7	3.5	120
July 31			6	6	17	38	20	3	2	1	2	5	89.1	3.7	120
Aug 3				1	8	8	33	31	11				91.1	3.1	72

Table XXII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Top Center Carton - Air Outside Ration Package

Temperature (^{o}F)

Period Ending	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	$\bar{x}$	s_x	N
June 26	2	3	11	13	20	22	15	7	6									87.5	3.6	120
July 1	6	19	23	23	21	7												83.6	2.7	120
July 6	5	17	23	19	24	5	4	2										84.1	3.1	120
July 11			7	11	32	23	25	2										87.5	2.4	105
July 16					8	11	18	18	22	15	8							92.7	3.4	119
July 21				7	22	27	19	16	7									89.3	2.7	67
July 26	1	4	16	22	26	16	7	6	2									86.2	4.3	120
July 31		1	1	10	23	32	17	5	3	1	1	1	1	1	1	2	1	89.4	5.0	120
Aug 3				8	5	24	25	8										90.4	4.3	72

Table XXIII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Top Center Carton Food

Temperature (^{o}F)

Period Ending	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	$\bar{x}$	S_x	N
June 26	1	1	7	15	21	20	18	10	7			88.0	3.3	120
July 1	1	12	30	34	22							83.8	1.9	120
July 6	1	22	24	27	16	8	2					83.9	2.6	120
July 11			2	13	30	42	10	2				87.5	1.9	105
July 16				1	7	18	18	8	27	20	1	92.4	3.3	119
July 21				3	23	31	15	23	4			89.3	2.7	68
July 26		2	11	22	25	26	10	2				86.4	3.1	120
July 31				8	22	38	14	4	4	4	3	89.2	4.2	120
Aug 3					8	4	36	37	10			91.4	2.1	72

Table XXIV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Top Southwest Corner Carton - Air

Temperature (°F)

Period Ending	72-3	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	112-3	114-5	$\bar{x}$	S_x	N
June 26			2	6	4	6	17	13	12	9	8	9	9	4	1								88.4	5.7	120
July 1	1	2	6	11	19	14	14	17	13	2													83.0	3.9	120
July 6			7	11	13	14	14	14	13	9	3												84.0	4.4	120
July 11					1	11	17	20	13	22	6	3	4	2	1								88.1	4.0	105
July 16						2	1	5	9	14	14	17	15	11	6	5	1						93.9	4.5	119
July 21						1	7	21	16	21	21	7	4										89.8	3.3	67
July 26			1	1	14	9	21	15	14	12	5	2	3	2									86.5	5.1	120
July 31				1	8	3	7	17	17	25	5	2	4	3	1			1	1	1	2	2	90.1	7.2	120
Aug 3						7	4	8	19	28	10	7	4	5	3								91.0	5.5	72

Table XXV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Second Layer Center Carton Air

Temperature ($^{\circ}F$)

Period Ending	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	$\bar{x}$	s_x	N
June 26		1	4	20	20	17	22	12	3		88.1	3.0	120
July 1		4	32	49	14						84.0	1.4	120
July 6	1	9	37	32	16	5					83.9	2.0	120
July 11				10	34	45	10				87.6	1.6	105
July 16					8	20	18	10	23	22	92.2	3.2	119
July 21				4	29	23	15	15	13		89.5	3.0	68
July 26		2	6	28	25	27	10	1			86.6	2.7	120
July 31				5	22	50	11	10	2		88.5	2.1	120
August 3					3	7	57	29	3	1	91.0	1.5	72

Table XXVI

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Middle Layer Outer Carton West Face - Air

Temperature (°F)

Period Ending	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	$\bar{x}$	s_x	N
June 26		2	9	17	22	20	18	7	4			87.6	3.2	120
July 1	3	16	29	31	18	2						83.5	2.2	120
July 6	2	26	17	29	14	9	2					83.7	2.7	120
July 11			1	14	37	38	9	1				87.4	1.7	105
July 16					8	14	18	17	18	23	2	92.6	3.3	119
July 21				6	18	25	27	15	9			89.6	2.6	67
July 26		6	12	25	19	17	12	4	3			86.4	3.5	120
July 31				8	18	34	25	10	2	2		88.9	2.5	120
August 3				6	11	31	30	19	1	1		89.7	2.3	72

Table XXVII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Middle Layer Outer Carton West Face - Food

Temperature (^{o}F)

Period Ending	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	$\bar{x}$	S_x	N
June 26		2	7	17	21	24	17	8	3			87.7	3.1	120
July 1	2	9	33	36	19							83.7	1.9	120
July 6	1	23	23	29	16	7	1					83.7	2.5	120
July 11			1	12	39	39	9					87.4	1.6	105
July 16					8	16	18	16	18	22	2	92.5	3.3	119
July 21				6	16	28	24	15	10			89.6	2.7	67
July 26		5	8	29	17	22	9	5	2			86.6	3.3	120
July 31				6	19	36	26	10	3			89.0	2.4	120
August 3				1	10	31	39	17	1	1		89.9	2.0	72

Table XXVIII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Stack Center Carton Air

Temperature ($^{\circ}F$)

