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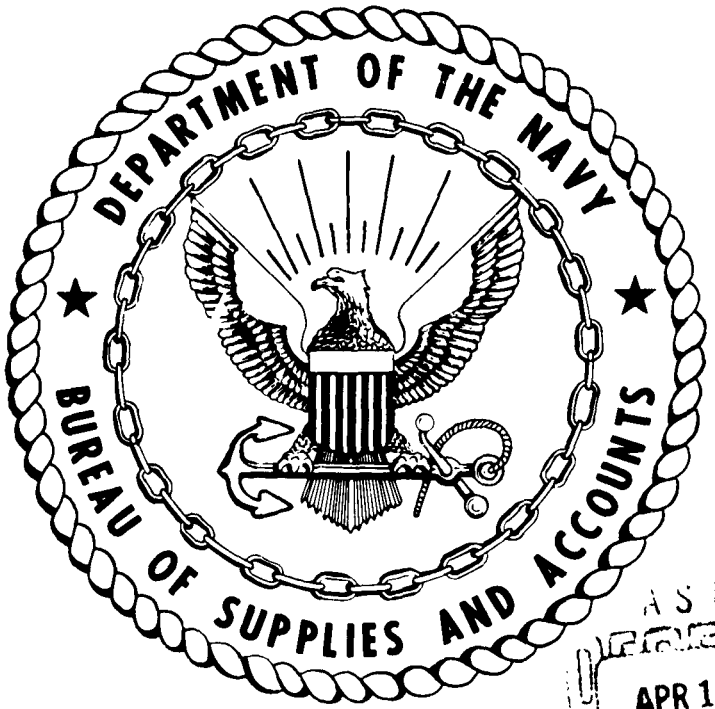
EVALUATION OF NAVAL SHIPBOARD SPECIFICATION GRIDDLES



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TECHNICAL REPORT REVIEW

Evaluation of Naval Shipboard Specification Griddles

Task and Subtask NT-F015-13-001-119-5
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By direction

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Department of the Navy
Washington 25, D. C.

EVALUATION OF NAVAL SHIPBOARD SPECIFICATION GRIDDLES

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EVALUATION OF NAVAL SHIPBOARD SPECIFICATION GRIDDLES

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ABSTRACT

Two Naval shipboard specification griddles, each fabricated by a different manufacturer, were studied to determine conformance with the engineering performance characteristics of the applicable Military Specification MIL-G-21210A(SHIPS) dated 15 July 1959. Also studied were the food preparation characteristics of these griddles. It was found that neither of the two griddles investigated met the engineering characteristics and performance requirements of the specification. The food preparation performance of one of the griddles tested was substantially superior to the other unit. It was considered that the food preparation characteristics relate quite satisfactorily to the specification performance requirements. As a result of deficiencies in the design of the grease drawer in both griddles a recommended change in the specification requirement was submitted.

SUMMARY

PROBLEM

1. To evaluate two Naval specification shipboard griddles (each fabricated by a different manufacturer) for the following:

a. Conformity to Military Specification MIL-G-21210A (SHIPS) dated 13 July 1959.

b. Capability to produce acceptable food items.

2. Determine the adequacy of the current military specification.

CONCLUSIONS

1. Both Griddle "X" and Griddle "Y" did not meet the performance requirements of the applicable specification, and will require design changes in order to conform.

2. The temperature distribution on Griddle "X" was satisfactory except for the two left and right front corner areas; temperature distribution on Griddle "Y" was satisfactory except for the area along the front of the griddle which was low, and the center of the griddle which was high.

3. In addition to the temperature distribution deficiencies, both Griddle "X" and Griddle "Y" have minor design deficiencies. The deficiencies of Griddle "X" relate to the design of the grease drawer; the deficiencies of Griddle "Y" relate to both design of the grease drawer and to thermostat calibration.

4. The food preparation performance of Griddle "X" was superior to the performance of Griddle "Y". All food products prepared on Griddle "X" were considered usable while small but important percentages of food prepared on Griddle "Y" were considered unusable. Also, Griddle "X" produced a considerably more uniform product throughout the griddle surface.

5. The basic provisions and requirements of the current specification are, in general, considered adequate except for a design change in the grease drawer.

RECOMMENDATIONS

1. That both Griddle "X" and Griddle "Y" be modified to eliminate the deficiencies in temperature distribution and in design of the grease drawer so as to conform to Military Specification MIL-G-21210A(SHIPS) dated 13 July 1959.

2. That the requirements specified in paragraph 3.12.5 of MIL-G-21210A be changed to provide a more suitable and safer design for the grease drawer. The 8 qt. capacity of this drawer should be retained; however, the minimum depth should be 5" in lieu of 3" specified. Also, the requirement for a positive locking mechanism should be added. An additional desirable feature of this drawer would be a second handle on the rear to permit carrying this implement in the same manner as a pot.

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EVALUATION OF NAVAL SHIPBOARD SPECIFICATION GRIDDLES

INTRODUCTION

As a result of a continuing program by the Bureau of Supplies and Accounts and the Bureau of Ships to improve electrical galley equipment, the Bureau of Supplies and Accounts authorized the Naval Supply Research and Development Facility to study the functional food preparation characteristics of electrically heated griddles used aboard ship.*

Previous studies conducted by this Facility for the Bureau of Ships on the Type "A" range** and Type "S" range*** established the temperature characteristics required for satisfactory grilling performance. A comprehensive investigation+ on the Navy griddle covered by Specification MIL-C-001218A revealed that the 10 kw (kilowatt) input and temperature distribution pattern were unsatisfactory from the standpoint of producing a uniform product and griddling operation. Based on the unsatisfactory performance, the study recommended that a new griddle be designed and constructed with a minimum power input of 22 watts per square inch. As a direct result of these research studies, the Bureau of Ships prepared a new specification§ for a shipboard griddle. This specification was subsequently revised to provide four thermostatically controlled sections in lieu of two.‡

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*CHBUSANDA ltr W3 A11/2 of 19 Aug 1955.

