

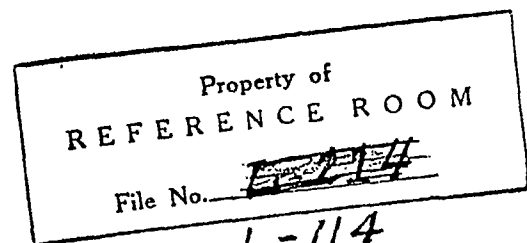
Examination and Test

of

CORRULUX

from

CORRULUX DIVISION OF
Libbey-Owens-Ford Glass Company
Houston, Texas



Laboratory Report
No. 11864
July 1, 1951
Revised March 23, 1953

FACTORY MUTUAL LABORATORIES
UNDER THE DIRECTION OF THE
Associated Factory Mutual Fire
Insurance Companies

184 High Street, Boston 10, Mass.

MEMORANDUM TO CH. DRAFTSMAN
& SQ. LEADERS PREPARED.
G.G. 7-15-55

FACTORY MUTUAL LABORATORIES

UNDER THE DIRECTION OF THE
ASSOCIATED FACTORY MUTUAL FIRE INSURANCE COMPANIES
184 HIGH STREET - BOSTON - MASSACHUSETTS

REPORT NO. 11864
Class No. 4420
EXAMINATION AND TEST OF
Corrulux

DATE July 1, 1951
Revised March 23, 1953

FROM
Corrulux Division of
Libbey-Owens-Ford
Glass Company
Houston, Texas

ABSTRACT

The Corrulux Division of Libbey-Owens-Ford Glass Company has available a corrugated translucent material for use as skylights on buildings sheathed with any of the corrugated roofing and siding products such as aluminum, protected metal, asbestos, etc. The material can be applied without modification of the building framework or method of attachment. Panels of Corrulux are being extensively used as interior and exterior decorations.

Corrulux is a reinforced plastic panel or sheet consisting of thermosetting polyester resins and a fibrous glass mat. The glass mat is impregnated with resins and molded to desired shape. The material is available in several standard colors.

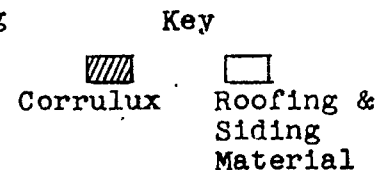
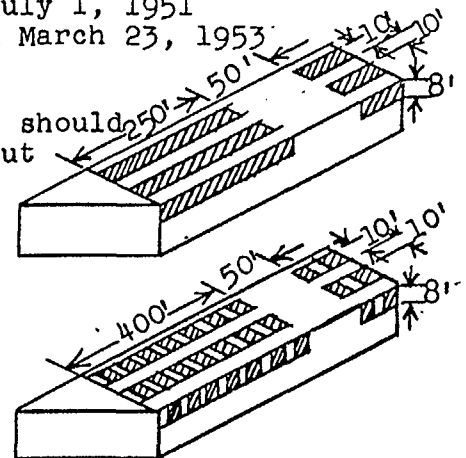
Tests were conducted to determine the fire hazard presented by the use of Corrulux sheets on a building. Corrulux will ignite and burn when exposed to flame impingement or temperatures of about 850° F. The plastic resins are vaporized or distilled from the material, resulting in discoloration of the surface when exposed to temperatures ranging from 500° F. to 800° F. The rate of vaporization increases as the temperature increases with little damage to the material in the 500° F. range.

The installation of corrugated Corrulux for use as lighting panels in a building will not introduce a serious fire hazard when installed in accordance with the following recommendations. These recommendations apply to lighting panels in both the roof and sidewalls of a building.

1. Unlimited areas of Corrulux may be used if the building has sprinkler protection.
2. For occupancies and building construction materials in which sprinklers could normally be omitted -

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- a. The row or band of Corrugulux sheets should not extend more than 250 ft. without a 50 ft. space of the roofing or or siding material being used.
- b. When Corrugulux sheets are used as small panels or intermittent areas instead of continuous rows, a 50 ft. separation of roofing or siding material should be provided every 400 ft.
- c. Adjacent or parallel continuous rows or panels of Corrugulux should be separated by at least 10 ft. of roofing and siding material.
- d. The Corrugulux sidewall panels should be located near the eave line and not more than 8 ft. high.



MATERIAL

Corrugulux is a translucent, reinforced, corrugated plastic sheet consisting of thermo-setting polyester resins and a fibrous glass mat. The glass mat is obtained from the Owens-Corning Fiberglas Corporation in a roll form and weighs about 2 ounces per sq. ft. The glass mat is impregnated with resins and molded to desired shape. The finished plastic sheet is manufactured in different sizes and corrugations so as to match the corrugations of siding and roofing materials available on the market. Corrugulux can be used on standard purlin spacings up to five (5) feet without additional framing members. The six standard colors available are coral, skylight green, light ivory, sky blue, sunlight yellow and forest green.

The manufacturer states that Corrugulux will not crack, warp, buckle or sag and is resistant to mildew, humidity, rot, salt water all weather elements and most all industrial gases.