Period Ending	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	$\bar{x}$	S_x	N
June 26		5	18	22	19	21	14			88.1	2.8	120
July 1	3	25	60	12						84.1	1.3	120
July 6	8	35	40	15	1	1				83.8	1.7	120
July 11			17	30	44	9				87.4	1.7	105
July 16				8	21	17	13	21	21	92.1	3.2	119
July 21			3	28	25	15	15	13		89.5	2.9	67
July 26	2	4	25	29	31	9				86.7	2.2	120
July 31			2	23	51	15	8			88.4	1.8	120
August 3					17	76	4	1	1	90.3	1.2	72

Table XXIX

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Bottom Center Carton Air

Temperature (°F)

Period Ending	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	$\bar{x}$	S_x	N
June 26			1	5	23	17	18	22	9	4			87.9	3.1	120
July 1	2	7	20	23	37	11							82.9	2.4	120
July 6	1	4	19	25	37	11	2						83.3	2.3	120
July 11			2	8	11	34	37	7					86.8	2.2	105
July 16						8	21	16	13	18	23	1	92.2	3.3	119
July 21					1	31	28	13	2	13			89.3	2.9	67
July 26			2	6	22	32	27	10					86.5	2.3	120
July 31					3	21	58	12	5				88.3	1.6	120
August 3							47	47	4	1			89.7	1.2	72

Table XXX

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Center of Lower Surface of Tarpaulin Cover

Temperature (^{o}F)

Period Ending	50-9	60-9	70-9	80-9	90-9	100-9	110-9	120-9	130-9	140-9	150-9	$\bar{x}$	s_x	N
June 26	12	15	16	11	9	3	5	11	11	6	1	93.3	30.0	120
July 1	12	17	18	9	5	7	7	9	9	4		90.6	28.0	120
July 6	7	23	17	11	3	6	6	8	11	6	1	92.3	28.8	120
July 11	1	18	18	15	5	10	8	10	10	4	2	96.1	27.1	105
July 16			8	35	16	7	4	8	10	10	2	103.5	23.7	119
July 21			21	36	9	12	9	10		1	1	94.5	18.9	67
July 26		7	26	26	9	4	7	9	9	2		94.0	22.5	120
July 31		1	28	24	8	9	5	7	10	4	1	97.4	23.5	120

Table XXXI

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Air Under Foil - West Side

Temperature (°F)

Period Ending	68-9	70-1	72-3	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	$\bar{x}$	S_x	N
June 26	1	2	4	3	7	8	7	5	8	7	7	12	5	7	4	4	5	2		1	86.6	8.5	120
July 1			4	12	10	7	11	10	8	8	8	13	7								82.7	6.1	120
July 6			2	5	12	9	10	8	10	11	6	10	12	4							84.0	6.3	120
July 11					6	10	9	9	8	9	12	7	8	7	8	4	2				87.3	6.6	105
July 16									6	11	13	11	11	8	12	7	9	8	3	2	93.7	5.9	119
July 21							9	10	18	12	6	10	13	12	9						88.4	5.0	67
July 26					10	11	7	14	10	12	8	7	12	3	3	2	1				85.5	7.4	120
July 31																							
August 3						3	3	10	14	14	10	10	10	17	4	1					89.2	8.5	72

Table XXXII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly with Foil Stack - Air Under Fiberboard Sleeve of Top Carton

Temperature (^{o}F)

Period Ending	72-3	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	$\bar{x}$	S_x	N
June 26	3	3	7	8	7	9	8	7	9	9	7	6	4	5	3	2		1	86.8	7.9	120
July 1	6	14	6	11	10	8	8	4	7	11	10	4							82.9	6.8	120
July 6	3	6	11	11	7	11	9	8	7	4	9	9	2	2					84.4	6.9	120
July 11	2	2	4	11	9	8	7	9	7	10	9	8	10	4	1				87.1	7.0	105
July 16						1	8	10	13	10	13	6	10	9	7	7	5	2	93.5	6.1	119
July 21					7	9	19	13	7	9	9	16	9						88.6	5.0	67
July 26			13	7	8	12	10	12	9	9	8	4	3	1	2				85.4	6.2	120
July 31																					
August 3				6	3	8	12	12	12	8	11	14	7						88.6	9.1	72

Table XXXIII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Top Center Carton Air

Temperature (°F)

Period Ending	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	$\bar{x}$	S_x	N
June 26			1	6	6	10	14	12	13	11	16	7	4	1				89.7	5.0	120
July 1		2	8	12	14	17	14	17	10	3								84.9	4.0	120
July 6	1	5	10	12	12	16	16	12	9	5	2							84.7	4.5	120
July 11				1	10	10	16	17	15	15	14	1						88.9	3.9	105
July 16						2	5	4	13	15	17	13	13	13	2	2		94.9	4.5	119
July 21					3	4	16	18	21	21	18							90.1	3.3	68
July 26			4	7	12	15	14	17	15	7	2	6						87.2	4.5	120
July 31					2	7	16	14	16	17	8	10	2	2	2	2	2	91.4	5.1	120
August 3						5	5	14	26	18	10	7	5	8				92.0	4.1	72

Table XXXIV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Top Center Carton - Air Outside Ration Package

Temperature (^{o}F)

