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BUILDING RESEARCH DIVISION

FOR
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WASHINGTON, D. C. 20548



U. S. DEPARTMENT OF COMMERCE NATIONAL BUREAU OF STANDARDS

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FIRES ENDURANCE TEST
OF
THREE BULKHEAD ASSEMBLIES

ABSTRACT

Three bulkhead assemblies were subjected to standard fire tests to determine their suitability for approval by the U. S. Coast Guard for use in merchant vessels. The three assemblies differed only in the details of the joint system. The unexposed surface temperatures of each remained within the specified limits for more than 15 min. Two remained effective barriers to the passage of flame throughout the 1 hour test, the third for over 30 min.

1. INTRODUCTION

As requested by the U. S. Coast Guard, in a letter dated November 15, 1955 (and as discussed in previous correspondence, reference 164.008/33) three "Navilite" bulkhead assemblies were subjected to a fire endurance test in compliance with Subpart 164.008-3(b) of Specification for Bulkhead Panels for Merchant Vessels. The assemblies were manufactured by Dansk Sternit-Fabrik A/S, Denmark, and shipped to the National Bureau of Standards ready for erection in the test frame. The test was conducted December 5, 1955.

2. TEST SPECIMENS

The three test specimens were alike, except for the details of the vertical joint located in each, consisting of 7/8 in. thick "Navilite" suitably mounted for placement in the furnace test frame. Each bulkhead specimen consisted of two panels of "Navilite", one 7 ft 10-1/8 in. high by 2 ft 8-3/4 in. wide and the other 7 ft 10-1/8 in. high by 1 ft 4-1/4 in. wide, butted together along their height. The Navilite was secured to the test frame as shown in figure 1. The joint for the bulkhead of construction I consisted of a steel spline 0.79 by 0.12 in. by full height that fit into a groove in the butted edges of each Navilite panel. That for the bulkhead of construction II consisted of an iron flat 2.95 in. wide, 0.16 in. thick, and full height secured to each face by 1 in. round head screws at about 1 ft on centers and staggered right and left of the joint. The joint system for the bulkhead of construction III consisted of a 1.75 by 0.12 in. steel strip secured to each face by flat head machine screws through the Navilite. The heads of the screws fit in countersunk holes in the steel strip on the fire exposed face and the threaded ends screwed into tapped holes in the strip on the other face. The screws were about 1 ft on centers and staggered right and left of the joint.

3. TEST METHOD

The three bulkheads were mounted in a single test frame that had been subdivided for bulkhead tests. Eight thermocouples were placed on the unexposed surface of each bulkhead under 6 by 6 by 0.4 in. felted asbestos pads. Of these eight, three were along the joint and the others on the 2 ft 8-3/4 in. wide panel of Davillite. Eight thermocouples were used on each bulkhead rather than nine so that the data from the three bulkheads could be recorded on two 12 point recording potentiometers. Other than for the number of unexposed surface thermocouples, the test was conducted in compliance with the provisions of Subpart 104.000-3(b) of Specification for Bulkhead Panels for Merchant Vessels. The furnace fires were controlled to produce temperatures as close as feasible to those defined by the standard time-temperature curve of ASTM E119-53, which include 1000°F at 5 min, 1300°F at 10 min, 1550°F at 30 min, and 1700°F at 1 hour.

4. RESULTS

The condition of the specimens immediately before the test is shown in Figure 2. In addition to the personnel of the US Fire Protection Section, the following witnessed the test:

R. A. Adams, LCDR, USCG, Washington, D. C.
W. P. Boyls, Lt, USCG, Washington, D. C.
W. V. Morsing-Larsen, Dansk Hvernit-Fabrik, Aalborg, Denmark

4.1 Observations During Test

The metal strip over the joint on the exposed surface of bulkhead III was bowed 2 to 3 in. away from the surface near midheight at 6-1/2 min. That on the exposed surface of bulkhead II was bowed away over the upper half of its height at 8 min. That on the unexposed surface of bulkhead III was bowed out slightly just below midheight at 10 min. A diagonal crack 2 in. long had developed by 23 min in the unexposed surface of bulkhead II adjacent to the top of the joint. The spline in bulkhead I had broken through the unexposed surface at midheight and bowed 4 to 5 in. from its initial position by 29 min. A horizontal crack across part of the wider (2 ft 8-3/4 in.) section of bulkhead II about 1-1/2 to 3 ft from the bottom was observed at 31 min. At the same time, the glow of the furnaces was visible through the crack observed at 23 min.

DECLARATION

I, the undersigned, do hereby certify that the foregoing is a true and correct copy of the original as the same appears in the records of the Board of Health of the City of New York, and that the same has been compared with the original and found to be a true and correct copy thereof.

CERTIFICATE

The undersigned, the undersigned, do hereby certify that the foregoing is a true and correct copy of the original as the same appears in the records of the Board of Health of the City of New York, and that the same has been compared with the original and found to be a true and correct copy thereof.

DECLARATION

I, the undersigned, do hereby certify that the foregoing is a true and correct copy of the original as the same appears in the records of the Board of Health of the City of New York, and that the same has been compared with the original and found to be a true and correct copy thereof.

The crack in bulkhead II observed at 31 min had extended across all the wider section and a similar crack extended across the narrower section by 36 min. At this time, the bulkheads had deflected from their original positions, as measured at midnight, as follows: bulkhead I, 0.67 in.; bulkhead II, 2.35 in.; bulkhead III, 1.2 in., all towards the fire. The glow of the furnace was visible through the horizontal crack in the narrow section of bulkhead II at 40 min. A crack 3 to 4 in. long had developed through the devilite at midnight along one edge of bulkhead I at 44 min. A fine horizontal crack had developed across the narrow section of bulkhead III at 49 min whereas the crack across bulkhead II was about 1/8 in. wide. Glow was visible in the crack in bulkhead III at 57 min. The test was stopped at 1 hour.