The material is not fragile and is reasonably resistant to sharp blows, impact and vibrations.

Corrugulux is available in different widths (26 to 42 inches) and in various lengths up to 12 feet. The material weighs approximately nine (9) ounces per square foot. It is easily cut with hand or power equipment and can be nailed, screwed or bolted to any suitable surface. When Corrugulux is used as a structural panel, such as a skylight, it should be installed in the same manner as the corrugated roofing or siding material with which it is being used.

$$\frac{9.00}{16} = 56 \text{ lbs/sq. ft.} \quad \checkmark 5 \quad 225 \text{ lbs/sq. ft. for 18 ga. galv.}$$

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TEST EQUIPMENT AND PROCEDURE

Large Furnace

Tests were conducted in the large construction material furnace, details of which are shown on Appendix Sheet 11. Five feet of noncombustible wall and roof not shown on the sketch have been added to the burner end of the furnace. The open side of the furnace was covered with an insulating noncombustible wall material. The top was covered with alternate sheets of corrugated iron and a combination of corrugated iron and Corrulux supported by steel framework. See Appendix Sheet 1 for details of the installation. The Corrulux sheets were 27-1/2 inches wide and 5 feet long with sides lapped 1-1/2 corrugations. The ends lap on the Corrulux were 6 inches leaving 4 feet exposed to furnace temperatures. The corrugated iron sheets were 22 gage, 27-1/2 inches wide and about 7 feet long. The end laps of the Corrulux and corrugated iron were sealed with a vinyl type mastic manufactured by Armstrong Cork Company.

The exposing fire in the furnace was produced by four gun type, six gallon per hour oil burning nozzles operating at 100 lbs. pressure. Additional air for combustion of the test material was provided by means of an auxiliary blower and duct system. Flames from the burners impinged on the under side of the first sheet of Corrulux.

Temperature of the air film on the under side of the sheets within the furnace were recorded by a system of thermocouples located as shown on Appendix Sheet 2. A check test was conducted on the large furnace and comparable results were obtained.

Brand Test

In addition to the large furnace tests, the Corrulux sheets were subjected to a burning brand test to determine the ignition time and extent of flame spread from a fire exposure on the outside of a building roof. The sheets were inclined with a minimum pitch of 3 inches in 12 and subjected to a burning brand about 12 inches square, consisting of 36 pieces of 7/8 inch square soft pine wood in 3 layers. The brand was ignited and permitted to burn vigorously before being placed on the Corrulux sheet.

Oven Tests

Several small strips of Corrulux about 1-3/4 inches x 5 inches long were exposed for 15 minutes to furnace temperatures ranging from 550° F. to 850° F. The strips were mounted on a metal rack in the oven. In these tests, the oven was adjusted to a specified constant temperature and the test strips inserted.

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Observations were made throughout a 15 minute period noting changes in physical appearances, emission of vapors and other data.

The log of the various tests are attached in the Appendix. See Appendix Sheets 2 and 3 for thermocouple locations and air film temperatures under the roof during the large furnace test. Photographs of the exposed and unexposed surface of the Corrugulux taken before and after the furnace test are shown in Appendix Sheets 4 and 5.

REMARKS

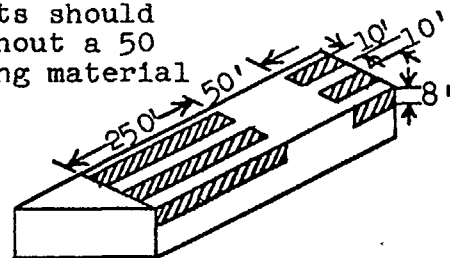
Corrugulux will ignite and burn when exposed to flame impingement or a temperature of 850-900° F. or more. At lower temperatures 500° F. - 800° F. the plastic resins are vaporized or distilled from the material resulting in discoloration of the surface.

The glass fiber mat in the material prevents the transfer or spread of flames from one side of the sheet to the opposite side when supported on all four sides. Corrugulux is readily ignited by flame impingement, however, the flame spread is very slow except when exposed to temperatures of 800° F. and over.

CONCLUSIONS

The installation of corrugated Corrugulux for use as lighting panels in a building will not introduce a serious fire hazard when installed in accordance with the following recommendations. These recommendations apply to lighting panels in both the roof and sidewalls of a building.

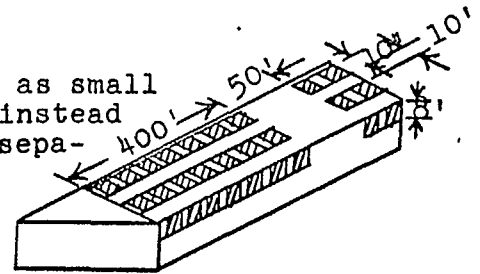
1. Unlimited areas of Corrugulux may be used if the building has sprinkler protection.
2. For occupancies and building construction materials in which sprinklers could normally be omitted -
 - a. The row or band of Corrugulux sheets should not extend more than 250 ft. without a 50 ft. space of the roofing or siding material being used.