Period Ending	72-3	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	$\bar{x}$	s_x	N
June 26				5	7	5	10	11	7	12	8	9	7	11	3	2				90.0	6.4	120
July 1		3	7	8	12	13	9	10	13	14	8	2								84.8	5.2	120
July 6	1	3	6	10	9	11	10	13	16	7	7	6	2							85.0	5.6	120
July 11				1	6	10	10	12	9	14	14	7	9	6						89.1	5.1	105
July 16							2	2	8	14	12	15	15	13	9	7	2	1		95.1	4.7	119
July 21						1	7	18	13	18	22	13	7							90.4	3.6	68
July 26				2	8	14	17	13	12	14	6	7	2	1	3					87.4	4.9	120
July 31						1	4	15	17	15	12	8	13	4	5	2		2	3	92.5	5.7	120
August 3							8	12	18	15	15	11	7	8	1					90.2	4.9	72

Table XXXV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Top Center Carton Food

Temperature (^{o}F)

Period Ending	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100 -1	102 -3	104 -5	$\bar{x}$	s_x	N
June 26				5	10	7	17	10	14	12	14	5	5	1			89.6	4.9	120
July 1		3	12	9	17	15	15	17	11	1							84.6	4.0	120
July 6	1	5	11	14	7	18	17	12	7	5	2						84.5	4.6	120
July 11				1	11	12	16	14	17	15	11	1					88.6	3.9	105
July 16					1	2	3	6	13	15	18	14	13	11	4		94.6	4.4	119
July 21					3	7	12	22	26	19	10						89.8	2.9	68
July 26			3	8	10	20	15	15	18	3	3	4					86.8	4.2	120
July 31					1	4	18	19	26	12	4	7	4	4		1	90.7	4.2	120
August 3						5	7	15	30	15	8	8	4	5			91.6	3.8	72

Table XXXVI

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Top Southwest Corner Carton - Air

Temperature (°F)

Period Ending	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	$\bar{x}$	S_x	N
June 26		1	4	5	5	12	9	8	12	13	6	9	11	3					89.9	6.0	120
July 1	2	2	12	12	12	11	15	14	13	7									84.9	4.6	120
July 6	2	7	9	10	11	10	14	13	8	8	5	2							85.4	5.4	120
July 11				3	9	12	12	10	16	12	12	9	2						89.4	4.7	105
July 16					1	2	2	8	9	13	13	17	12	10	9	2	1	1	95.6	5.0	119
July 21					1	9	12	15	18	19	16	6	4						90.8	3.8	68
July 26			3	9	11	15	11	12	12	10	7	1	2	3	2				87.9	5.6	120
July 31				1	1	6	12	11	20	6	3	6	10	10	3	4	1	6	93.9	6.9	120
August 3					1	5	7	15	22	14	8	7	4	7	5	1	1		92.5	5.3	72

Table XXXVII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Middle Layer Outer Carton West Face - Air

Temperature (°F)

Period Ending	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	$\bar{x}$	S_x	N
June 26		2	5	5	12	17	11	13	12	11	7	3			89.2	5.0	120
July 1	1	4	21	17	20	15	14	8							84.4	3.4	120
July 6	3	10	16	12	12	20	11	8	7	1					84.7	4.4	120
July 11				7	14	20	17	16	15	8	3				88.7	3.6	105
July 16					2	2	10	8	17	18	19	13	7	2	94.3	4.0	119
July 21					3	21	26	19	23	7					89.6	2.7	68
July 26		2	7	11	22	20	16	12	5	5					86.5	3.7	120
July 31					7	18	31	27	7	6	1	3			89.5	3.0	120
August 3					7	8	39	24	19	3					89.5	2.3	72

Table XXXVIII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Middle Layer Outer Carton West Face - Food

Temperature (^{o}F)

Period Ending	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	$\bar{x}$	s_x	N
June 26			2	7	12	14	18	16	14	8	7			89.2	4.1	120
July 1		2	18	17	25	16	21							84.5	2.9	120
July 6	1	8	18	15	19	11	17	9	2					84.5	3.8	120
July 11				5	16	18	23	17	16	4	1			88.5	3.1	105
July 16					2	2	11	9	18	22	17	13	7	93.9	3.7	119
July 21					3	22	31	18	18	9				89.4	2.7	68
July 26			7	10	22	22	21	11	5	2				86.5	3.2	120
July 31				5	16	43	21	7	3	3	1			89.3	2.6	120
August 3					3	12	36	32	17					89.5	1.9	72

Table XXXIX

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Second Layer Center Carton Air

Temperature (^{o}F)

Period Ending	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	$\bar{x}$	s_x	N
June 26				4	22	23	12	23	14	1			90.0	3.0	120
July 1			7	32	42	19							85.9	1.7	120
July 6	2	12	25	25	17	16	3						84.5	2.7	120
July 11				1	19	30	46	5					89.0	1.6	105
July 16					4	11	13	19	10	28	12	2	93.7	3.5	119
July 21				1	15	32	19	15	16	1			90.3	2.7	68
July 26		2	6	17	30	24	14	6					87.2	2.7	120
July 31					9	33	47	7	1	2			89.7	1.8	120
August 3						7	62	31					90.9	1.2	72

Table XL

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Stack Center Carton Air

Temperature (^{o}F)