**Sub-project report CR-55-103, "Evaluation of Navy Standard Type-A Range Manufactured by Associated Products, Inc.", dated 13 Feb 1956

***Subtask 13-001-124(X)Report 81, "Functional Studies of a Type-S Range Manufactured by Associated Products, Inc.", dated 10 Dec 1959.

+Subtask report 13-001-93-17, "Influence of Electrical and Temperature Characteristics of Griddle on Griddling Operation", dated 11 May 1960.

§MIL-G-21210(SHIPS) 5 Mar 1958, "Griddle, Self-Heating, Electrical, Naval Shipboard".

‡MIL-G-21210A(SHIPS) 13 July 1959, "Griddle, Self-Heating, Electrical, Naval Shipboard".

The primary purpose of this investigation was to evaluate the performance of two griddles purchased under this specification* for conformance to specified requirements. A second objective was to determine if the current specification* was adequate to assure the procurement of shipboard griddles with satisfactory food preparation characteristics.

DESCRIPTION OF EQUIPMENT

A. General

For this investigation, two shipboard type griddles were purchased from two different manufacturers willing to make this item for the Navy. The name plate data for each griddle are given below:

Griddle "X"**

Navy Electrical Equipment		
CAT. 101HC7	SER: C-16691-1	YR.Blt: 1959
K.W.: 18.2	V: 440	CIR: AC 3PH. 60 CY.

Griddle "Y"**

Unit: Electric Griddle		
Model: 390N	Serial: 24784	
Volts: 440	Phase 3	Cycle 60 AC
Watts: 19000	Year MFD: 1960	
Cont. No.: 138-2-48167/59		
Shock Modified Hi: 390N-TREV.C		

Figs. 1 and 2, page 3, show the two griddles used for this study.

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*MIL-G-21210A(SHIPS) 13 July 1959, "Griddle, Self-Heating, Electrical, Naval Shipboard".

**Identification of griddle manufacturers can be provided to governmental agencies on a "need to know" basis.

Fig. 1. - Griddle "X". NAVSUPRANDFAC Photo 696-4.

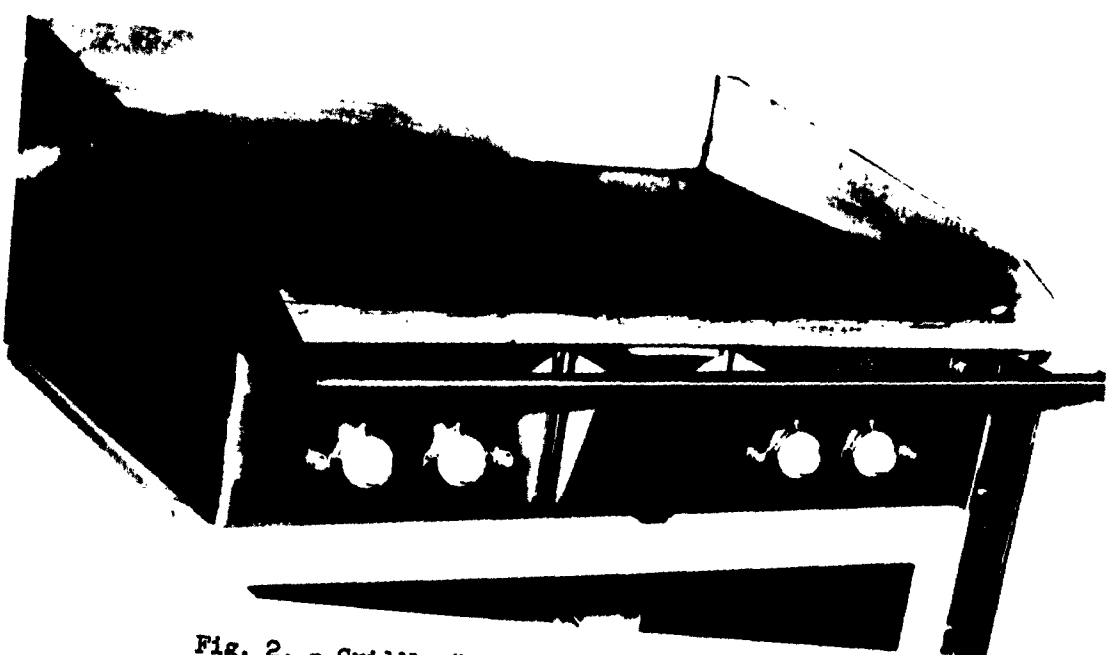

Fig. 2. - Griddle "Y". NAVSUPRANDFAC Photo 696-3.

B. Construction Characteristics

1. Griddle Top

The griddle top is made of heavy sheet steel (boiler plate) and measures 36 inches wide by 24 inches deep. A corrosion-resisting steel splash guard measuring 5 inches high across the rear of the griddle with sides tapering to approximately 2 inches at the front of the griddle, is continuously welded to the griddle surface along the sides and back. The griddle top (with heating elements and insulation) is supported on an enclosed griddle body designed for mounting on a counter or dresser.

2. Grease Trough and Grease Drawer

A grease trough is provided at the front of the griddle with a drain opening which allows grease to drain into an 8-quart capacity grease drawer removable from the front. The grease drawer in Griddle "X" was provided with a locking device, and with baffles. The grease drawer in Griddle "Y" was not provided with baffles.

3. Guardrail

On Griddle "X", a corrosion-resisting steel guardrail, extending beyond the front of the griddle top, is supported by brackets connected to the body. On Griddle "Y" the guardrail is supported by an extension of the side splash guard.

C. Heating Elements and Controls

The griddle top is heated by enclosed conduction-type heating elements clamped to the underside of the griddle and arranged so as to heat the top in four equal sections. Each section, covering the depth of the cooking surface from front to rear, is controlled by a separate thermostatic control marked for temperatures from 200°F. to 450°F. on Griddle "X", and to 425°F. on Griddle "Y". Four red indicator lights (one for each section of the griddle) light up in conjunction with thermostat operation to show when the heating elements are energized.

The right and left halves of the griddle are symmetrical in arrangement of the heating elements and location of the thermostat sensing elements. Fig. 3, page 5 and Fig. 4, page 6, show outline drawings of the heating elements for the two griddles.