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- b. When Corrugulux sheets are used as small panels or intermittent areas instead of continuous rows, a 50 ft. separation of roofing or siding material should be provided every 400 ft.



- c. Adjacent or parallel continuous rows or panels of Corrugulux should be separated by at least 10 ft. of roofing and siding material.

- d. The Corrugulux sidewall panels should be located near the eave line and not more than 8 ft. high.

Key
 Corrugulux Roofing
& Siding
Material

FACTORY MUTUAL LABORATORIES

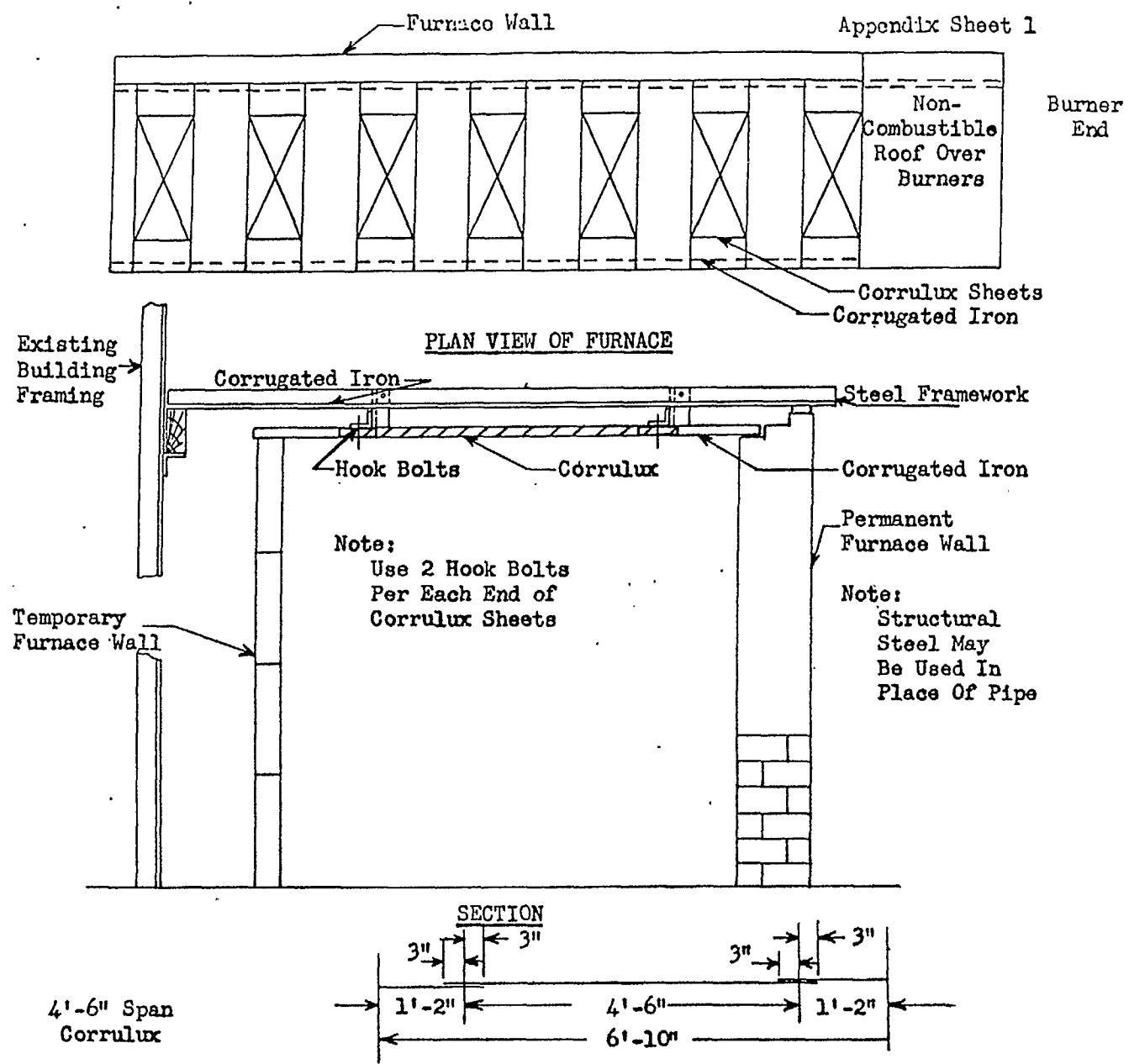
Norman J. Thompson
Norman J. Thompson,
Director

WRL:RJ-275

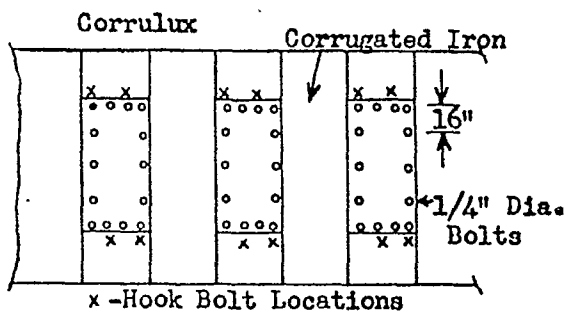
TESTS & REPORT BY: W. R. Lucas, Engr.
R. C. Corson, Engr.