Period Ending	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	$\bar{x}$	s_x	N
June 26				8	33	9	21	17	11			89.3	3.0	120
July 1			10	41	44	4						85.4	1.5	120
July 6	1	11	27	29	19	12						84.3	2.3	120
July 11				4	24	41	29	3				88.5	1.7	105
July 16					4	13	12	18	19	19	13	93.4	3.5	119
July 21				1	22	34	12	13	18			89.9	2.8	68
July 26			2	6	16	32	28	11	4			87.1	2.5	120
July 31				2	6	49	39	3				89.1	1.3	120
August 3					4	26	68	1				89.8	1.0	72

Table XLI

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Bottom Center Carton Air

Temperature (°F)

Period Ending	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	$\bar{x}$	s_x	N
June 26			3	9	24	21	12	19	3	8			87.4	3.5	120
July 1	1	2	28	22	26	22							83.2	2.4	120
July 6	2	10	20	24	21	13	8	1					83.1	3.0	120
July 11				11	14	28	29	15	2				87.0	2.4	105
July 16					2	3	15	11	18	21	18	12	93.1	3.5	119
July 21					3	25	37	10	16	9			89.2	2.7	68
July 26			6	7	26	28	21	8	3				86.3	1.7	120
July 31					3	21	55	15	4	2			88.5	1.7	120
August 3					1	22	51	22	33				88.5	1.5	72

Table XLII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Center of Lower Surface of Tarpaulin Cover

Temperature (°F)

Period[a] Ending	50-9	60-9	70-9	80-9	90-9	100-9	110-9	120-9	130-9	140-9	$\bar{x}$	s_x	N
June 26	2	17	22	15	9	6	7	9	11	2	92.5	25.0	120
July 1		24	23	15	16	5	12	4	1		85.5	19.1	120

[a] Data for periods after July 1 are missing.

Table XLIII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Air Under Fiberboard Sleeve of Top Carton - East Side

Temperature (^{o}F)

Period Ending	66 -7	68 -9	70 -1	72 -3	74 -5	76 -7	78 -9	80 -1	82 -3	84 -5	86 -7	88 -9	90 -1	92 -3	94 -5	96 -7	98 -9	100 -1	102 -3	104 -5	106 -7	108 -9	110 -1	112 -3	114 -5	116 -7	118 -9	$\bar{x}$	s_x	N
June 26	2	2	1	7	7	3	6	4	5	4	5	4	5	3	2	7	5	5	3	7	3	5	1	2			1	89.9	12.6	120
July 1	1	7	7	8	4	7	4	6	5	4	5	4	4	7	8	9	4	3		2								84.3	10.3	120
July 6	2	2	7	8	5	3	6	7	6	7	5	2	5	4	7	4	7	6	5	1								85.2	10.6	120
July 11			1	5	7	4	4	7	7	7	6	4	7	5	7	5	7	8	5	6	3							89.1	10.2	105
July 16									3	5	11	13	9	8	6	3	6	5	7	7	7	7	2	1	1			95.6	8.3	119
July 21							3	10	13	13	7	10	6	4	6	10	9	4	3									89.2	6.8	68
July 26					7	10	9	8	7	10	5	7	5	5	5	7	6	2	3	1	1							86.5	8.4	120
July 31																														
Aug 3							1	4	18	10	10	8	10	7	7	3	1	10	3	1	1	1						90.2	10.3	72

Table XLIV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Raised Fly Stack - Air Under Fiberboard Sleeve of Top Carton - West Side

Temperature (°F)

Period Ending	64 -5	66 -7	68 -9	70 -1	72 -3	74 -5	76 -7	78 -9	80 -1	82 -3	84 -5	86 -7	88 -9	90 -1	92 -3	94 -5	96 -7	98 -9	100 -1	102 -3	104 -5	106 -7	108 -9	110 -1	112 -3	114 -5	$\bar{x}$	S_x	N
June 26	1	2	2		7	4	6	6	2	6	3	7	3	4	3	7	4	5	6	5	5	2	7	1	1		89.4	12.3	120
July 1		1	7	6	8	5	8	2	6	7	4	5	4	3	8	6	12	5	1	2							84.1	10.2	120
July 6		2	2	6	9	5	3	7	6	7	7	4	2	6	3	5	7	7	4	6	1						85.3	10.5	120
July 11				1	4	9	3	4	8	7	5	7	5	8	4	7	5	7	7	5	6	4					89.2	10.2	105
July 16										2	6	11	12	10	8	6	3	6	6	6	6	8	7	2	1	1	95.7	8.3	119
July 21								3	6	18	12	9	10	6	3	6	10	7	7	3							89.4	6.9	68
July 26						6	12	5	11	8	8	7	7	6	5	4	4	8	3	1	2	1	1				87.0	8.6	120
July 31																													
Aug 3									5	12	15	5	12	8	7	6	3	3	8	4	3	1	1				90.5	10.6	72

Table XLV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Tight Paulin Stack - Top Center Carton Air

Temperature (^{o}F)