4.2 Temperatures

The fire exposure severity was 99.0 percent of standard. The temperatures on the unexposed surfaces of the three specimens had risen 250°F above the initial at the times indicated in the following table.

	250 Degree F rise	
	Panel	Joint
	min	min
Bulkhead I (spline)		
Average	0:21.1	0:19.6
One point	0:17.4	0:17.4
Bulkhead II (screws)		
Average	0:17.5	0:21.9
One point	0:17.1	0:17.4
Bulkhead III (machine screws)		
Average	0:26.5	0:19.4
One point	0:17.3	0:17.4

Reproductions of the potentiometer charts, indicating the recorded temperatures in detail, are given at the end of this report.

4.3 Condition After Test

At the end of the test, each bulkhead was bowed toward the furnace fires and had one or more horizontal cracks in the exposed surface. Bulkheads II and III also had significant cracks in the unexposed surface. Cracks in both sections of Bulkhead II and in the narrow section of Bulkhead III extended all the way across the respective sections and completely through the Navilite. The condition of the specimens was not noticeably changed after overnight cooling.

5. SUMMARY

Bulkhead I exhibited considerable deflection. The spline broke through the exposed surface but there was no other significant damage. The temperatures on the unexposed surface remained within the specified limits for 17 min and the specimen remained an effective barrier to flames for the full 1 hour test period.

Bulkhead II also exhibited considerable deflection. The metal strip over the joint on the exposed surface broke loose over a major portion of its height early in the test. That on the unexposed surface became detached from the wide section of Navilite in the top 1 to 2 ft. A small piece of the Navilite broke off the top of the wide section at the joint and the sections became offset at the top. The glow of the furnace was visible at that location at 31 min, and through a crack across the narrow section at 40 min. The temperatures on the unexposed surface remained within the specified limits for 17 min and the specimen remained an effective barrier to flames throughout the first 30 min of the test period.

Bulkhead III exhibited considerable deflection. The metal joint cover strips buckled between the machine screws at two places on the exposed surface and one on the unexposed surface but did not break free of any of the machine screws. A crack developed across the narrow section and through the Navilite late in the test, but it did not open appreciably. The temperatures on the unexposed surface remained within the specified limits for 17 min and the specimen remained an effective barrier to flames throughout the entire 1 hour test period.

THE HISTORY OF THE UNITED STATES

The first part of the book deals with the early years of the nation, from the time of the first settlers to the end of the Revolutionary War. It covers the period of the early colonial period, the struggle for independence, and the formation of the new government.

CHAPTER I

The first part of the book deals with the early years of the nation, from the time of the first settlers to the end of the Revolutionary War. It covers the period of the early colonial period, the struggle for independence, and the formation of the new government.

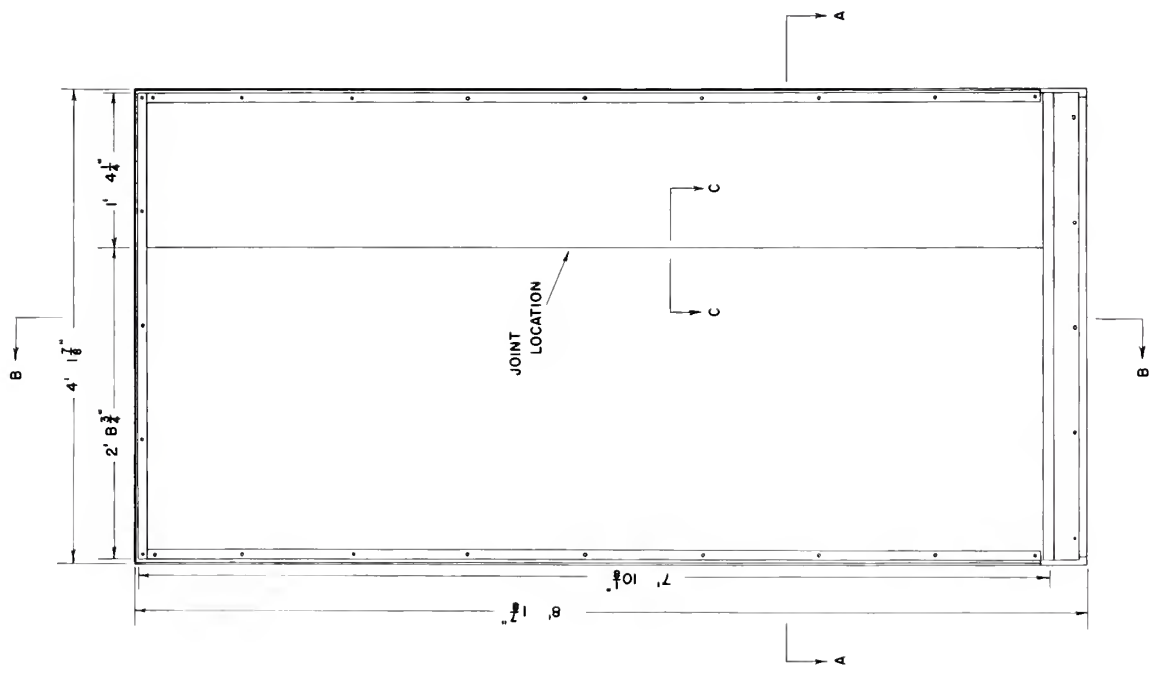
The second part of the book deals with the years from the end of the Revolutionary War to the beginning of the Civil War. It covers the period of the early republic, the expansion of the nation, and the struggle over slavery.

The third part of the book deals with the years from the beginning of the Civil War to the present. It covers the period of the Civil War, Reconstruction, and the modern era of the United States.