Griddle "X" has a total of 14 individual heating elements, three individual rectangular spiral-shaped heating elements for each section, plus one additional element surrounding each half of the griddle. Griddle "Y" has a total of eight individual "hairpin" type heating elements (two for each section).

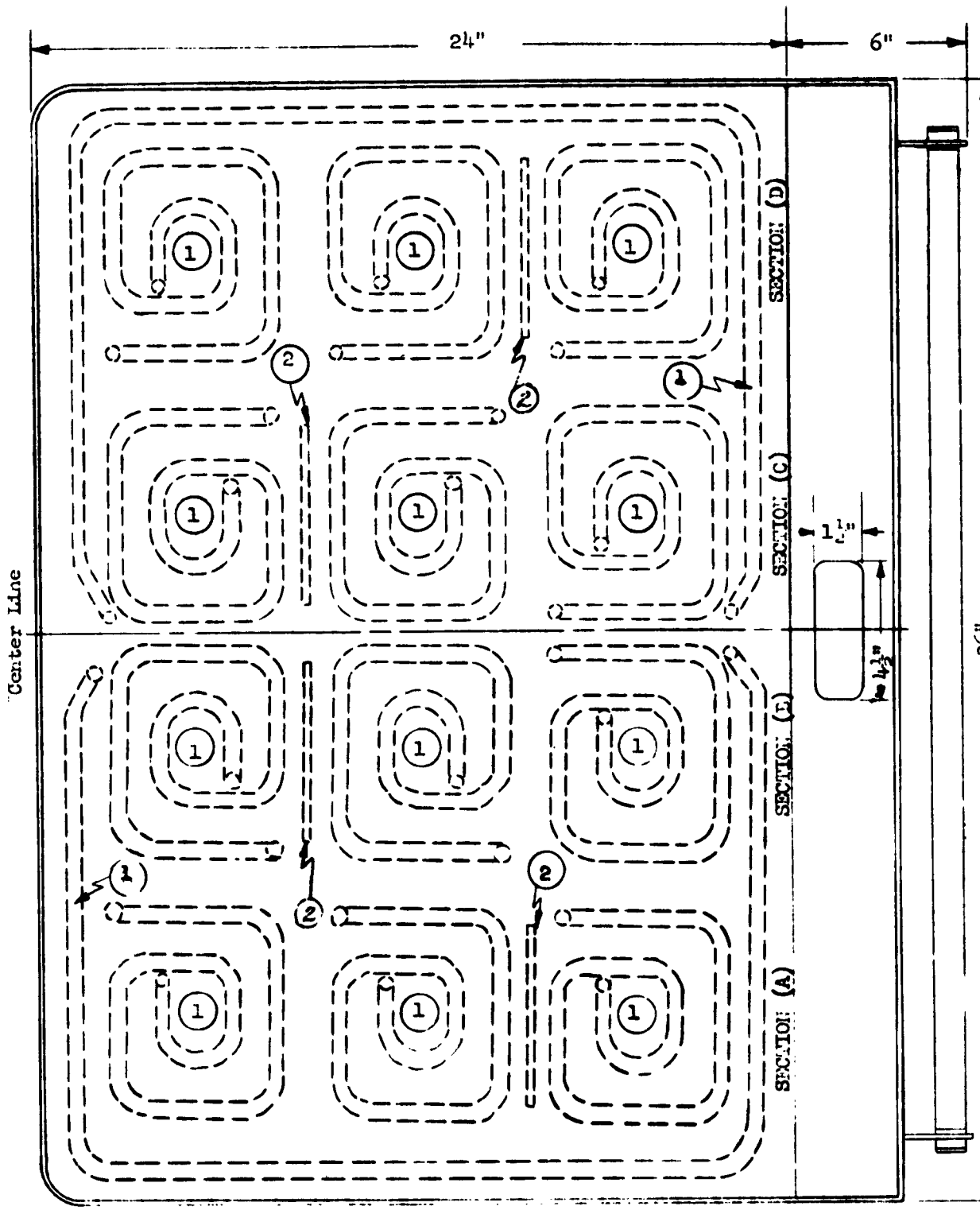

Fig. 3. - Outline drawing of Griddle "X" showing location of heating elements (1), thermostats (2), and griddle sections (A), (B), (C) and (D).