ATTACHED: Appendix Sheets 1 - 11

USHO 002841



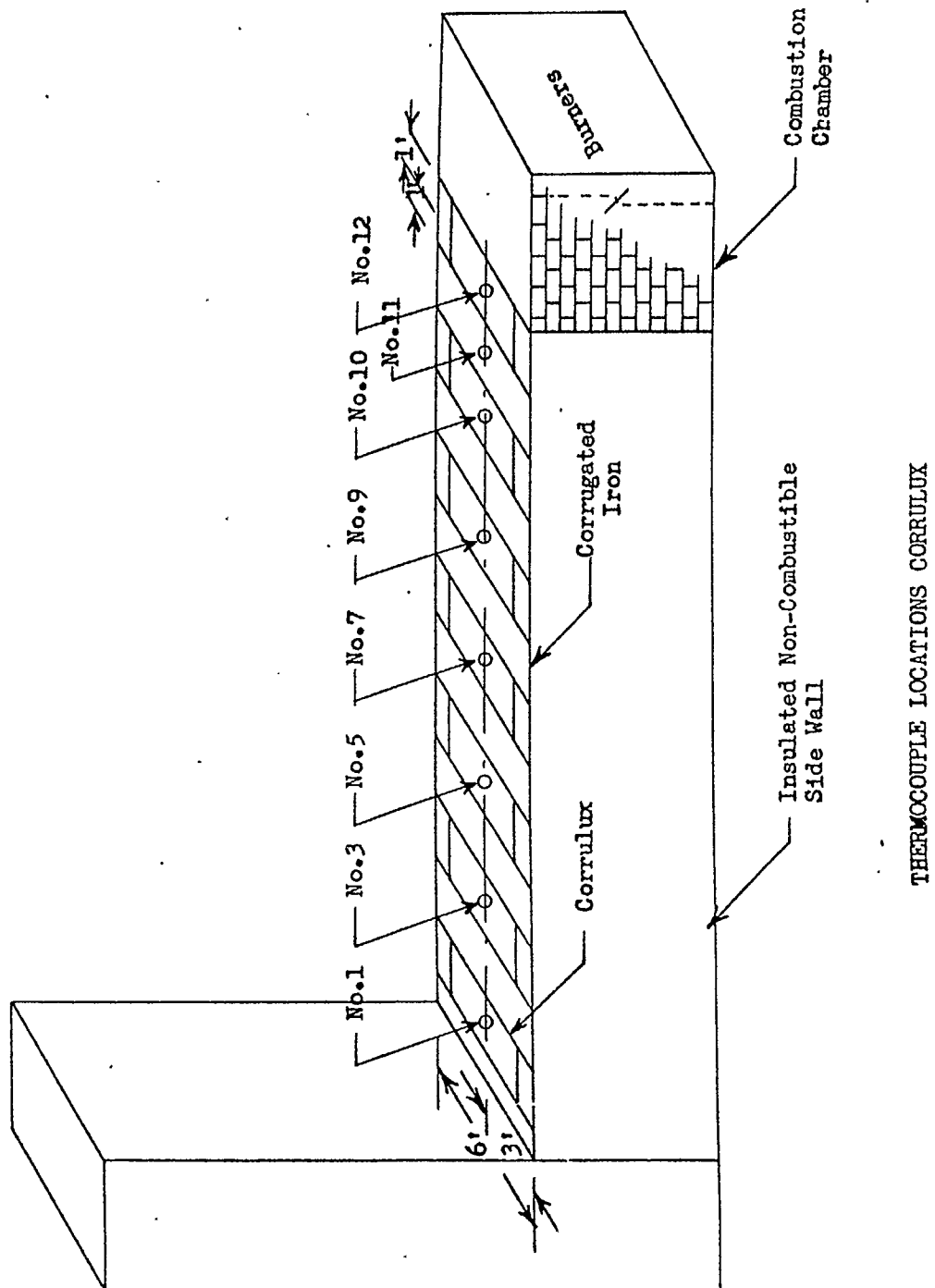
COMBINATION CORRULUX & CORRUGATED IRON SHEETS DETAIL



BOLT SPACING

TEST SET-UP

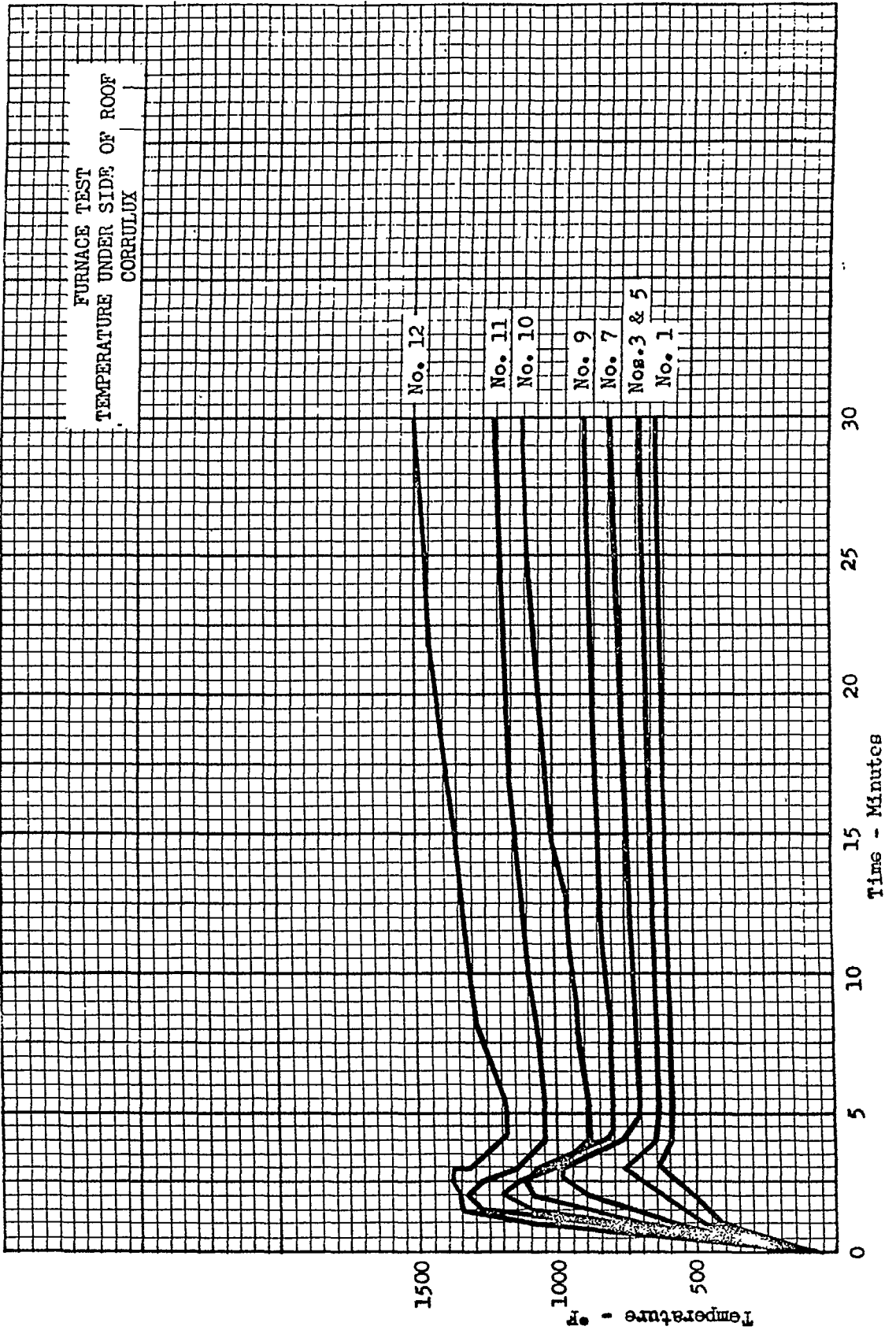
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USHO 002843

184 HIGH STREET BOSTON MASS

ASSOCIATED FACTORY MUTUAL FIRE INSURANCE COMPANIES



FACTORY MUTUAL LABORATORIES
Boston, Mass.

Report No. 11864
July 1, 1951

USHO 002844

LOG OF TESTS

FURNACE TEST

Alternate sheets of Corrulux and Corrugated Iron. Exposure 4 burners. (Nos. 2, 4, 6 & 9).

The first sheet of Corrulux started to sag or buckle at 30 seconds and ignited at 1 minute. Flames spread rapidly to the second sheet of Corrulux and extended in a narrow path about 1 ft. wide, 15 ft. down the furnace at 1 minute 40 seconds; 20 ft. at 2 minutes, 30 seconds; and receded back to 15 ft. at 3 minutes. Active flaming on the under surface was out at 3 minutes and 30 seconds. Examination of the exposed surface after the test indicated that only the first two sheets of Corrulux were actually ignited. The flames observed in the furnace apparently were volatile gases distilled from the first two sheets.

Exposed Surface

The Corrulux sheets in the burner end of the furnace were discolored by the active flaming and at 7-1/2 minutes the plastic resins were completely destroyed in the first sheet as the fiberglass mat was white in color. As the test progressed, the discoloration of the plastic resins in the various sheets gradually became less pronounced toward the flue end of the furnace. After 30 minutes of exposure time, discoloration had extended to the 4th sheet with partial discoloration on the remaining sheets.

Outside Surface

The discoloration on the outside of the Corrulux sheets was somewhat slower than on the exposed surface. No visual damage was noted at 6 minutes. However, at 8 minutes, the first sheet was black in color and the discoloration became less pronounced toward the flue end of the furnace, extending to the 4th sheet when the test ended.