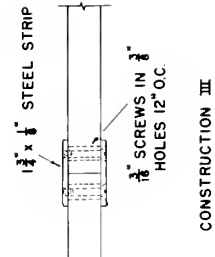
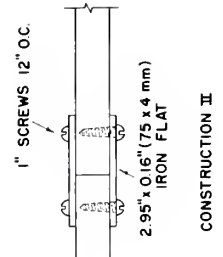
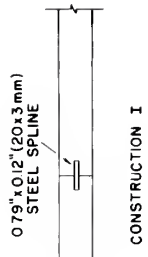
Figure 1. *Identification and characteristics of...*



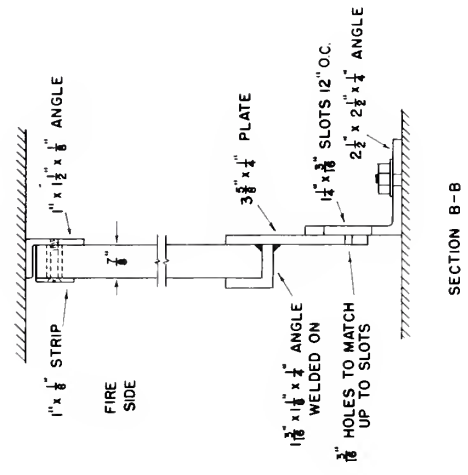
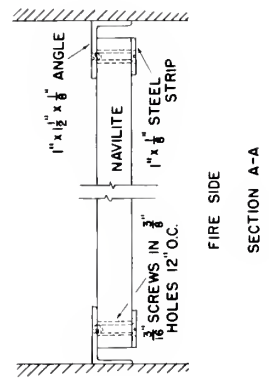
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BULKHEAD TEST MOUNTING, FROM FIRE SIDE



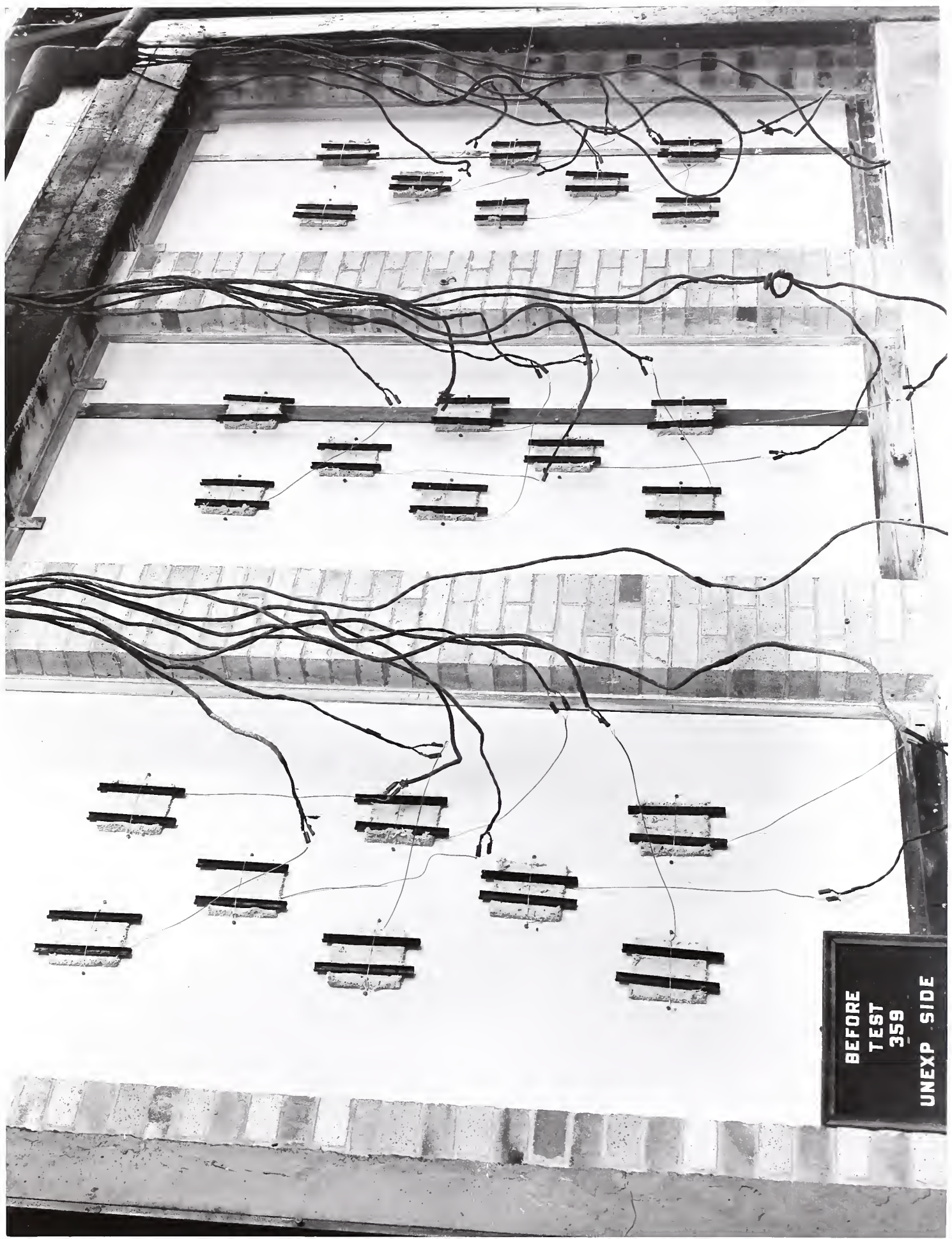
SECTION C-C
JOINT DETAILS



25479

Figure 2. Unexposed surface before test. Construction
I, II, III from left to right. 100 4515
Fig. 23337-4