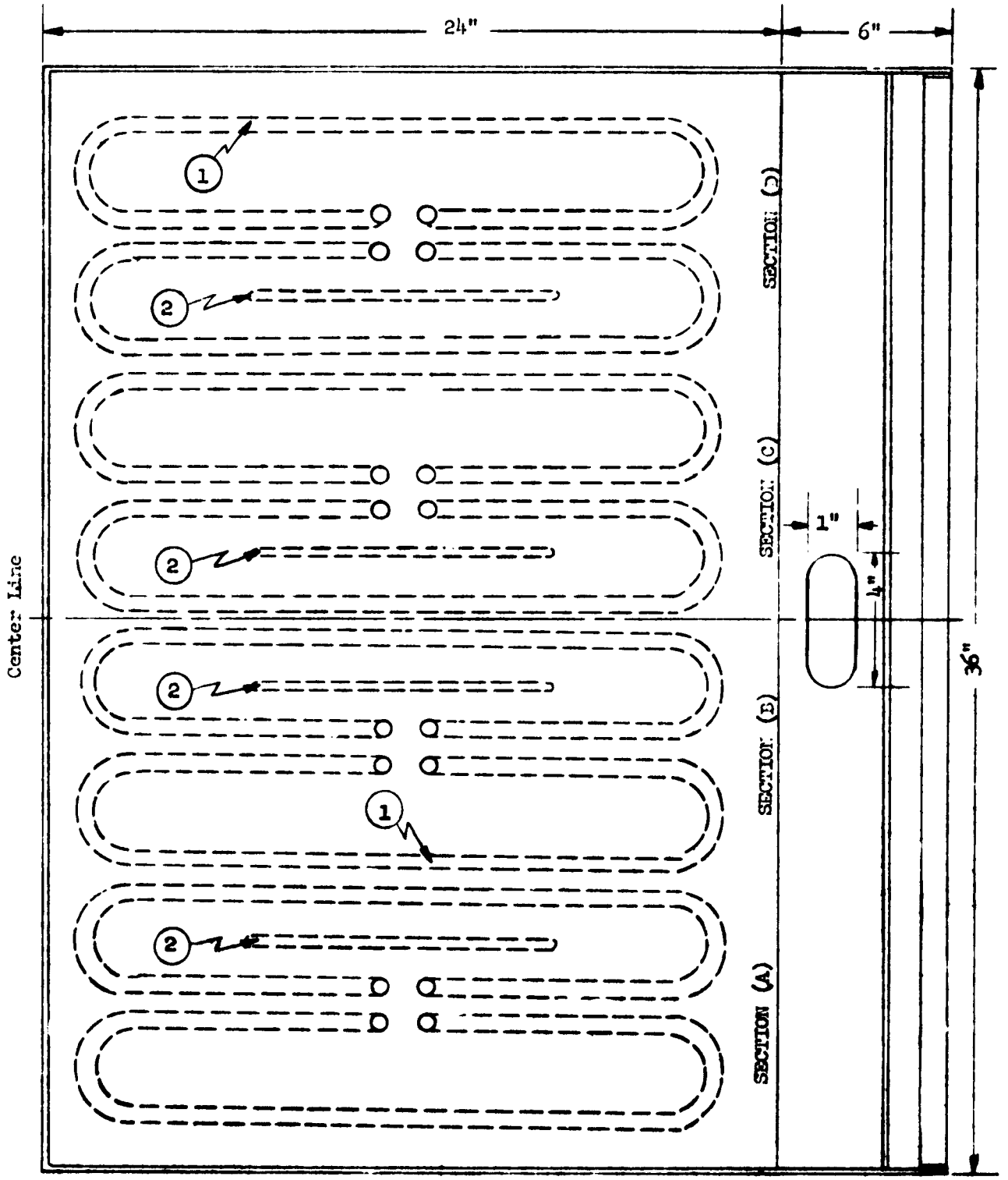

Fig. 4. - Outline drawing of Griddle "Y" showing location of heating elements (1), thermostats (2), and griddle sections (A), (B), (C) and (D).

TEST PROCEDURES*

A. Electrical

1. Wattage Input

With the griddle operated at the rated voltage (440 V, AC), 3 phase, 60 cycles, total power input was recorded on a recording wattmeter. Average wattage input was calculated from three successive "on" cycles of the griddle.

2. Unbalance Between Phases

Power in each phase was calculated from data taken by using three recording ammeters recording the current in each phase, and one voltmeter recording the voltage across each of the 3 phases.

3. Insulation Resistance

Insulation resistance tests were made with a 500 volt DC megohmmeter on the isolated 440 volt and the isolated 110 volt circuits respectively, with power to the griddles "off". Measurements were made between the heating elements and the griddle body with the griddles at room temperature as well as with the griddles at normal operating temperature.

B. Thermal

Forty-eight, 24 gauge calibrated iron-constantan (Type J) thermocouples were welded to the grilling surface of the griddle. The thermocouple layout pattern is shown in Fig. 5, page 8. All temperatures were recorded on high-speed, strip-chart potentiometers.

1. Thermostatic Switch Calibration and Temperature Control

Average cooking surface temperature was determined for each section of the griddle controlled by a thermostat; calibration studies were conducted at dial settings of 325°F., 375°F., and 425°F. After steady surface conditions** were reached, simultaneous temperature measurements at 12 points on each griddle section were recorded

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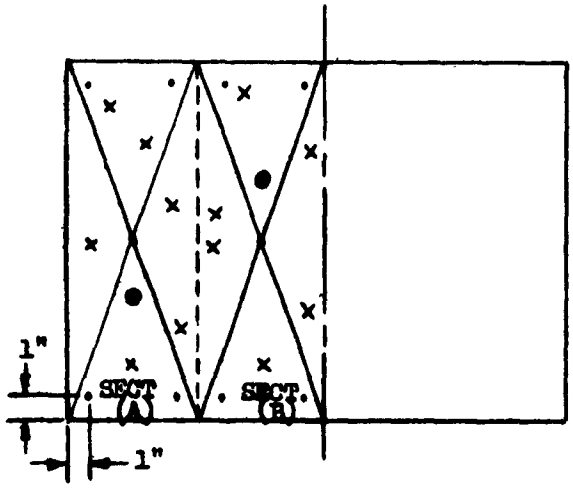
*In accordance with specification requirements of Military Specification MIL-G-21210A(SHIPS) dated 13 July 1959, "Griddle, Self-Heating, Electric, Naval Shipboard" where applicable.

**See Appendix A for definition of terms.



LEGEND

- Fixed Points
- × Random Points
- ⊕ Point above temperature sensing element

4 Corner Points (1" from edges)

1 Center Point (Intersection of Diagonals)

1 Point above thermostat sensing element

6 Points selected at random with at least 1 Point in each section bounded by diagonals

Fig. 5. - Outline drawing of each section of left half of griddle, indicating temperature measurement points.

for 3 consecutive cycles of thermostat operation. The average cooking surface temperature* was calculated by averaging all temperatures simultaneously at the three peaks and three valleys in the temperature cycle. Temperature amplitude* for each thermostatic switch was calculated as the average difference between maximum and minimum cooking surface temperature for the 3 consecutive cycles. In the event that any thermostat dial was found to be out of calibration, the procedure above was repeated at different dial settings to determine the dial setting needed to attain average surface temperatures of 325°F., 375°F. and 425°F.

2. Temperature Distribution

Temperature distribution on the left half of each griddle surface at corrected thermostat dial settings of 325°F., 375°F., and 425°F. was determined from data recorded during the thermostatic switch calibration and temperature control study. Simultaneous temperature measurements at 12 points on each of two griddle sections covering the left half of the griddle were recorded at the peak of three consecutive temperature cycles in the recalibrated condition.

3. Heating Time

With the griddle at room temperature and with the thermostat dials set at a calibrated 425°F., each griddle section was simultaneously energized to determine the length of time required for the griddle section to reach a temperature of 400°F. For this study, the average of three separate runs was used to determine heating time.

4. In addition to the above thermal tests, temperature measurements of the grease receptacle handle, guardrail, and thermostatic control dial were recorded for at least one hour during operation of the griddle at 375°F.