Examination of Material After the TestOutside Surface

First Sheet: Plastic resins were almost completely consumed with fiberglass mat left intact. Fiberglass mat still retains the corrugated shape but was being supported in place at the sides and ends by the corrugated iron. Fiberglass is black in color with white streaks in the low corrugations.

Second Sheet: Practically all of the plastic resins have been burned or distilled out of Fiberglass mat. Individual fibers in mat are easily distinguished. Corrugations in the material can be easily crushed with finger pressure. Top of corrugations are dark brown in color while the low portion is black.

Third Sheet: Low corrugation is blackish brown in color while the top is the original green color. Plastic resins have been distilled from low corrugation as individual glass fibers are apparent.

Fourth Sheet: Low corrugation brown in color but top is original color. Strength of sheet has been impaired as sheet is easily deflected.

Fifth Sheet: No discoloration of sheet and very little impairment to structural strength.

Sixth and Seventh Sheets: No damage.

Exposed Surface

First Sheet: Plastic resins have been completely distilled out. Fiberglas mat is white in color indicating the bonding adhesion has been destroyed and Fiberglas is in original wool form.

Second Sheet: Majority of plastic resins burned or distilled out. Individual fibers in glass mat easily identified and white in color. Corrugations easily crushed.

Third Sheet: Plastic resins have been completely distilled out in portion of low corrugation facing the burners. Portion of low corrugation facing the flue end of the furnace is brown in color and Fiberglas still covered with plastic resins. Exposed Fiberglas is white in color. Strength of sheet impaired.

Fourth Sheet: Exposed side of low corrugation is black in color, some of the plastic resin remains on Fiberglas. Top of corrugation is not damaged and remains original color.

Fifth Sheet: Small black specks or spots covering the side of the low corrugation facing the burners. No damage to top of corrugation.

Sixth and Seventh Sheets: No damage to the material.

A repeat tests was conducted on the large furnace with about the same results except flame spread on the exposed surface covered the entire width of the sheets.

The first sheet of Corrulux ignited after 30 seconds of exposure. Flames had spread 10 ft. down the furnace at 1 minute and 15 ft. at 1 minute and 45 seconds. The path of flames extended across the entire width of the furnace or 6 ft. Flames were 20 ft. down the furnace at 2 minutes and 15 seconds and were still at this location at 2 minutes and 45 seconds. Flames were receding or fading back at 3 minutes and had disappeared at 3 minutes and 30 seconds except for one small isolated area. All flaming on the exposed surface was out at 4 minutes.

The damage to the Corrugulux sheets was about the same as in the previous tests except the 5th, 6th and 7th sheets were discolored more in the repeat test than in the first test.

BRAND TESTS

One sheet of Corrugulux (4 ft. x 2 ft. in size) attached on 4 sides to corrugated iron was inclined with a slope of 3 inches in 12 and subjected to a burning brand. The brand consisted of a grid 12 inches square and about 3 inches thick, made of thirty-six 12 inch long strips of nominal 1 inch square (dressed to 25/32 in.) kiln-dried, non-resinous pine. The strips were placed in three layers of 12 strips each spaced about 1/4 inch apart.

The brand was preburned over a pan of alcohol for 2-1/2 minutes and placed on the Corrugulux sheet. Vigorous burning of the brand had not been established so it was immediately removed and preburned for an additional 2-1/2 minutes making 5 minutes total preburn. The Corrugulux was ignited after the brand had been placed on the sheet one minute. Flames very slowly spread up the sheet from the brand and finally involved the entire sheet. Nine minutes were required for the flames to travel about 35 inches with no lateral spread. The burning rate and flame spread was very slow and could have been easily extinguished with first-aid equipment at any time. The brand was entirely consumed after 22 minutes and flames had extended over the entire area of the Corrugulux sheet.

Examination of the sheet after the flames had faded out showed that the glass fibers were exposed in an area under the brand while the rest of the sheet was merely discolored having turned a brownish color.

Tests with smaller brands in general gave similar results except the flames spread more slowly and area of total flame spread was smaller.

SMALL STRIP TESTS IN FURNACE

Strips of Corrugulux 1-3/4 in. x 5 in. in size subjected to various constant furnace temperatures. The following is a tabulation of test results.

Test 1 - Oven Temperature 500° F.

<u>Exposure Time - Min.</u>	<u>Observation</u>
1	no change
5	slight vaporization, no color change in specimen
10	vapors coming off at increasing rate and specimen slightly discolored around edges.
15	vapors coming off at moderate rate, specimen showing evidence of scorching.

A 1/8 in. x 1 in. long test flame was inserted in the oven and produced flashing of vapors. There was no continued burning and when sample was removed, its color was noted to have changed to a yellow-green but was apparently not otherwise affected.

Test 2 - Oven Temperature 550°F.

<u>Exposure Time - Min.</u>	<u>Observation</u>
1	no change
3	slight vaporization, no color change.
5	vaporizing more rapidly, some discoloration (yellow-green cast).
10	little change from previous observation.
15	vapors coming off moderately, specimen discolored to a light brown color.