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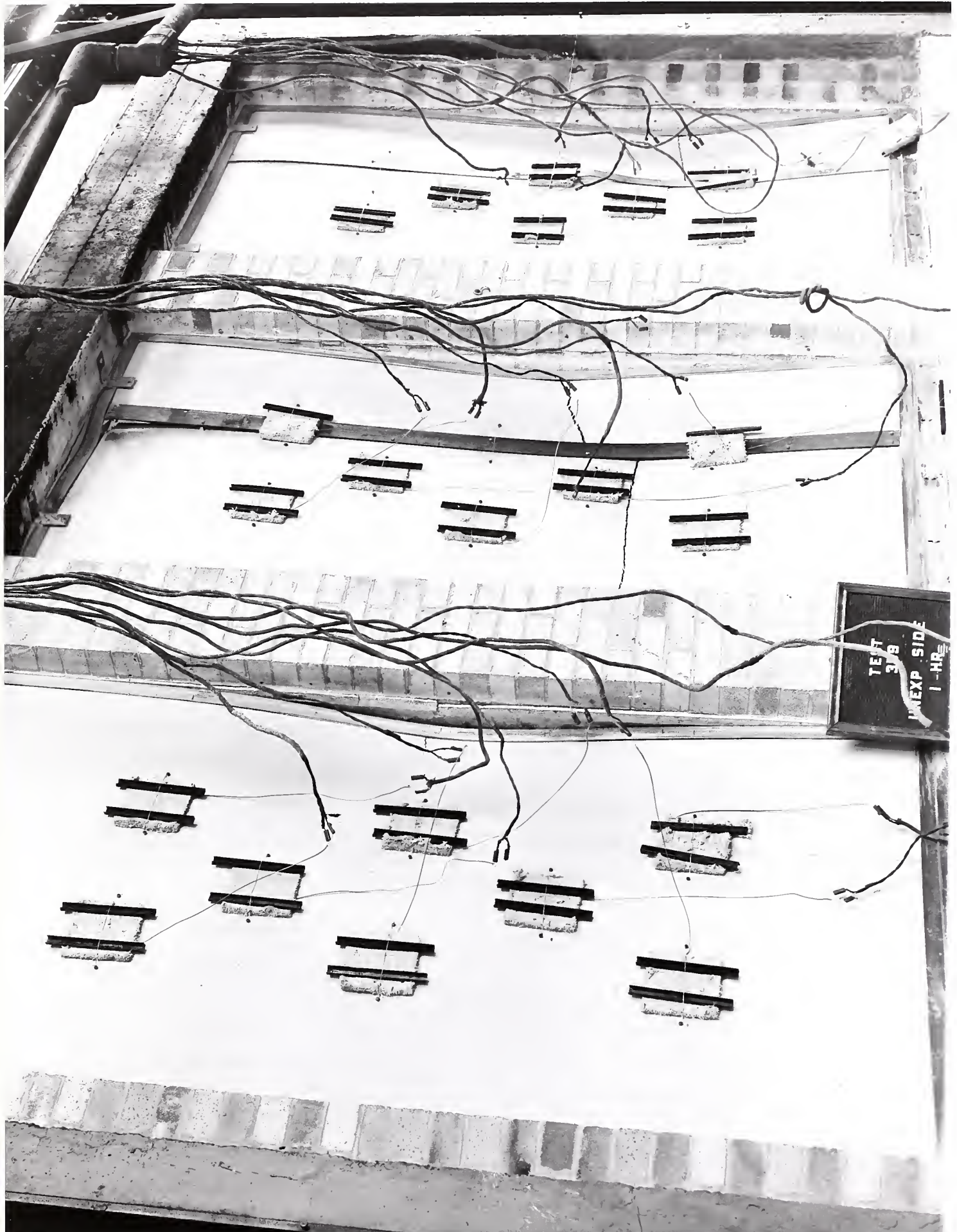


BEFORE
TEST
359
UNEXP SIDE

4-18810



Figure 3. Oxidized surface at end of test. (No 4515
log. 4337-5)



TEST 319
INEXP. SIDE
1-HR.