Period Ending	84 -5	86 -7	88 -9	90 -1	92 -3	94 -5	96 -7	98 -9	100 -1	102 -3	104 -5	106 -7	108 -9	110 -1	112 -3	114 -5	116 -7	118 -9	$\bar{x}$	S	N
June 26	2	4	4	7	6	9	8	7	7	8	5	7	12	7	5				100.0	7.7	120
July 1	7	7	10	7	9	5	8	7	5	9	7	5	7	7					97.2	8.0	120
July 6	5	7	9	7	11	5	9	7	7	5	7	5	12	3					97.3	7.9	120
July 11		1	6	7	8	9	9	10	4	8	9	4	9	8	9	2			100.9	7.8	105
July 16					1	6	6	12	11	10	7	7	13	4	10	6	4	4	105.3	6.8	119
July 21				3	3	10	15	9	13	4	9	7	9	4	9	4			102.3	6.6	68
July 26		2	5	5	12	7	13	8	8	8	6	6	10	3	3	2			99.8	7.1	120
July 31			2	6	8	11	11	12	10	8	7	4	12	4	1	2	1		100.3	6.5	120
Aug 3				1	10	17	12	8	11	17	6	5	8	4					99.9	5.4	72

Table XLVI

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Tight Paulin Stack - Top Center Carton - Air Outside Ration Package

Temperature (°F)

Period Ending	82 -3	84 -5	86 -7	88 -9	90 -1	92 -3	94 -5	96 -7	98 -9	100 -1	102 -3	104 -5	106 -7	108 -9	110 -1	112 -3	114 -5	116 -7	118 -9	120 -1	122 -3	124 -5	126 -7	128 -9	$\overline{x}$	S_x	N
June 26	3	4	7	6	9	7	6	4	6	2	6	2	4	2	5	5	2	6	7	2	3			1	101.1	12.1	120
July 1	4	12	6	8	10	4	6	5	3	2	5	2	3	4	2	6	2	5	3	4		2			98.5	12.2	120
July 6	5	7	11	8	7	8	7	2	3	3	2	3	5	2	2	3	4	2	7	4	2				98.7	12.4	120
July 11		4	9	6	9	7	7	5	5	6	4	2	4	2	6	2	3	4	6	4	2	4	4		102.3	12.8	105
July 16				1		5	8	12	11	10	5	7	3	3	2	4	2	2	5	6	2	5	2	3	106.5	10.9	119
July 21					.7	10	15	10	9	7	4	1	4	6	3	4	1	6	3		3	3	1		102.6	10.0	68
July 26			3	4	6	11	10	16	7	6	3	2	4	4	4	2	3	2	6	2	2	2			101.3	10.1	120
July 31				3	15	8	7	12	9	5	2	5	3	7	2	2	5	2	8	1		1	1		101.5	9.9	120
Aug 3					10	17	11	5	8	12	3	5		11	1		1		7	5	1				101.3	9.4	72

Table XLVII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Tight Paulin Stack - Top Center Carton Food

Temperature (°F)

Period Ending	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	112-3	114-5	116-7	118-9	$\bar{x}$	s_x	N
June 26	2	2	2	7	7	9	7	10	9	8	7	7	12	8	1				100.3	7.0	120
July 1	2	4	8	10	9	10	6	8	9	7	12	3	7	3					97.6	7.1	120
July 6		7	9	8	9	8	7	12	6	7	7	7	11						97.6	7.0	120
July 11			3	8	9	7	9	12	9	6	6	7	13	7	7				101.0	7.1	105
July 16					1	3	7	8	16	8	7	8	13	11	7	5	5	2	105.5	6.3	119
July 21				1	1	6	13	12	13	7	10	6	19	4	6				102.8	5.6	68
July 26		1	2	4	7	9	12	14	16	7	5	7	12	2	2	1			100.2	6.0	120
July 31				2	5	12	12	17	21	5	2	5	15		1	1			100.2	5.2	120
Aug 3					4	15	15	11	33	7	3	3	8						99.5	4.1	72

Table XLVIII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Tight Paulin Stack - Top Southwest Corner Carton - Air

Temperature (°F)

Period Ending	72-3	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	112-3	114-5	116-7	118-9	120-1	122-3	124-5	$\bar{x}$	s_x	N
June 26	1	2	1	7	2	5	4	3	6	5	3	6	6	4	2	7	5	5	9	2	3	4	3	3				97.0	12.3	120
July 1	2	4	6	4	6	5	3	5	4	7	2	5	6	2	6	6	7	3	4	5	4	3	1					93.9	12.3	120
July 6	1	3	3	4	8	5	2	6	5	4	5	5	2	5	4	3	4	4	7	4	5	3	5					95.3	12.8	120
July 11				6	2	6	7	3	7	3	7	4	3	5	5	3	5	7	6	4	3	4	5	8	2			99.2	12.8	105
July 16									2	8	8	6	8	8	5	5	2	6	5	5	4	5	5	2	5	4	5	104.9	10.8	119
July 21						1	3	6	6	12	6	7	6	9	3	4	1	3	10	4	1	6	3	4	3			100.2	10.5	68
July 26				1	3	4	4	5	7	12	6	7	3	8	5	2	4	4	7	5	1	3	3	5				97.7	10.9	120
July 31					3	2	1	8	7	8	5	6	5	11	6	1	5	2	7	1	5	10	2	2		2		99.4	10.9	120
Aug 3					1		3	4	5	19	1	4	5	7	6	5	10	4	7		4	1	4	3	3		1	99.9	10.4	72

Table XLIX

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Tight Paulin Stack - Middle Layer Outer Carton West Face - Air