C. Food Preparation

1. General

a. Food items

The food items selected for food preparation studies are listed below. All of these foods were prepared in accordance with the current Navy Recipe Service cards.

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*See Appendix A for definition of terms.

Food Item	Navy Recipe Card No.
Hamburgers	J-22
Steaks	J-19
Griddle Cakes	C-13
Fried Eggs	F-18

b. Methods of operation and criteria established

(1) All foods were prepared by an experienced Navy commissaryman.

(2) The griddle was loaded to capacity with the food item starting from the front, left-hand corner of the grill and progressing from front to rear, left to right.

(3) All items were turned over and removed from the grill in the same sequence used for loading.*

(4) Determination of acceptable product for color and texture was judged by the Navy cook and technologists conducting the studies.

2. Production Rate

Production rate for each food item (para. C1.a.) was calculated from data obtained by averaging acceptable product resulting from three runs of four consecutive "loadings" for each griddle under study. The amount (or portion) of each food item which could be placed on the griddle was determined by observation.

The following loading pattern was used for the food production studies:

TABLE I. LOADING PATTERN USED FOR FOOD PRODUCTION STUDIES ON NAVY GRIDDLES

Food Item	No. Of Portions	No. Of Rows (Front to Rear)	No. Each Row (Across Griddle)
Hamburgers**	27	6	9
Steaks*** (8 oz.)	21	3	7
Griddle Cakes**	10	4	5
Fried Eggs**	15	3	5

*See Appendix A for definition of terms
**Portion consisted of two items
***4-Way Beef

D. General Observations

During various studies conducted on the griddles, observations were made on: ease of cleaning the unit, safety features, and other design features which affected operation.

FINDINGS

A. Electrical

Table II, below, shows the specification requirements and results of the electrical characteristics studies for the "X" and "Y" electric griddles.

TABLE II. ELECTRICAL CHARACTERISTICS OF GRIDDLES (AT RATED VOLTAGE)

Electrical Characteristics	Griddle		Specification Required MIL-G-21210A(SHIPS)
	"X"	"Y"	
Wattage Input (kw)	18.48	19.32	19 ± 5%
Unbalance between phases (kw)	0.31	2.13	5 (Maximum)
Insulation Resistance at 75 F.* for:			Not less than:
440 Volt Circuit (Megohms)	∞	∞	4
110 Volt Circuit	∞	∞	4
Insulation Resistance at 375 F.* for:			Not less than:
440 Volt Circuit	∞	∞	2
110 Volt Circuit	∞	∞	2

*Average surface temperature.

It can be seen from Table II that the electrical characteristics of wattage input, unbalance between phases, and insulation resistance of the griddles at room temperature and at operating temperature, are within the specification requirements of MIL-G-21210A(SHIPS).

B. Thermal

1. Thermostatic Switch Calibration and Temperature Control

Thermostatic switch calibration characteristics for the "X" and "Y" griddles in the "as received" condition are shown in Table III, page 13. Table IV, page 14, shows the thermal characteristics of the griddles after recalibration of the thermostatic switch.

It can be seen from Table III, that the deviation from the thermostat dial setting of 325°F. for the "as received" Griddle "X" at any section ranged from 0°F. to +13°F.; at thermostat dial setting 375°F. the deviation ranged from -11°F. to +5°F.; and, at thermostat dial setting of 425°F. the deviation ranged from -5°F. to -27°F. For "as received" Griddle "Y", Table III shows the deviation from the thermostat dial settings as follows: for 325°F. the range was from -23°F. to +9°F.; for 375°F. the range was from -35°F. to 0°F.; and for 425°F. the range was from -56°F. to -13°F.

Table IV shows that the recalibrated Griddle "X" maintained an average temperature within 5°F. of the surface temperatures of 325°F., 375°F. and 425°F. Recalibrated Griddle "Y" maintained an average temperature within 5°F. of the surface temperatures of 325°F. and 375°F.; however, it was not possible to obtain an average surface temperature at 425°F. The range deviation was from -56°F. to -13°F. at the maximum setting possible on the thermostat dial. The maximum temperature amplitude for Griddle "X" was 40°F. on Section D, with a calibrated temperature of 325°F. The maximum temperature amplitude for Griddle "Y" was 62°F. on Section D, with a calibrated temperature of 375°F.

2. Temperature Distribution

The temperature distribution over the left halves of the recalibrated Griddles "X" and "Y" is shown in Table V, page 15. It can be seen from Table V that the temperature deviation on the outside section (section A) of Griddle "X" exceeded -14% of the average maximum temperature when the average surface temperature was ±5°F. of the recalibrated thermostatic dial settings. For Griddle "Y" it was found that for recalibrated dial settings of 325°F., and 375°F. the outside section (section A) of the griddle exceeded ±14% of the average maximum temperature when the average surface temperature was ±5°F. of the recalibrated thermostatic dial settings; the inside section, (section B) exceeded +14%. No data were reported for the 425°F. setting on Griddle "Y" since it was found that the thermostatic control dial could not be calibrated.

TABLE III. THERMOSTATIC SWITCH CALIBRATION CHARACTERISTICS FOR GRIDDLES "X" AND "Y", "AS RECEIVED"

Griddle	Thermostat Dial Setting (°F.)	Section* A Temperature (°F.)					Section B Temperature (°F.)					Section C Temperature (°F.)					Section D Temperature (°F.)				
		Av. Min.	Av. Max.	Avg.	Dev.	Ampl.	Av. Min.	Av. Max.	Av. Avg.	Dev.	Ampl.	Av. Min.	Av. Max.	Avg.	Dev.	Ampl.	Av. Min.	Av. Max.	Avg.	Dev.	Ampl.
X	325	312	343	328	+3	31	324	352	338	+13	28	316	352	334	+9	36	305	345	325	0	40
Y	325	306	345	324	-1	39	309	358	334	+9	49	310	357	334	+9	47	273	330	302	-23	57
X	375	347	380	364	-11	33	366	395	380	+5	29	360	393	377	+2	33	347	385	366	-9	38
Y	375	347	388	368	-7	41	350	400	375	0	50	351	397	374	-1	46	311	365	340	-35	54
X	425	388	419	403	-22	31	408	432	420	-5	24	403	423	413	-12	20	379	417	398	-27	38
Y	425	380	418	399	-26	38	382	426	404	-21	44	392	431	412	-13	39	341	397	369	-56	56

*Sections lettered from left to right facing griddle = See Figs. 3 and 4 (pages 5 and 6).