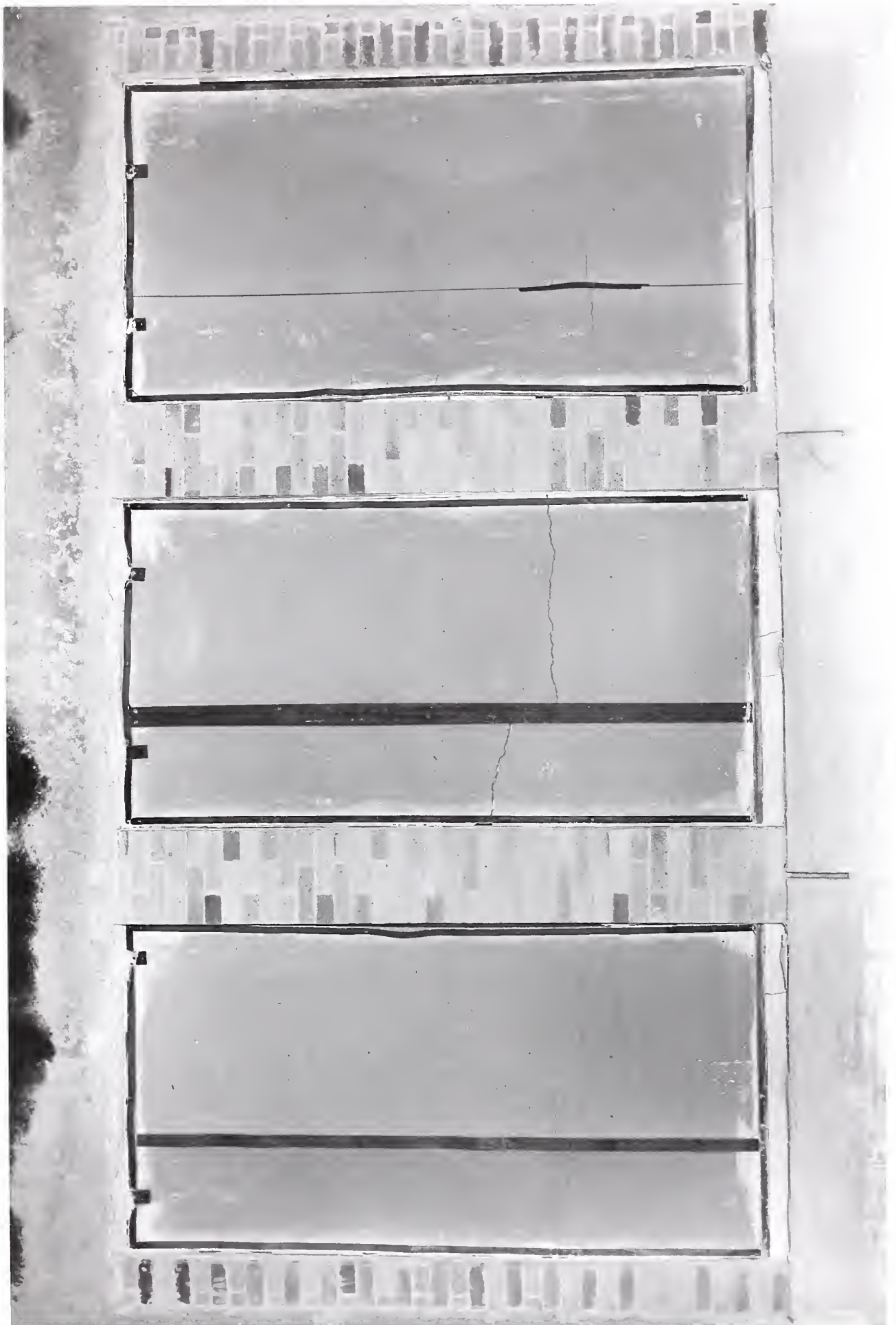


Figure 4. Exposed surface after test, constructions I, II, III from right to left. MS 4919
Reg. 25337-3





2000

GAS OF

0 100 200 300

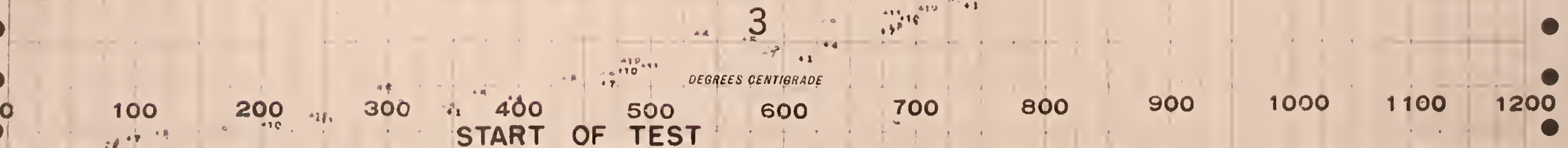
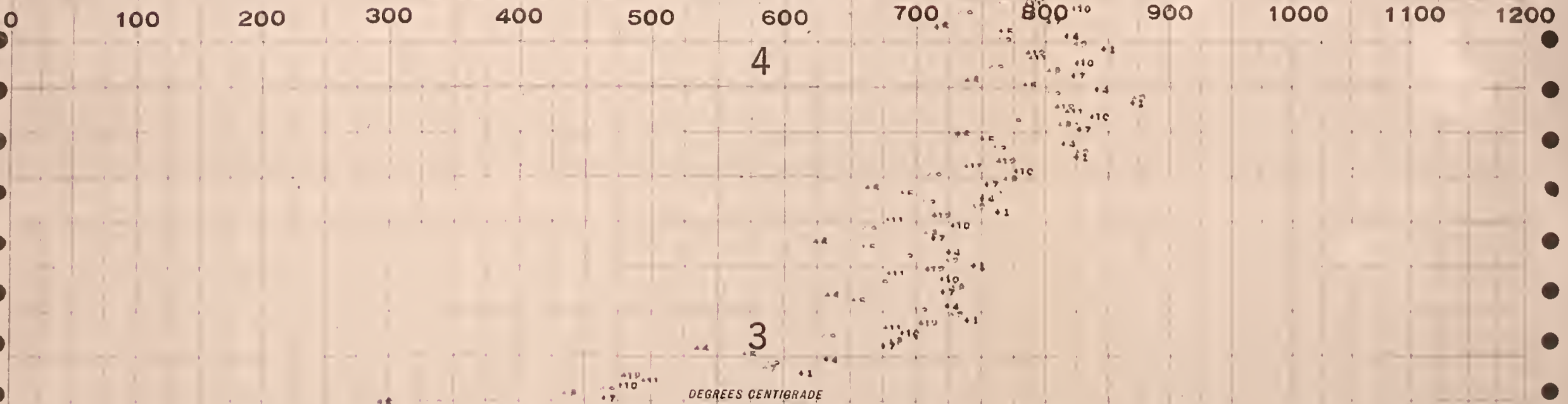
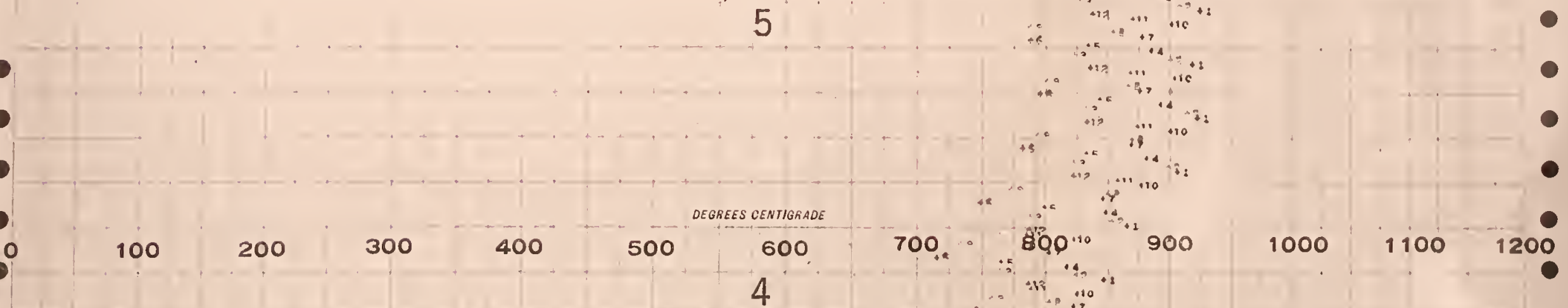
0 100 200 300