Temperature (°F)

Period Ending	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	112-3	114-5	116-7	$\bar{x}$	S_x	N
June 26		2	5	12	12	14	7	11	9	9	7	8	3	1				97.4	6.0	120
July 1	2	3	18	14	14	9	9	8	7	5	5	4						94.4	5.6	120
July 6	5	10	14	10	10	10	12	7	7	4	5	3	2					94.2	6.3	120
July 11				10	12	15	11	10	11	6	9	4	6	3	2			98.6	5.9	105
July 16				1	2	6	8	8	16	16	7	10	12	4	5	3	2	103.6	5.8	119
July 21				1	1	10	16	18	22	10	13	4	3					99.8	4.0	68
July 26		1	1	7	8	15	22	12	13	6	3	3	7					97.8	4.9	120
July 31				2	10	17	17	22	15	5	2	6	4					98.3	4.0	120
Aug 3				1		18	28	17	15	7	4	3	7					98.9	4.0	72

Table L

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Tight Paulin Stack - Middle Layer Outer Carton West Face - Food

Temperature (°F)

Period Ending	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	112-3	114-5	$\bar{x}$	S_x	N
June 26	1	2	4	11	13	12	11	10	12	9	9	4	1				97 0	5.2	120
July 1	2	3	15	14	17	12	9	8	8	6	5						94.2	5.0	120
July 6	4	9	12	13	11	13	10	8	7	5	4	2					93.9	5.6	120
July 11				9	11	14	16	10	10	10	6	8	3	1			98.2	5.2	105
July 16				1	2	5	8	9	15	17	8	10	12	7	3	2	103.1	5 3	119
July 21				1	1	9	18	21	21	12	13	4					99.5	3.5	68
July 26		1	1	4	11	17	21	15	11	7	3	4	5				97.7	4.7	120
July 31					11	18	19	16	13	7	10	2	2				98.4	4.0	120
Aug 3					3	14	35	14	14	8	5	7					98.6	3.6	72

Table LI

Percentage Frequencies, Means, and Standard Deviations of Hourly Observations by Five Day Periods

Tight Paulin Stack - Second Layer Center Carton Air

Temperature (°F)

Period[a] Ending	92-3	94-5	96-7	98-9	100-1	102-3	$\bar{x}$	S_x	N
July 26	1	2	2	34	52	9	99.7	1.6	120
July 31		2	6	75	17	1	98.6	1.1	120
Aug 3		1	7	61	31		98.9	1.0	72

[a]Data are missing for periods prior to July 26.

Table LII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Tight Paulin Stack - Stack Center Carton Air

Temperature (°F)

Period Ending	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	$\bar{x}$	s_x	N
June 26	1	10	10	16	46	17				91.5	2.3	120
July 1			5	61	34					91.2	1.0	120
July 6		9	72	19						88.7	1.0	120
July 11			7	43	11	37	2			92.1	2.1	105
July 16	1			2	18	33	24	21	1	95.4	2.3	119
July 21					1	15	41	37	6	97.0	1.7	68
July 26					2	17	52	20	9	96.8	1.8	120
July 31				17	28	28	12	14	1	94.1	2.5	120
Aug 3					4	50	44	1		95.4	1.1	72

Table LIII

Percentage Frequencies, Means, and Standard Deviations of Hourly Observations by Five Day Periods

Tight Paulin Stack - Bottom Center Carton Air

Temperature (°F)

Period Ending	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	$\bar{x}$	s_x	N
June 26			9	11	41	28	11				88.9	2.1	120
July 1			8	60	30						87.0	1.1	120
July 6		1	49	33	16						85.8	1.5	120
July 11				23	29	39	9				89.2	1.8	105
July 16	1				2	25	25	18	27	1	93.3	2.6	119
July 21					4	41	12	21	22		92.9	2.5	68
July 26				2	9	30	39	17	3		91.8	2.0	120
July 31					5	36	29	25	5		92.3	2.0	120
Aug 3						39	51	8	1		91.9	1.4	72

Table LIV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Tight Paulin Stack - Center of Lower Surface of Tarpaulin Cover

Temperature (°F)

Period Ending	50-9	60-9	70-9	80-9	90-9	100-9	110-9	120-9	130-9	140-9	150-9	160-9	170-9	$\bar{x}$	s_x	N
June 26	2	20	19	10	4	5	5	9	11	8	4	1	1	99.0	31.7	120
July 1	3	27	16	7	7	7	7	7	7	8	4	1	1	95.9	31.8	120
July 6	1	26	19	7	7	6	7	5	6	7	8	2		97.2	32.7	120
July 11		17	20	10	9	5	6	7	7	6	9	4	1	101.9	32.7	105
July 16			5	35	15	7	6	8	8	5	8	2		106.7	26.7	119
July 21			18	34	12	9	6	10	4	4	3			98.5	22.4	68
July 26		3	22	26	12	7	7	3	7	7	5			99.3	25.9	120
July 31			27	24	8	7	11	7	5	7	2	2		101.1	25.6	120
Aug 3			8	42	10	12	7	5	3	6	7			101.3	24.3	72

Table LV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Tight Paulin Stack - Air One Half Inch Below Center of Tarpaulin

Temperature (°F)

Period[a] Ending	70-9	80-9	90-9	100-9	110-9	120-9	130-9	140-9	$\bar{x}$	s_x	N
July 26	4	32	27	10	8	12	7	1	99.9	18.0	120
July 31	1	38	19	10	10	10	9	2	101.8	18.3	120
Aug 3		32	25	19	6	4	12	1	101.8	17.4	72

----

[a] Data are missing for periods prior to July 26.

