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FINAL REPORT

STUDIES TO EVALUATE HEAT-TRANSFER COEFFICIENTS OF INSULATED PANELS, II

By

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This report covers the work done under Project 2017, Heat-Transfer Coefficients of Insulated Panels, sponsored by Giffels and Vallet, Inc. and the following manufacturers of insulated panels:

2017-1 George Koch Sons, Inc.
Evansville, Indiana

2017-2 Pullman-Standard Car Manufacturing Company
Chicago, Illinois

2017-3 Steelcraft Manufacturing Company
Rossmoyne, Ohio

2017-4 R. C. Mahon Company
Detroit, Michigan.

The object of the work was to evaluate the overall heat-transmission rate through closed structures of insulated panels of different design. For each type of panel, a unit approximately 4 ft by 4 ft by 8 ft was assembled, the inside air temperature raised to about 150°F with an electric heater, and room air temperature maintained at about 80°F. After equilibrium conditions were attained, the steady-state temperatures were recorded and the rate of energy input measured. From these test data, the following results were computed, based on the inside area of the structure:

Manufacturer and Panel Designation	Overall Transmission Rate, Btu/(hr)(sq ft)(°F)
George Koch Sons, Inc.	0.15
Pullman-Standard Car Manufacturing Company	
Type "B"	0.24
Type "C"	0.19
Modified Type "C"	0.17
Steelcraft Manufacturing Company	
Standard, 16-inch coverage	0.20
Standard, 24-inch coverage	0.18
Plastic connectors, 24-inch coverage	0.14
R. C. Mahon Company	0.17

DESCRIPTION OF PANELS AND ASSEMBLIES

All the panels were made of metal facings enclosing 3 inches of Fiberglas insulation. The details of the structure and the panels were specified by Giffels and Vallet, Inc. All the units were erected on a wood and steel support in the test room by the manufacturer or under his supervision. Conduction to the support was minimized by having only edge contact with steel angles. The actual inside dimensions of the assembled structures were measured, and are included as Table I.

A brief description of the panels of each manufacturer follows.

George Koch Sons, Inc.

The structure had sides, top, and bottom made up of four panels each, of uneven widths, with a male-female type connection where the panels of any wall were joined together. The ends were a single large panel. The panel was held together at the jointure, where the inside and outside faces were crimped onto perforated sheet-metal channels. A strip of insulating tape in the crimp between the channel and panel faces eliminated metal-to-metal contact. It was necessary to hand-pack insulation at each jointure. Pictures of the Koch panel structure are included as Fig. 1.