TABLE IV. THERMOSTATIC SWITCH CALIBRATION CHARACTERISTICS FOR RECALIBRATED GRIDDLES "X" AND "Y"

Griddle	Thermostat Dial Setting (°F.)	Section A Temperature (°F.)					Thermostat Dial Setting (°F.)	Section B Temperature (°F.)					Thermostat Dial Setting (°F.)	Section C Temperature (°F.)					Thermostat Dial Setting (°F.)	Section D Temperature (°F.)				
		Av. Min.	Av. Max.	Avg.	Dev.	Ampl.		Av. Min.	Av. Max.	Avg.	Dev.	Ampl.		Av. Min.	Av. Max.	Avg.	Dev.	Ampl.		Av. Min.	Av. Max.	Avg.	Dev.	Ampl.
X(325)	325	306	340	323	-2	34	315	315	338	327	+2	23	315	310	347	329	+4	37	325	306	346	326	+1	40
Y(325)	330	304	348	326	-1	44	350	301	358	330	+5	57	315	303	350	327	+2	47	325	299	360	330	+5	61
X(375)	385	355	387	371	-4	32	370	365	388	377	+2	23	375	360	393	377	+2	33	385	352	389	371	-4	37
Y(375)	387	354	397	376	+1	43	375	342	401	372	-3	59	370	347	400	374	-1	53	410	348	410	379	+4	62
X(425)	450	405	436	421	-4	31	425	410	432	421	-4	22	435	413	438	426	+1	25	450	408	434	421	-4	26
Y(425)	425*	380	418	399	-26	38	425	382	426	404	-21	44	425	392	431	412	-13	39	425	341	397	369	-56	56

*Could not be calibrated, as 425°F. was the maximum possible dial setting of thermostat.

TABLE V. TEMPERATURE DISTRIBUTION OVER LEFT HALVES OF RECALIBRATED GRIDDLES "X" AND "Y"

Griddle	Average Surface Temp. (±5°F.)	Griddle Section	Thermostat Dial Setting (°F.)*	Average Maximum Temp. (°F.)	Temperature Distribution				Specification Requirement**
					Range (°F.)		% Deviation		
					Min.	Max.	Low	High	
X	325	A	325	340	270	375	20.6	10.3	14% maximum deviation from average maximum temperature
X	325	B	315	338	306	361	9.5	6.8	
Y	325	A	330	348	267	401	23.3	15.2	
Y	325	B	350	358	308	414	14.0	15.6	
X	375	A	385	307	307	426	20.7	10.1	
X	375	B	370	388	348	410	10.3	5.7	
Y	375	A	387	397	306	460	22.9	15.9	
Y	375	B	375	401	348	465	13.2	16.0	
X	425	A	450	436	345	479	20.8	9.9	
X	425	B	425	432	392	457	9.3	5.8	
Y	425	A	Could not be calibrated***						
Y	425	B							

*Determined from calibration data - Table IV.
**Specification MIL-G-21210A(SHIPS), 13 July 1959.
***At maximum thermostat dial setting, the average temperature was 402°F. on SectionsA and B.

3. Heating Time

The average time for each griddle to reach 400°F. is shown in Table VI, below.

TABLE VI. HEATING TIME FOR CALIBRATED* GRIDDLES "X" AND "Y" AT RATED VOLTAGE WITH 425°F. THERMOSTATIC DIAL SETTING

Griddle	Specification Requirement		Section							
			A		B		C		D	
	Time (min.)	Temp. (°F.)	Avg. Time	Avg. Temp.	Avg. Time	Avg. Temp.	Avg. Time	Avg. Temp.	Avg. Time	Avg. Temp.
X	15	400	8.1	404	8.4	405	8.3	404	8.3	400
Y			8.1	396	7.1	400	6.7	402	7.8	401

*Heating time for "as received" condition same as calibrated.

It can be seen from Table VI that the heating times found on Griddle "X" and Griddle "Y" are within the specification requirements of MIL-G-21210A(SHIPS).

4. Additional Temperature Data

Table VII, below, shows the results of temperature measurements taken at the grease receptacle handle, guardrail, and thermostatic control dials on Griddles "X" and "Y" during operation of the unit at 375°F. for at least one hour.

TABLE VII. AVERAGE TEMPERATURE OF GRIDDLE PARTS NORMALLY HANDLED DURING OPERATION OF UNIT

Griddle	Grease Receptacle* Handle (°F.)	Guard Rail (°F.)	Thermostatic Control Dial (°F.)
X	84	81	93
Y	87	90	92

*Grease receptacle empty.

C. Food Preparation

Table VIII, page 18, summarizes the observations on the food preparation studies conducted on Griddles "X" and "Y". Table IX, page 19, shows the production rate of the griddles in addition to the product quality of the food items prepared. It can be seen from Table IX that Griddle "X" produced 100% satisfactory portions as compared to a somewhat lower acceptability percentage for Griddle "Y".

D. General Observations

1. Cleaning of Griddles

(a) Griddle "X" - Griddle "X" was considered easy to clean. The rounded rear corners on the splash guard and the wide stainless steel trough at the front of the griddle were particularly desirable features to facilitate cleaning.

(b) Griddle "Y" - Griddle "Y" was considered relatively easy to clean; but it had several features which were more difficult to clean than on Griddle "X". The rear corners of the splash guard were formed into a sharp right angle making it difficult to clean thoroughly. This can be seen in Fig. 2, page 3. The trough at the front of the griddle was made of carbon steel and painted aluminum. It discolored in use and presented an unsightly appearance.