Table LVI

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Open Stack - Outside Air

Temperature (°F)

Period Ending	66-7	68-9	70-1	72-3	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-1	112-3	114-5	$\overline{x}$	s_x	N
June 26	1		2	4	6	3	3	5	2	6	5	8	7	6	6	6	6	5	6	2	2	3	4	2	1	90.9	11.7	120
July 1		2	5	6	9	2	6	7	6	7	7	1	7	7	6	10	9	5								85.9	9.6	120
July 6		1	5	5	5	7	2	4	7	8	3	5	7	5	5	5	12	7	6							87.6	9.9	120
July 11			2		7	3	6	6	7	4	5	4	7	7	4	5	7	7	7	7	3					90.3	10.2	120
July 16								2		2	3	7	9	9	9	10	8	9	5	7	6	8	4	1		97.6	7.5	120
July 21						1	2	4	7	15	12	7	9	6	8	7	11	8	2							90.5	6.7	120
July 26						3	10	9	7	9	7	8	7	4	7	7	8	6	2	5						89.3	8.1	120
July 31						1		7	7	5	8	9	7	8	11	7	10	6	8	3	2					92.6	7.2	120
Aug 3									4	5	7	14	12	7	11	10	11	7	10	1						93.4	5.8	72

Table LVII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Open Stack - Top Center Carton Air

Temperature (°F)

Period Ending	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	$\bar{x}$	s_x	N
June 26		3	3	5	6	10	8	9	11	13	8	8	9	7	1				90.2	6.5	120
July 1	2	6	8	14	10	8	8	12	10	14	8								85.8	5.7	120
July 6	1	7	7	9	8	10	12	11	12	11	7	5	1						86.5	5.9	120
July 11				7	9	10	9	9	11	9	11	11	9	4	12	5	7	3	90.5	5.8	105
July 16					1		2	5	8	9	13	14	12	9					97.5	5.6	119
July 21					3	6	9	13	10	12	13	13	18	3					92.5	4.7	68
July 26		1	6	7	8	11	8	12	10	11	8	9	7	2					88.8	6.0	120
July 31			1	2	8	7	12	10	17	12	10	12	5	3					90.4	5.2	120
Aug 3					1	5	17	11	17	17	21	10	1						91.0	3.7	72

Table LVIII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Open Stack - Top Center Carton - Air Outside Ration Package

Temperature (^{o}F)

Period Ending	50-9	60-9	70-9	80-9	90-9	100-9	110-9	120-9	130-9	$\bar{x}$	S_x	N
June 26	3	17	17	15	9	22	13	2		88.7	18.8	120
July 1	5	22	18	11	13	17	12	2		85.7	19.4	120
July 6	1	22	21	12	12	12	14	6		87.2	20.0	120
July 11		16	22	13	9	15	13	8	3	91.6	20.2	105
July 16			2	37	19	13	16	10	2	98.8	15.4	119
July 21			18	37	16	18	7	4		91.8	13.0	68
July 26			27	33	12	14	10	3		90.5	14.8	120
July 31			27	24	20	20	7	2		91.3	13.5	120
Aug 3			11	36	25	19	8			92.3	11.3	72

Table LIX

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Open Stack - Top Center Carton Food

Temperature (°F)

Period Ending	74-5	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	$\bar{x}$	s_x	N
June 26		3	3	3	6	11	10	8	18	9	5	12	8	4					90.0	6.0	120
July 1	1	5	8	11	12	11	9	14	17	10	2								85.6	5.0	120
July 6		7	7	11	9	9	10	17	14	7	7	1							86.1	5.3	120
July 11				4	9	9	11	11	10	15	10	11	7						90.0	5.1	105
July 16					1	1	1	5	7	9	16	13	15	12	9	9	2	1	97.0	5.2	119
July 21					1	3	9	13	12	18	16	19	9						92.4	4.0	68
July 26		1	5	7	6	12	12	13	14	10	10	6	4						88.4	5.2	120
July 31				2	6	9	14	14	22	13	10	4	5						89.8	4.2	120
Aug 3						5	10	19	35	21	4	5							90.2	2.8	72

Table LX

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Open Stack - Top Southwest Corner Carton - Air

Temperature (°F)

Period Ending	70 -1	72 -3	74 -5	76 -7	78 -9	80 -1	82 -3	84 -5	86 -7	88 -9	90 -1	92 -3	94 -5	96 -7	98 -9	100 -1	102 -3	104 -5	106 -7	108 -9	110 -1	112 -3	$\bar{x}$	S_x	N
June 26	2	2	3	4	7	4	7	7	7	8	7	10	9	2	7	5	3	5					88.9	8.8	120
July 1	2	7	7	7	6	7	7	7	7	7	10	9	5	7	2								84.8	7.9	120
July 6	2	6	6	7	8	6	8	5	10	7	9	7	7	4	4	5							85.6	8.1	120
July 11				6	6	8	8	6	9	7	8	9	9	8	5	9	7						89.8	7.9	105
July 16						1		2	2	8	9	11	8	9	8	8	12	4	6	8	2	2	97.7	7.0	119
July 21							4	6	15	9	13	9	9	9	9	13	4						92.5	5.9	68
July 26			1	4	5	8	6	12	9	8	12	6	7	8	3	8	2						88.8	7.2	120
July 31					2	13	6	4	11	9	16	6	4	7	12	7		1	2				90.1	6.9	120
Aug 3						3	3	12	10	11	19	11	10	4	5	4	4	3					91.2	5.8	72