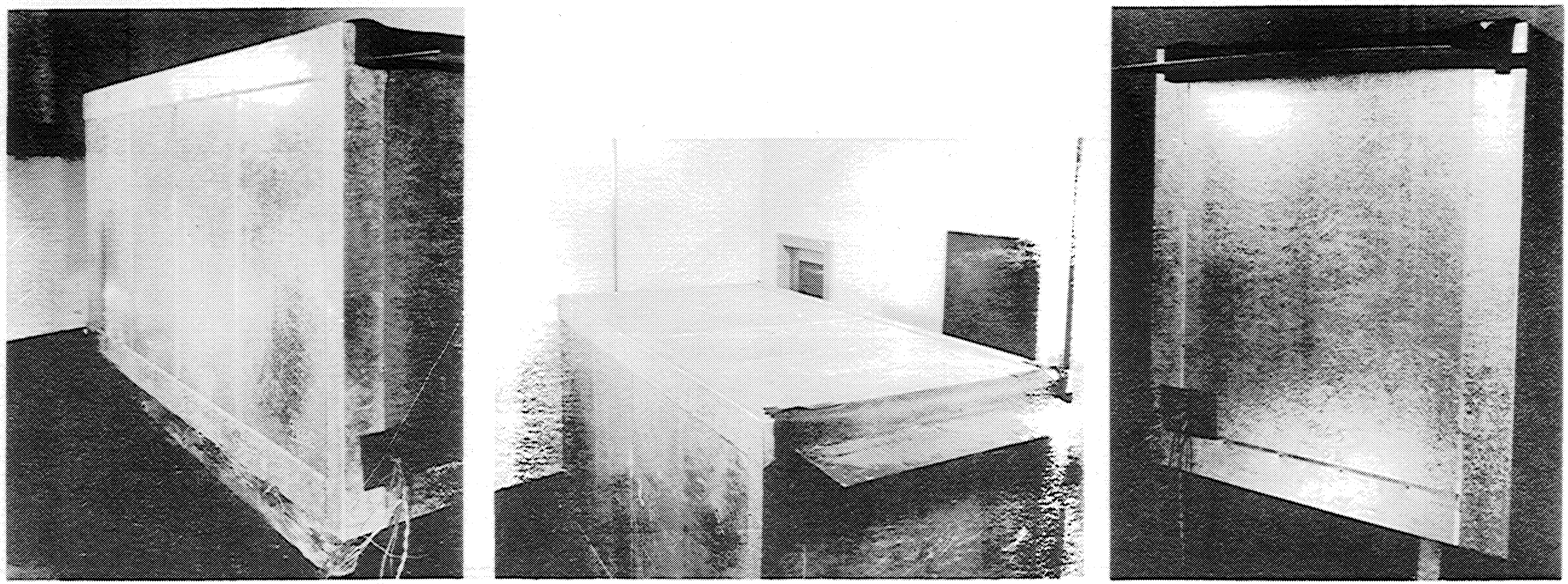

Fig. 1

TABLE I

INSIDE DIMENSIONS AND SURFACE AREAS OF PANEL ASSEMBLIES

Manufacturer and Designation	Length Inches	Width Inches	Height Inches	Area Square Feet
George Koch Sons, Inc.	87.1	40.5	46.8	131.9
Pullman-Standard Car Manufacturing Company				
Type "B"	87.0	40.6	46.4	131.3
Type "C"	87.1	40.6	46.4	131.4
Modified Type "C"	89.8	42.7	46.5	138.8
Steelcraft Manufacturing Company				
Standard-16 inch coverage	86.8	40.6	46.6	131.4
Standard-24 inch coverage	87.1	40.7	46.6	132.0
Plastic connectors-24 inch coverage	86.9	40.7	46.7	131.9
R. C. Mahon Company	87.1	40.6	46.7	131.9

Pullman-Standard Car Manufacturing Company

On all types, the sides, top, and bottom were each made of three 24-inch-wide panels and one narrower panel to make the structure the specified size. The ends had two panels each. The panel-to-panel jointure was of an interlocking "S" shape with a strip of insulating tape between the panels. The end closures were solid sheet-metal channels on the type "B" and type "C", but there were large holes in the type "C" modified to minimize the through-metal effects. The type "C" modified structure was somewhat larger than the others because the edge and corner arrangement was changed, moving the end closures away from the flashing to decrease the heat flow at the edges.

The "S" jointure of the type "B" panel was formed as a part of the faces, so that there was direct metal-to-metal contact from inside to outside. On the type "C", this contact was broken with a portion of the "S" joint being made of a formed plastic strip riveted into place. In the modified type "C" unit, the thickness of the felt tape at the jointure was increased to 1/8 inch to prevent the rivets from cutting through. Figure 2 shows pictures of the Pullman structure.

Steelcraft Manufacturing Company

These panels were different in construction from those of other manufacturers, because the inside and outside metal faces were fastened together at some intermediate point, rather than at the panel edges. In the case of the standard 16-inch and 24-inch panels, the connector was a perforated metal channel spot-welded into place through an insulating tape. In the case of the special 24-inch panel, these channels had one leg of formed plastic which was riveted to the other leg of the channel and the metal face.

Each of the structure walls was made up of standard-width panels (16-inch or 24-inch) and one nonstandard width to meet the specified structure dimensions. At the jointure of one panel to another, the inside and outside faces were separately mated with a male-female joint so that there was no through metal. Figure 3 is a picture of a typical steelcraft structure.