2. Safety Features of Griddles

(a) Griddle "X" - The grease drawer shown in Fig. 6, page 20, was shallow and long, with baffles in it. Although it had the specified capacity, it was considered difficult to remove and carry without spilling the contents. Also, each side of the grease drawer, immediately behind the front panel, had a small hole in it. The apparent purpose of this hole is to permit grease to run out of the drawer, as a warning to the operator, before it filled up too much. In use, when production runs were made, grease dripped out of these holes, ran down on the operator's shoes and onto the deck. The lip on the underside of the drain hole in the front drain trough was shallow and permitted grease to spread. Under ship's motion, the lip may not guide all the grease into the grease drawer.

(b) Griddle "Y" - The grease drawer shown in Fig. 6 lacked a positive latching mechanism to hold the drawer in place against ship's motion; a spring clip was provided for this purpose. Also lacking were baffles to reduce the sloshing of liquid in the drawer.

TABLE VIII. SUMMARY OF OBSERVATIONS ON FOOD PREPARATION

Product	Griddle "X"	Griddle "Y"
Hamburgers	All were acceptable and ranged from rare to medium. The rare hamburgers were located at the right side of the griddle.	All were acceptable ranging from rare to overdone. Rare located at right side of griddle. Ones in front row varied from load to load, rare to overdone. The overdone hamburgers had hard crusts.
Steaks	All steaks were acceptable with a range of medium to well done. None were burned or rare.	All steaks were acceptable with a range of rare to overdone. Rare steaks were located at the right front of the griddle. The overdone steaks were located in the left center section of the griddle.
Griddle Cakes	All were acceptable and evenly done. First one was ready to be turned as last was placed on griddle.	The range of doneness varied from underdone (not acceptable) to done. The unacceptable griddle cakes were located in the right front corner of the griddle. The light but acceptable griddle cakes were located across the front of the unit.
Fried Eggs	All eggs were acceptable and evenly done.	The range of doneness varied from well done to very soft (not acceptable). The unacceptable eggs were located at the right front, right rear and left front of the griddle.

TABLE IX. PRODUCTION RATE AND PRODUCT QUALITY OF GRIDDLES "X" AND "Y" WHEN PREPARING FOUR DIFFERENT FOOD PRODUCTS

Griddle	Food Product	Navy Recipe Card No.	Average No. of Portions Per Load	No. of Loadings	Average Surface Temp. (±5°F.)	No. of Unsatisfactory Portions	No. of Satisfactory Portions	Average Cooking Time Per Load (Min.)	Average Production Rate Acceptable (Portions/hr.)
X	Hamburgers	J-22	27	12	350	0	324	7.47	217
Y						0	324	9.37	173
X	Steaks	J-19	20	12	425	0	240	5.45	220
Y					396*	0	240	5.33	225
X	Griddle Cakes	C-13	10	12	375	0	120	2.39	251
Y						3	117	3.37	178
X	Fried Eggs	F-18	15	12	325	0	180	3.70	243
Y						3	177	4.09	220

*Maximum setting possible - J-19 (Issue 9) calls for 425°F. NOTE: NAVSUPRANDFAC recommendation of 6 March 1961 for Issue 10 calls for 400°F.

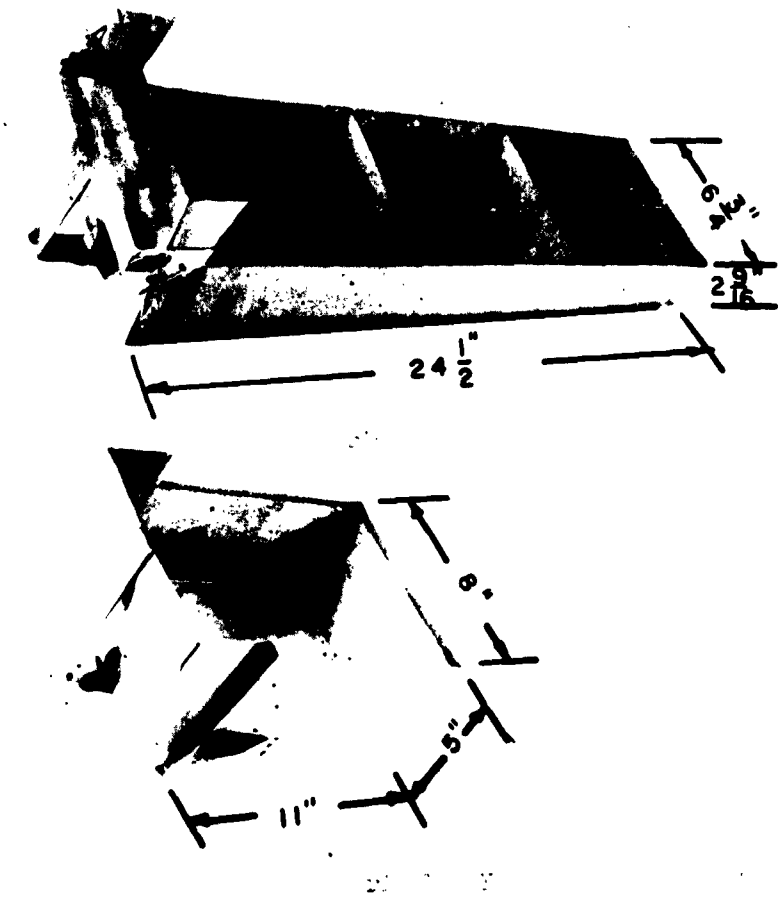

Fig. 6. - Grease drawers for Griddle "X" and Griddle "Y".
NAVSUPRANDFAC Photo No. 936-14.

DISCUSSION OF FINDINGS

A. Griddle "X"

Griddle "X" failed the temperature distribution test for the extreme left and right sections of the griddle top. It failed by exceeding the 14% deviation on the low temperature side only. An examination of the temperature recordings showed that the failure was due to a single point in each case, the extreme outside left front corner point on the left section, and the right rear corner point of the extreme right section of the griddle. In each test, the next highest point was from 30°to 39°F. higher than the low point. Examination of the foods showed reasonable uniformity of all foods prepared on this griddle with no foods considered to be so unacceptable as to be discarded.

It is considered that the manufacturer could very likely remedy this condition by providing about 10% more wattage in the two peripheral heating elements. It may also be possible to reposition the peripheral elements slightly outward toward the corners.