Remove sample at 15 minutes, specimen was pliable and showed definite scorching.

Test 3 - Oven Temperature 650°F.

<u>Exposure Time - Min.</u>	<u>Observation</u>
1	rapid vaporization
2	continued rapid vaporization, specimen darkening.
5	continued rapid vaporization, continued scorching of specimen.
10	vapors still coming off rapidly, specimen began to sag and turned to a greenish-brown color.
15	continued rapid vaporization, specimen turning dark brown.

Inserted test flame at 15 minute exposure and immediately ignited vapors. Flames flashed over the entire surface.

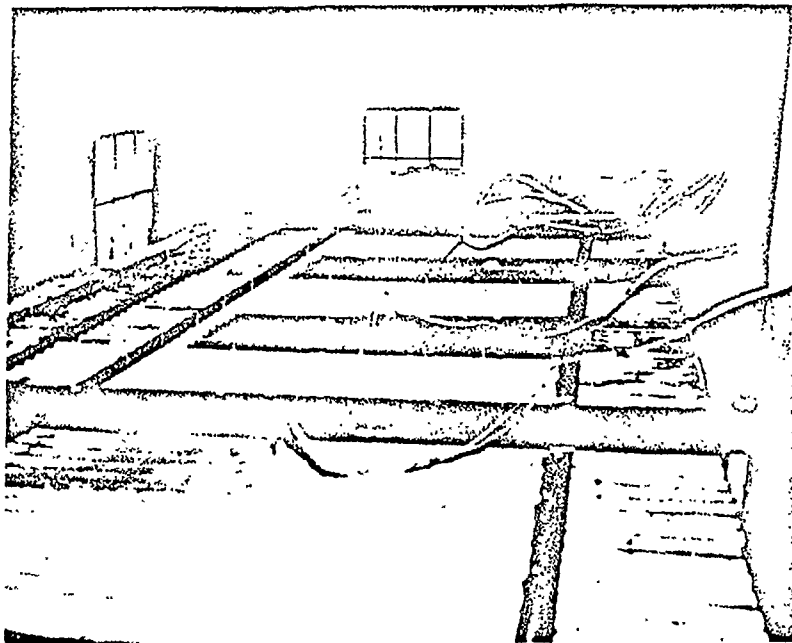
Test 4 - Oven Temperature 750° F.Exposure Time - Min.Observation

1/2	rapid vaporization took place almost immediately.
1	continued rapid vaporization, specimen softening and changing color.
2	extremely rapid vaporization, specimen sagging and scorching rapidly.
3	exothermic reaction taking place as indicated by an increase of vapor temperature to 790° F.
5	vapor temperature constant at 790° F. specimen dark brown in color.
7	specimen had softened and dropped away from metal rack.
10	vaporization decreasing and specimen charring.
15	specimen disintegrated.

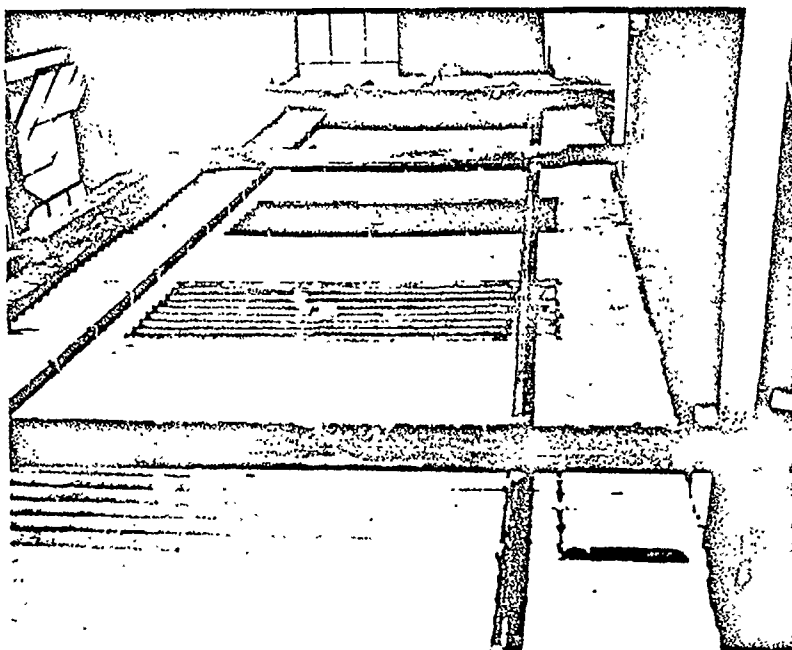
Specimen removed from oven at 15 minutes exposure and found to be completely charred. Little left of the binder and glass wool filler was very brittle and crumbled when cooled.

Test 5 - Oven Temperature 850° F.Exposure Time - Min.Observations

1/2	rapid vaporization, specimen scorching and softening.
1	vaporizing freely.
1-1/4	vapors ignited spontaneously and flames completely consumed the combustible portion of specimen.