R. C. Mahon Company

The inside and outside panel faces were fastened together at the jointures by crimping and spot welding onto sheet-metal channels with some of the through metal cut away. A typical male-female joint was used to join the panels of any wall together. The end closures were also of perforated

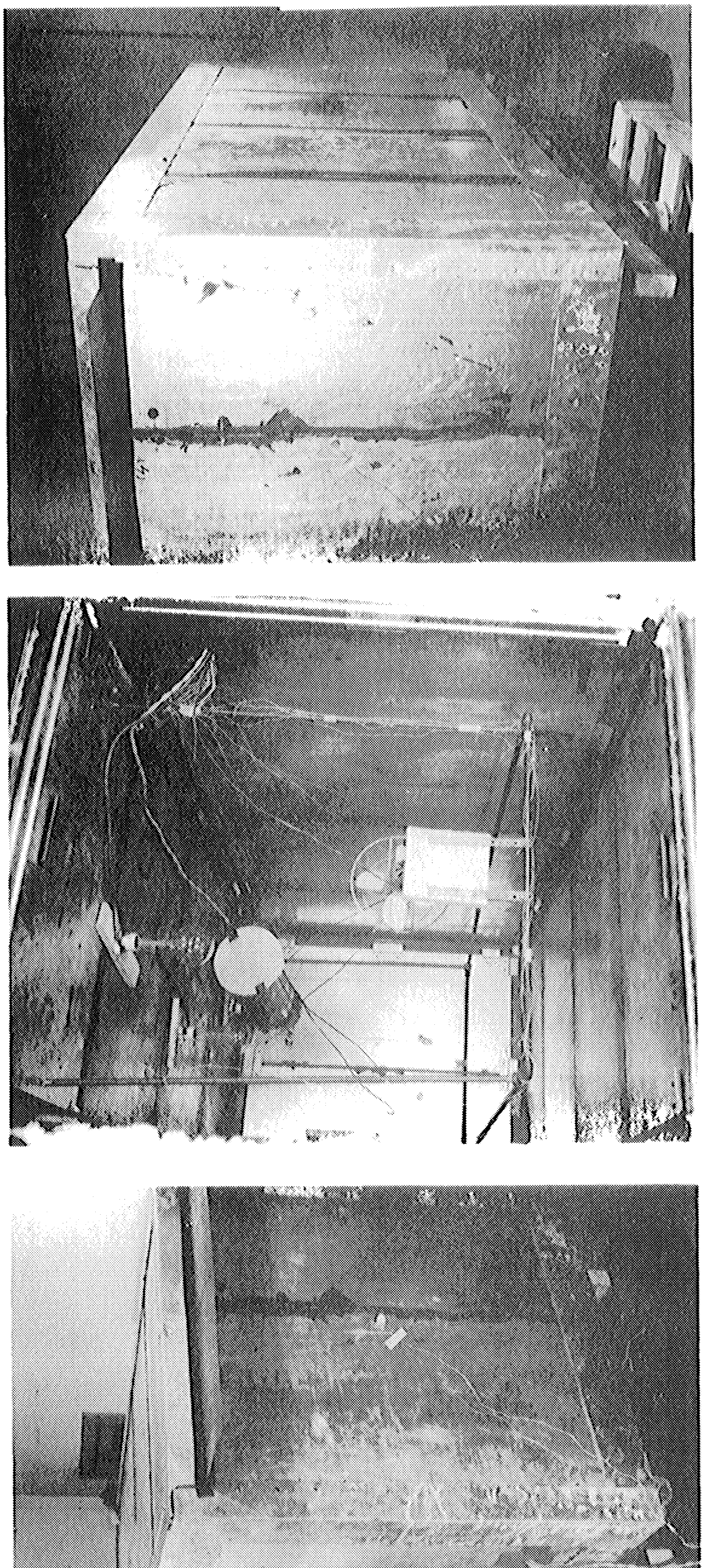

Fig. 2

Fig. 3

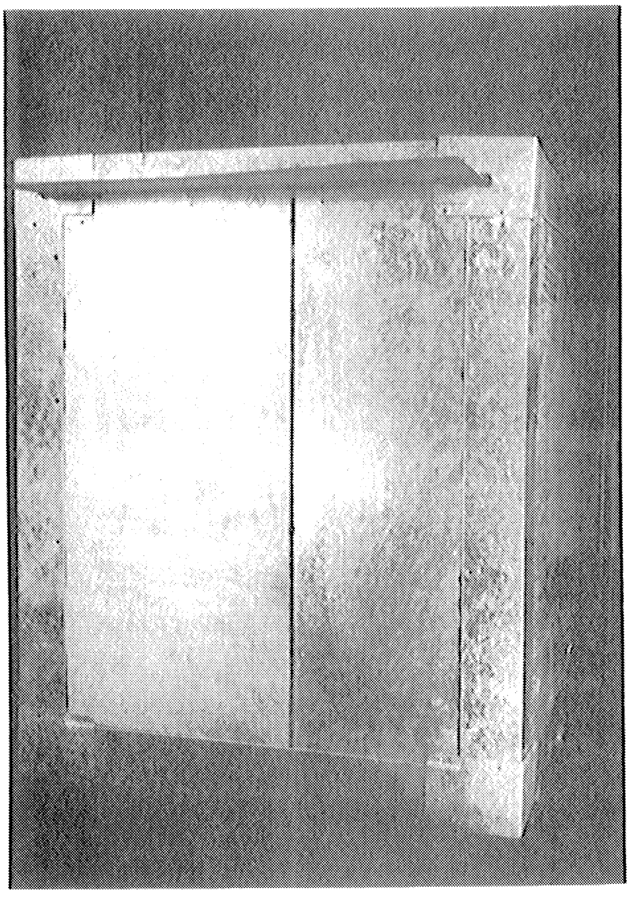

Fig. 4

metal channels spot-welded into place through a conductive rubber tape. The welding at the jointures was through this same tape. Two panels were used at each end. The picture of the Mahon structure is shown as Fig. 4.

INSTRUMENTATION AND EQUIPMENT

Instrumentation and equipment are the same as those used in Report of Studies to Evaluate Heat-Transfer Coefficients of Insulated Panels I, Project M905.

PROCEDURE

The procedure followed is also described in the report on Project M905.

RESULTS

The following table is a summary of the principal results used to calculate the overall coefficient of heat transfer:

Manufacturer and Designation	Energy Input, Btu/hr	Inside Air Temp, °F	Room Air Temp, °F	Inside Area, Sq ft	U, Btu / (hr)(sq ft)(°F)
Geo. Koch Sons, Inc.					
	1,358.4	147.3	78.8	131.9	0.15
Pullman-Standard Car Manufacturing Company					
Type "B" -	2,000.0	148.1	84.2	131.3	0.24
Type "C" -	1,761.1	159.6	87.6	131.4	0.19
Mod.Type "C" -	1,711.6	152.5	80.7	138.8	0.17
Steelcraft Manufacturing Company					
Stand-16-in. cov	1,843.0	155.1	85.2	131.4	0.20
Stand-24-in. cov	1,628.0	143.0	78.4	132.0	0.18
Plastic connectors 24-inch	1,150.2	155.6	91.8	131.9	0.14
R. C. Mahon Company					
	1,546.1	147.4	78.4	131.9	0.17

The coefficient of heat transfer was calculated from the equation

$$U = \frac{q}{A\Delta t} \quad ;$$

where

q = energy input, btu/hr;
U = heat-transfer coefficient, Btu/(hr)(sq ft)(°F);