0 100 200 300

NAVILITE

2000.0

GAS OFF 1 HR 00 MIN



NAVILITE BULKHEADS

FURNACE TEMPERATURES

8 IN. = 1 HR

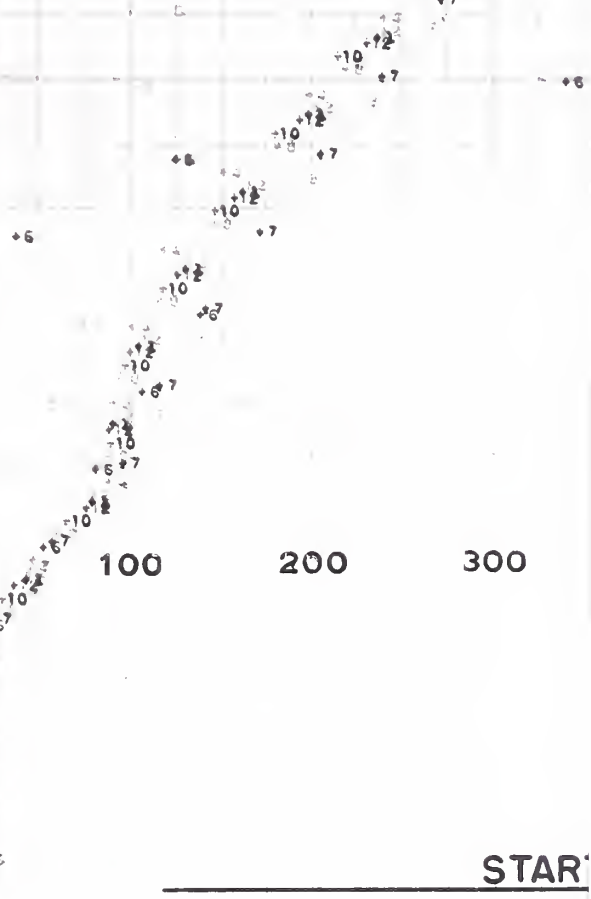
2

0 100 200 300

IC



0 100 200 300



NAVILITE BULKHEADS

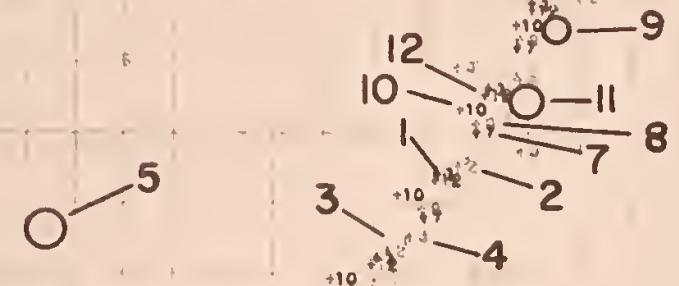
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GAS OFF 1 HR 00 MIN

DEGREES CENTIGRADE

0 100 200 300 400 500 600 700 800 900 1000 1100 1200

7

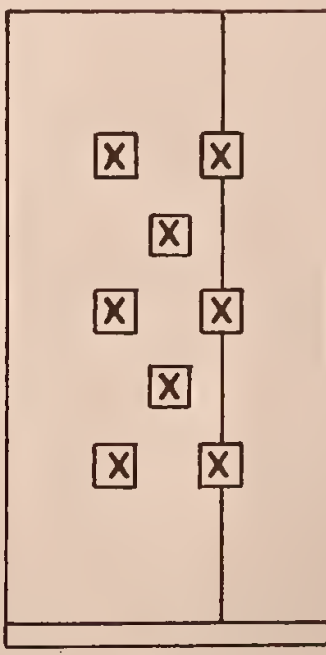
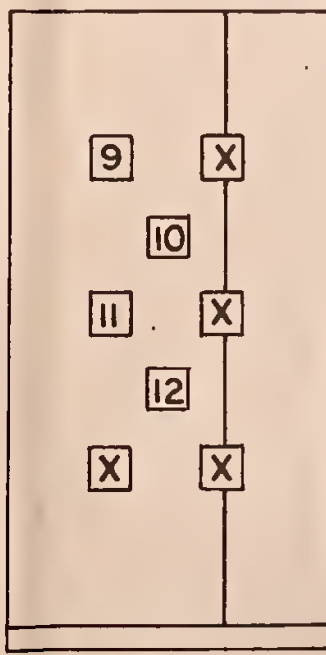
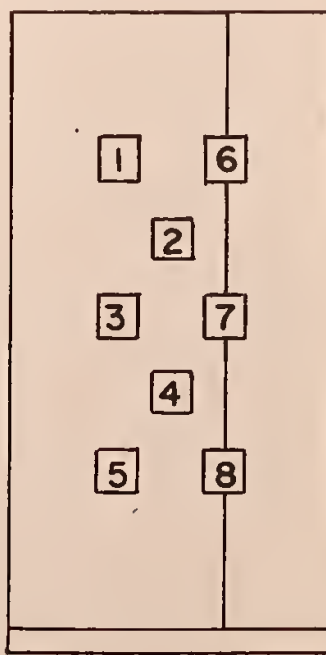