Table LXI

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Open Stack - Middle Layer Outer Carton West Face - Air

Temperature (°F)

Period Ending	76 -7	78 -9	80 -1	82 -3	84 -5	86 -7	88 -9	90 -1	92 -3	94 -5	96 -7	98 -9	100 -1	102 -3	104 -5	106 -7	108 -9	110 -1	$\bar{x}$	s_x	N
June 26		2	4	9	9	12	9	11	11	8	7	7	5	2	2				90.5	6.4	120
July 1	2	4	18	15	11	12	8	9	8	7	5								86.3	5.3	120
July 6		12	12	9	12	8	9	13	7	6	5	5	1						87.1	6.0	120
July 11				2	17	17	12	9	9	9	8	3	10	4					91.1	5.7	105
July 16				1		3	1	8	8	12	16	12	14	8	9	4	3	2	98.1	5.6	119
July 21					3	6	13	23	9	19	12	12	3						92.6	4.0	68
July 26		1	5	7	18	9	18	13	7	7	4	2	7						89.0	5.4	120
July 31				1	5	17	25	22	8	7	5	7	3						90.4	4.0	120
Aug 3					5	10	24	33	4	10	7	4	3						90.8	3.8	72

Table LXII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Open Stack - Middle Layer Outer Carton West Face - Food

Temperature (^{o}F)

Period Ending	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	$\bar{x}$	s_x	N
June 26		1	6	6	20	8	17	11	9	8	7	2	3			90.9	5.1	120
July 1	1	8	22	15	14	16	8	16								86.4	4.0	120
July 6		19	8	15	10	13	15	7	9	2	1					87.0	4.8	120
July 11					28	15	14	13	10	9	10					91.0	4.1	105
July 16				1	3	1	8	9	9	20	17	13	9	5	4	97.2	4.7	119
July 21				1	9	13	18	18	19	16	6					92.3	3.4	68
July 26		5	8	17	13	21	9	11	7	7	1					88.4	4.5	120
July 31			1	6	17	23	22	12	8	9	1					90.2	3.4	120
Aug 3				5	5	31	22	17	12	7						90.6	2.9	72

96

Table LXIII

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Open Stack - Second Layer Center Carton Air

Temperature (°F)

Period Ending	76-7	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	$\bar{x}$	s_x	N
June 26			3	3	15	19	14	14	13	13	5					89.0	4.0	120
July 1		4	7	29	26	27	7									84.2	2.4	120
July 6	1	7	13	16	30	12	16	4	1							84.5	3.3	120
July 11				2	15	21	32	21	7	2						88.2	2.4	105
July 16				1		3	7	13	11	21	15	18	9		1	94.6	4.0	119
July 21				1	6	15	23	25	12	18						90.0	3.1	68
July 26		5	7	5	17	20	19	18	7	1						86.8	3.6	120
July 31				3	10	17	28	33	7	2						88.5	2.5	120
Aug 3					10	14	36	39	1							88.7	1.9	72

Table LXIV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Open Stack - Stack Center Carton Air

Temperature (^{o}F)

Period Ending	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	$\bar{x}$	S_x	N
June 26			2	20	12	23	22	18	5			88.8	3.0	120
July 1		5	31	42	22							84.0	1.5	120
July 6	1	21	37	19	11	12						83.5	2.5	120
July 11			1	7	29	50	10	2				87.8	1.6	105
July 16					6	14	13	17	13	26	12	93.3	3.6	119
July 21			3	7	26	21	3	13	22	4		89.8	3.7	68
July 26		2	13	22	27	27	8					86.3	2.5	120
July 31			1	8	24	46	21					88.0	1.8	120
Aug 3			1	7	25	50	15	1				88.1	1.7	72

Table LXV

Percentage Frequencies, Means and Standard Deviations of Hourly Observations by Five Day Periods

Open Stack - Bottom Center Carton Air

Temperature (°F)

Period Ending	78-9	80-1	82-3	84-5	86-7	88-9	90-1	92-3	94-5	96-7	98-9	$\bar{x}$	S	N
June 26		1	11	17	21	14	17	14	15			87.9	3.5	120
July 1	2	20	35	35	8							83.0	1.9	120
July 6	8	29	29	13	10	10						82.9	2.8	120
July 11			5	17	30	39	9					87.0	1.9	105
July 16				2	7	17	8	17	11	28	11	93.1	3.9	119
July 21			1	12	28	16	4	12	22	4		89.6	3.8	68
July 26	1	5	12	27	28	19	7					85.9	2.6	120
July 31			2	13	26	47	11	2				87.7	1.8	120
Aug 3			1	10	28	44	12	4				87.9	2.1	72