Test Set-Up Showing
Unexposed Surface of Corrugulux

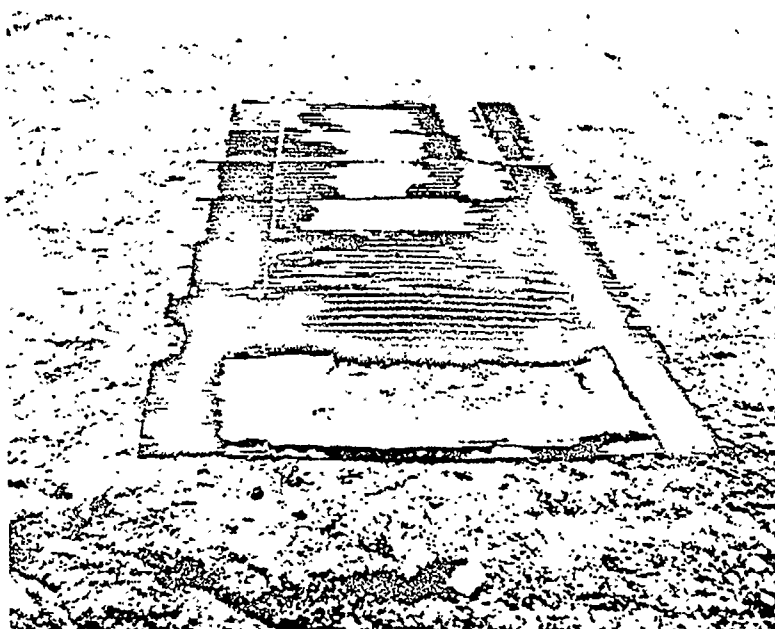


Unexposed Surface of Corrugulux
After Furnace Test

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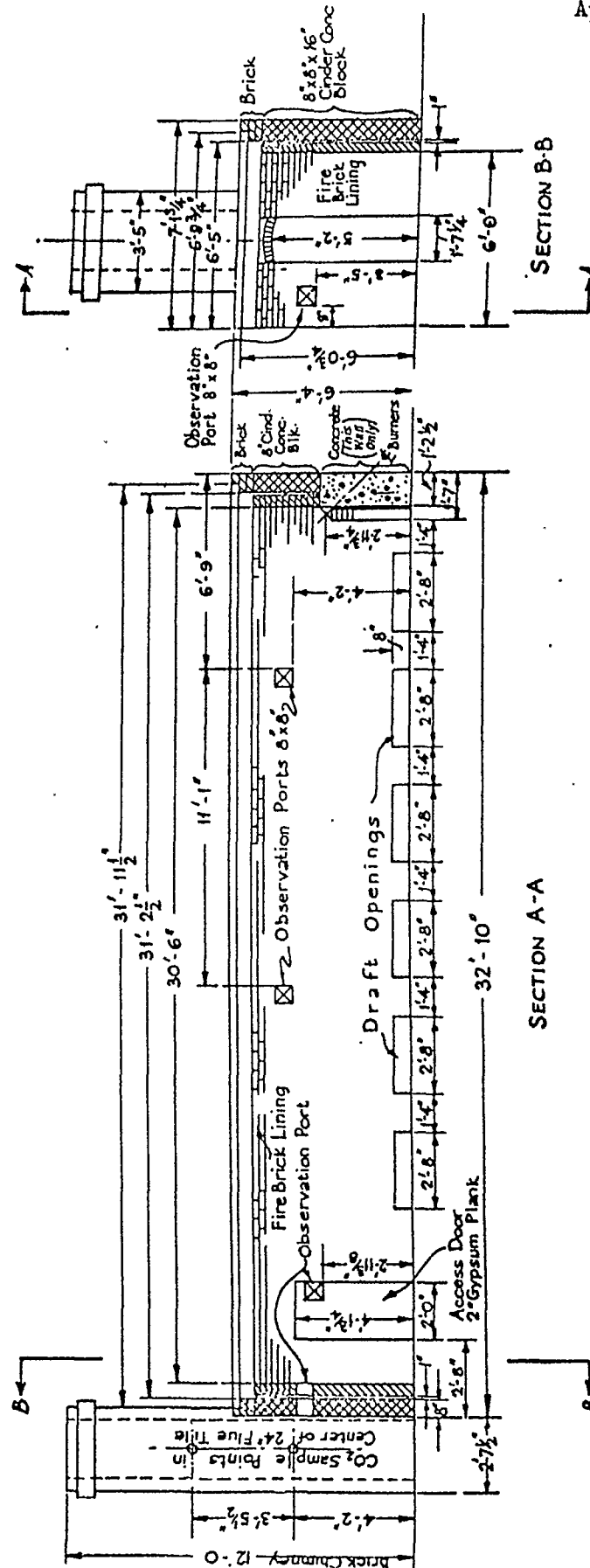


Unexposed Surface of First
Sheet of Corrugulux (Near Burners)
After Furnace Test



Exposed Surface of Corrugulux
Sheets After Furnace Test

USHO 002851



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Boston, Mass.

USHQ 002852

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