DEGREES CENTIGRADE

0 100 200 300 400 500 600 700 800 900 1000 1100 1200

6

UNEXPOSED SURFACE
THERMOCOUPLE LOCATIONS
X: SEE OTHER CHART



I

II

III

START OF TEST

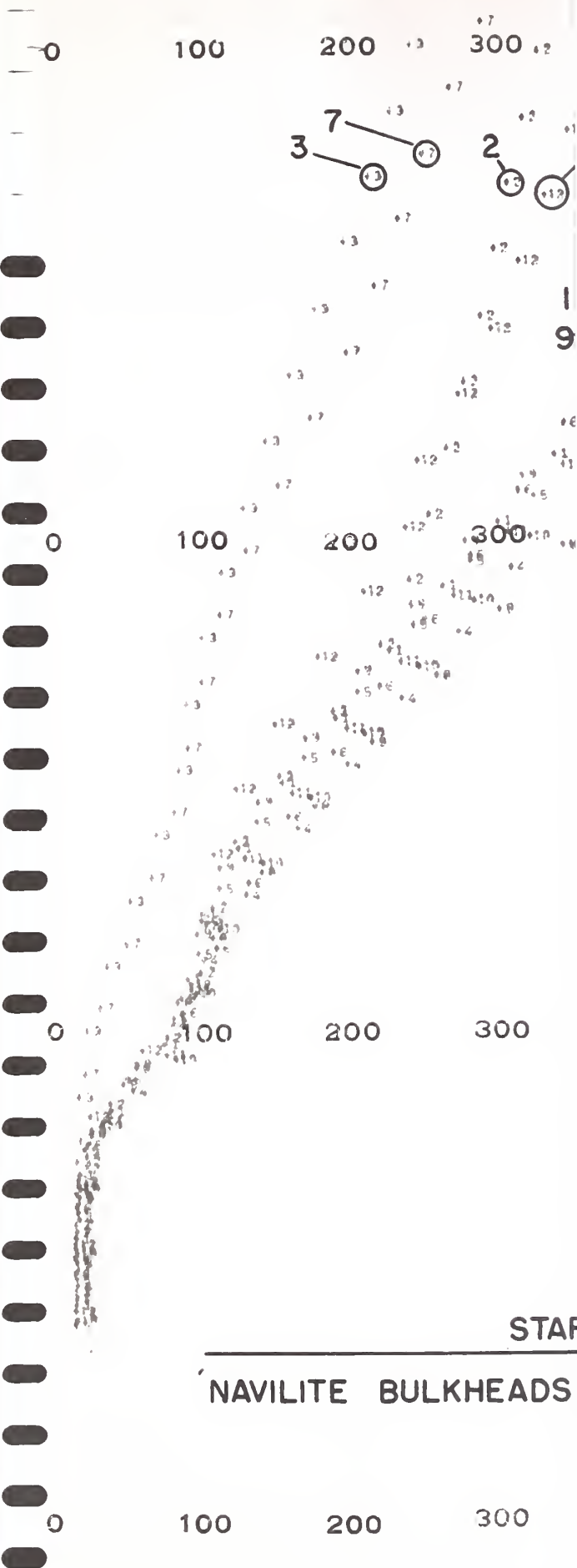
NAVILITE BULKHEADS UNEXPOSED SURFACE TEMPERATURES

8 IN. = 1 HR

3

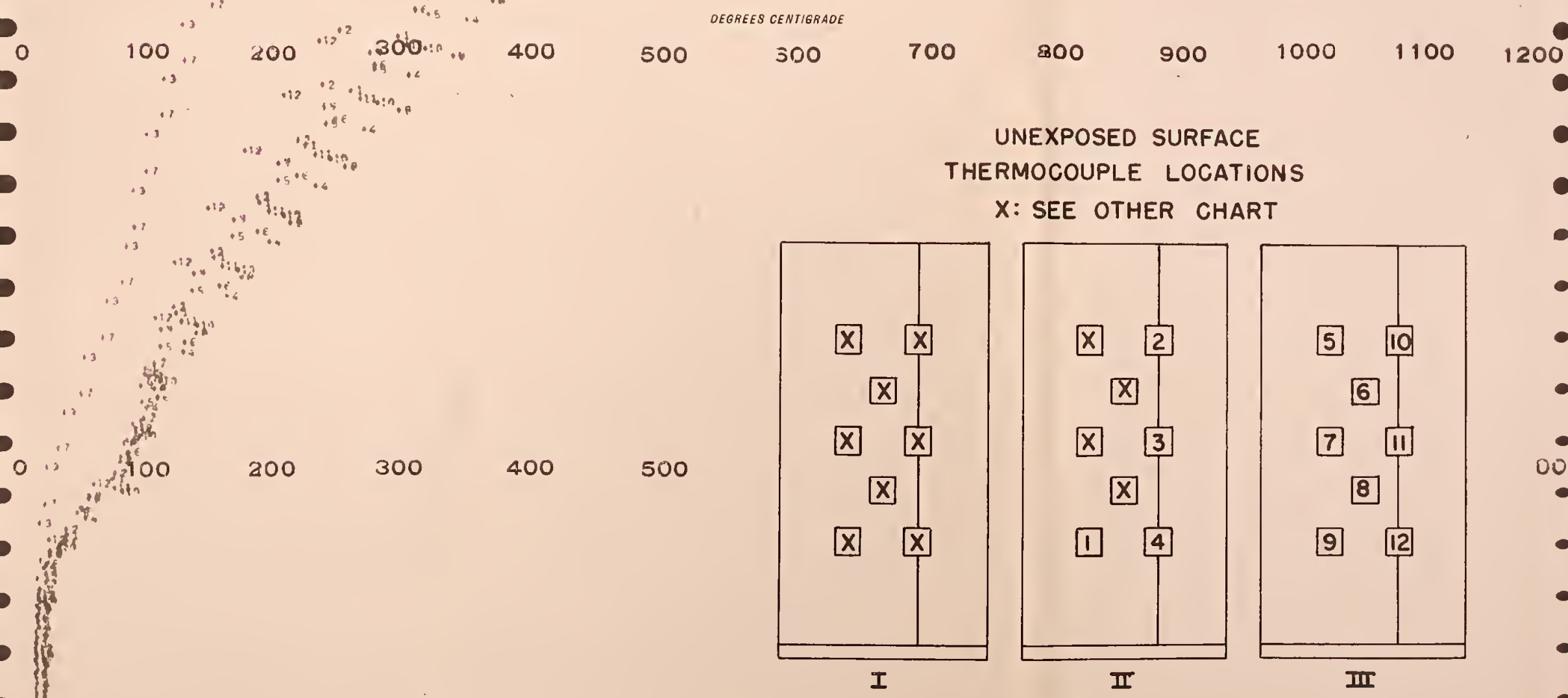