It is also considered that the design of the grease drawer is unsatisfactory due to its long, shallow shape which makes it extremely difficult to handle. It should be noted that the capacity and size of this drawer were within the limitation of the specification requirements of paragraph 3.12.5. It is therefore apparent that a change in the specification requirement is necessary to eliminate this deficiency.

B. Griddle "Y"

On Griddle "Y", the thermostat limitation is considered to be a defect. While the thermostat control dial was marked 425°F. at the maximum setting, the average temperature of the griddle surface was 396°F. Thus, it was not possible to calibrate the griddle for the 425°F. condition. From the practical standpoint of food production, the effect of this condition would be to reduce the production rate of foods requiring preparation at temperatures much above 400°F. However, there are very few foods requiring griddle temperature above 400°F. The Navy recipe service, at present, does not require griddling temperatures over 400°F. for any food item.

Griddle "Y" failed the temperature distribution test, and food preparation results showed deficiencies in the areas which were responsible for failure of this test.

On Griddle "Y", food prepared in the center was generally overdone, while food prepared at the front corners and along the front was generally underdone. Heat distribution on Griddle "Y" showed failures both above and below the acceptable value of ± 14%. The extreme left and right-hand sections failed the test both for high and low limits; the two center sections failed for high limit. Analysis of the temperature recordings showed that the low limits were exceeded by the extreme corner points with the next lowest point from 39° to 44°F. higher. The high limits were exceeded by points on each section located in the rear quadrant. These temperatures exceeded the next highest temperature in each section by about 5° to 14°F.

It is considered that Griddle "Y" could be improved by providing additional heat along the front and at the front corners. Possibly, addition of a single heating element, with the ends curved around the front corners, would improve the performance sufficiently to meet the temperature distribution requirement of the specification.

It is also considered that the basic physical dimensions of the grease drawer are satisfactory and make this unit relatively simple to carry; however, the spring clip provided for locking this drawer in position is not good and should be replaced with a positive latch.

C. General

A comparison of the production rates for the two griddles shows that Griddle "X" produced more acceptable portions per hour than Griddle "Y", as follows: hamburgers 25.4%; griddle cakes 41.0% and fried eggs 10.5%. Griddle "Y" out-performed Griddle "X" by 2.3% for steaks. The basic reason for the reduced production rate of Griddle "Y" was the excessive time required during successive batches for cleaning and scraping-down the griddle surface. This was necessary, primarily, because of the hot and cold spots on the griddle which caused the food item to stick on the griddle.

As a whole, the performance of both Griddle "X" and Griddle "Y" showed important improvements as compared to griddles previously studied. (See footnotes, page 1). The integrally welded splash guard on the sides and back permits the operator to work up to the limit of the available space as compared with former griddle designs which had grease drain troughs along the sides and back. The high power input (nominally 19 kw.) is a significant improvement in these griddles, minimizing temperature recovery and maximizing production rate. The correlation of the food preparation studies with the temperature distribution studies was good.

The importance of adequate wattage input and the need for uniform temperature distribution has been discussed in previous studies (see footnotes, page 1). Nevertheless, it should be reiterated that there is a distinct difference in operational practice between mass production food preparation as carried on in the Navy and commercial restaurant food preparation. In mass production food preparation, the food is loaded onto the griddle in a definite sequence, and is removed from the griddle, when done, in the same sequence. Thus, the operator does not have the time to compensate for griddle deficiencies by selecting items from "hot spots" for removal first and leaving other items on "cold spots" until they are done. In actual practice, the operator removes all food products in sequence and discards those which are too overdone or underdone. In commercial use, the operator seldom loads a griddle completely with food; thus, he may be able to use a griddle with lower wattage density. However, in shipboard use, to prepare food in accordance with the Navy Recipe Service, with a fully loaded griddle, sufficient wattage density, properly distributed, must be provided.

APPENDIX A

DEFINITIONS

1. Definitions from MIL-G-21210A(SHIPS) dated 13 July 1959, "GRIDDLE, SELF-HEATING, ELECTRIC, NAVAL SHIPBOARD"

3.18.1.1. Average cooking surface temperature. - The average cooking surface temperature is the average of the maximum and minimum cooking surface temperatures measured in 3 consecutive cycles after steady surface conditions have been reached.

3.18.1.2 Maximum and minimum cooking surface temperatures. - Maximum and minimum cooking surface temperatures are the average of the temperatures measured simultaneously at the peaks and valleys, respectively, of the temperature cycle.

3.18.1.3 Steady surface condition. - The steady surface condition is the condition reached after the surface heating unit has been under the control of the thermostat for the first 4 cycles of operation of the thermostat, or the condition reached after the thermostat cycling period becomes uniform, whichever occurs last.

3.18.1.4 Temperature amplitude. The temperature amplitude is the average difference between maximum and minimum cooking surface temperature measured in 3 consecutive cycles after steady surface conditions have been reached.

2. Food Production Terms

Loading - One "loading" consisted of one covering of the griddle with the food item under study (utilizing the entire griddle surface) from the time the griddle loading began until the griddle was again ready for loading. The following elements were included in the loading cycle: grease griddle, load griddle, unload griddle, cooking time, and clean griddle. Only over-all time was recorded for these studies.

Naval Supply Research and Development Facility, Bayonne, N. J.
EVALUATION OF NAVAL SHIPBOARD SPECIFICATION GRIDDLES, by H. T. Brey, M. L. Mayer and J. Pardo. Dec. 1962. 23 p. app. fig. tab. illus.

Two Naval shipboard specification griddles fabricated by different manufacturers, were studied to determine conformance with the engineering performance characteristics of MIL-G-21210A (SHIPS) 15 July 1959. The food characteristics of these griddles were also studied. Neither griddle met the engineering characteristics and performance requirements of the specification. The food preparation performance of one griddle was superior to the other. The food preparation characteristics relate quite satisfactorily to the specification requirements. As a result of deficiencies in the design of the grease draw in both griddles a recommended change in the specification was submitted.

1. Griddles Performance
I. Brey, H. T.
II. Mayer, M. L.
III. Title: Naval...
IV. NT F015-13-001-119-5
V. System No. 2101-11905-1

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