A = inside area, sq ft; and
Δt = temperature difference, °F

DISCUSSION OF RESULTS

The heat-transfer coefficients evaluated in this study are overall coefficients for a particular structure, and include a measure of the thermal properties of the corners, edges, and closures as well as those of the insulated panel. The results provide a valid comparison of panels of different manufacture, but they cannot be used as a general coefficient for wall sections.

Of the panels submitted, there were only two which met the specification of an overall coefficient of 0.17 Btu/(hr)(sq ft)(°F) without using a nonmetallic connector between the metal faces. The panels of George Koch Sons, Inc. were of a standard construction used for oven service, and had an overall coefficient of 0.15 Btu/(hr)(sq ft)(°F). The panels of the R. C. Mahon Company had a coefficient of 0.17 Btu/(hr)(sq ft)(°F), and also used no nonmetallic connectors except for a tape, of questionable value, in the spot-welded joints.

The initial tests on the Pullman-Standard panel structure type "C" indicated a coefficient of 0.19 Btu/(hr)(sq ft)(°F), which was above the specification. The edges of the panels were very close to the outside corner flashings, with no intermediate insulation, and a felt tape between the panels was so thin that rivet heads cut through, resulting in good metal-to-metal contact. Enlarging the structure slightly and using a thicker tape eliminated these difficulties and gave a final coefficient of 0.17 Btu/(hr)(sq ft)(°F).

The panels of the Steelcraft Manufacturing Company were somewhat different in construction than the others because the connectors between the metal faces were not at the panel edges. No structural or thermal advantage was apparent from this type of construction.