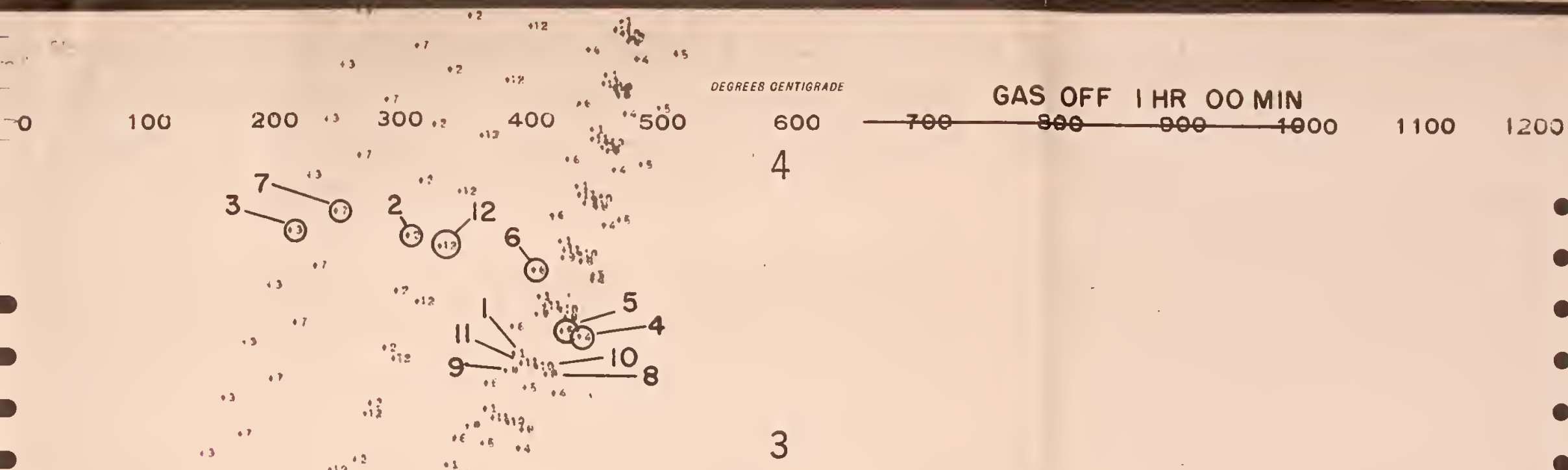
DEGREES CENTIGRADE

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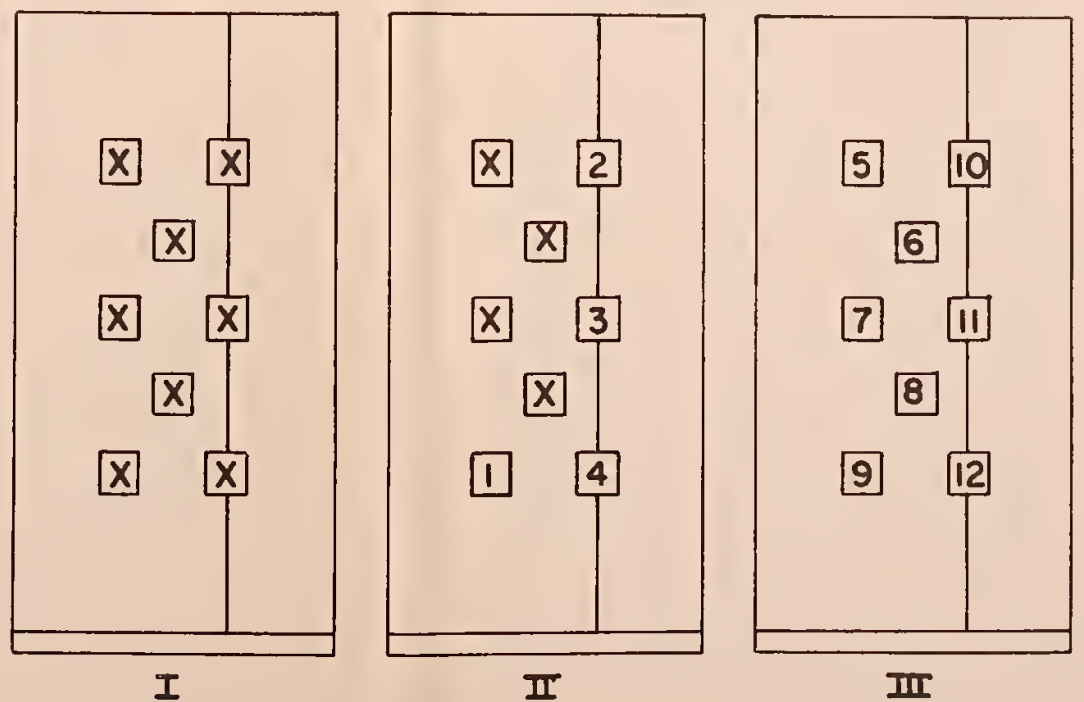


STAF

NAVILITE BULKHEADS



UNEXPOSED SURFACE
THERMOCOUPLE LOCATIONS
X: SEE OTHER CHART



START OF TEST
NAVILITE BULKHEADS UNEXPOSED SURFACE TEMPERATURES 8 IN. = 1 HR





